

ATLAS
of the
LIVING OLIVE SHELLS
of the
WORLD

Edward J. Petuch
&
Dennis M. Sargent

The Coastal Education & Research Foundation, Inc.
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A CERF Book



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We dedicate this work to our wives,
Linda J. Petuch and Sandra H. Sargent,
who patiently tolerated our infatuation
with the genus *Oliva* over so many years.

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1

Introduction

The term "olive shell" is given to any member of the gastropod mollusk (snail) genus *Oliva*, which represents the largest group in the prosobranch (marine snails) family Olividae. This family of large, colorful, and highly polished shells belongs to a larger group of closely related families, the superfamily Volutacea, all of which are popular with shell collectors.

Olive shells occur throughout tropical and subtropical areas; the majority of species prefer sandy locations near coral reefs or along sand beaches. These gastropods are colonial and live together in large groups that often number in the thousands of individuals. Because of their intrinsic beauty and abundance in shallow water, many of the larger, gaudy-colored species from the South Pacific are collected by the tens of thousands and shipped in sacks for the commercial curio trade. Because of their aesthetic appeal and ease of collection, olive shells rank within the top fifteen most popular families amongst shell collectors.

To both marine biologists and shell collectors (conchologists), olive shells are important and interesting animals. They are among the commonest faunal components of shallow water tropical marine ecosystems and are often the dominant animals on sandy-bottomed lagoons. In some regions of the South Pacific, such as the Philippines, Indonesia, and New Guinea, a single sand flat may support over twenty different species of *Oliva*. In other areas of the world, such as Peru, southern Australia, and western Africa, only a single

species of *Oliva* will be present, but in great abundance. Deeper water (100 meters) sandy-bottom areas often support such huge populations of olives that they can be commercially harvested using long-line fishing gear and baited hooks. Some of the rarer deep-water olives have been collected in this manner in the Philippines and Mauritius.

Unfortunately, the ecological and commercial predominance of the olive shells is not reflected in the systematics and taxonomy of the group. Of all the larger volutacean groups, the genus *Oliva* has received the least attention to its phylogenetic structure and interspecific relationships. For example, such obviously different animals as *Oliva porphyria* and *Oliva oliva* were placed together in the same generic grouping without consideration for their evolutionary histories, zoogeographic patterns, or extreme divergence in shell form. The chaotic status of olivid systematics challenged us to conduct a systematic survey of the phylogenetic relationships within the genus. This effort involved arranging morphologically closely-related species into subgeneric groupings. Some of these groups had been described already by previous workers but other new groups are proposed here for the first time. Hopefully, this new taxonomic arrangement and overview of the genus by subgeneric units will permit easier species identifications for many of the more obscure groups. In addition to consideration of shell morphology, we also approach the systematics of the olive shells from a zoogeographic point of view, because most species have distinct geographic distributions. A discussion of the distribution patterns of olive species is given in the Chapter 6.

Attempts to unravel the subtle differences between subgeneric groupings within the genus *Oliva* ultimately focus on details of shell form. The major structural features of olive shells are illustrated in Figure A. Eight criteria may be used to evaluate specific differences within a subgenus (many of the terms used here are defined in the Glossary). No two species will have all eight morphological criteria in common. By combining zoogeographic patterns (see Chapter 6) with aspects of shell form and color, unknown olives may be classified at subgenus and species level.

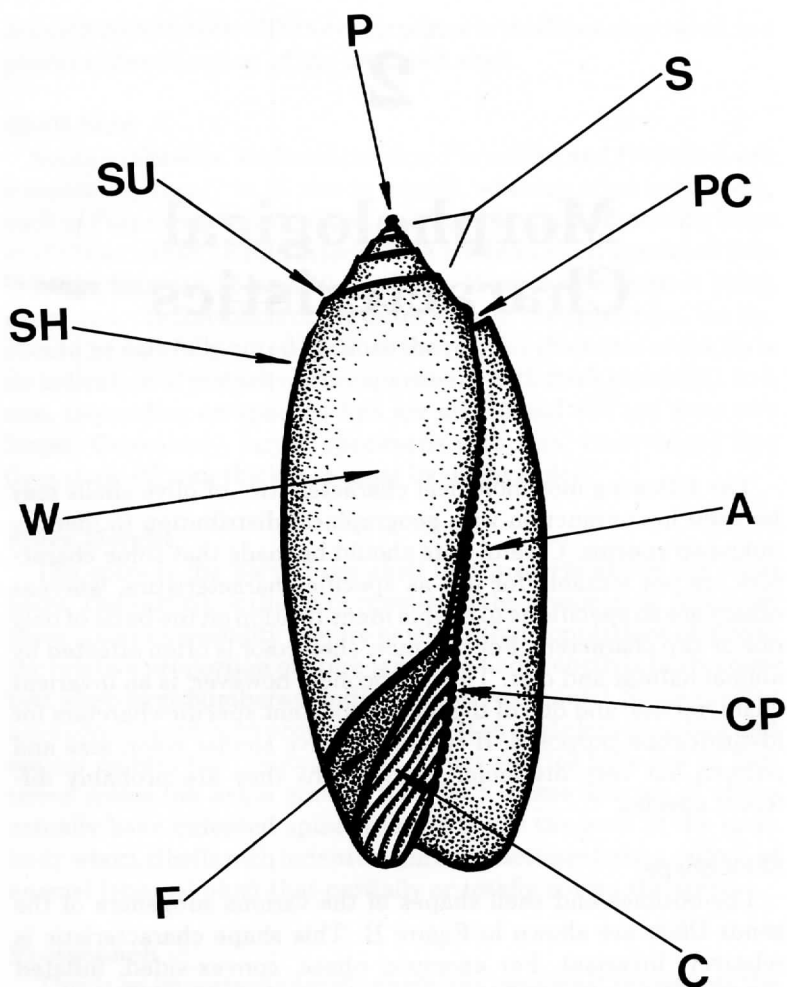


Figure A. Major structural features of a representative olive shell that are used for taxonomic classification in this work (Apertural view of shell). A = Aperture, B = Body Whorl, C = Columella, CP = Columellar Plications (plicae), F = Fasciole, P = Protoconch, PC = Posterior Canal, S = Spire, SH = Shoulder, and SU = Suture.

2

Morphological Characteristics

The following morphological characteristics of olive shells may be used in conjunction with geographical distribution to identify unknown species. Careful note should be made that some characters are not suitable for use as specific characteristics, whereas others are so specific as to enable identification on the basis of only one or two characters. For instance, shell color is often affected by animal habitat and diet. The protoconch, however, is an invariant characteristic and one of the most important specific characters for identification purposes. If two shells have similar color, size and pattern but very dissimilar protoconchs they are probably different species.

Shell Shape

The outlines and shell shapes of the various subgenera of the genus *Oliva* are shown in Figure B. This shape characteristic is relatively invariant. For example, obese, convex-sided, inflated species (Figure B, 5, 15, 18) are consistently inflated throughout their zoogeographical ranges and do not change their general shell shape from one area to another. Slender, straight-sided, elongated species (Figure B, 3, 8, 13) similarly conform to this general observation. Shell shape is the ratio of the shell length to its width. By comparing specimens to the drawings in Figure B, it should be possible to narrow the choices down to the appropriate subgenus. Sub-

sequent comparison with the color plates in this book may result in a positive identification of the unknown shell.

Shell Size

Some subgenera, such as *Acutoliva*, *Parvoliva*, and *Proxoliva*, are consistently tiny (7 to 15 mm in length), whereas other subgenera, such as *Porphyria*, *Miniaceoliva*, and *Viduoliva*, are commonly large shells (more than 75 mm in length). A medium sized specimen falls in range between 25 and 40 mm long. When a specimen is being examined, the thickness of the outer edge of the aperture, the lip, should be carefully noted because the relative thickness of the lip is an indication of maturity. Tiny specimens with thick blunted (1 to 6 mm, depending on species) lips are adults and will not grow any larger. Conversely, larger specimens with thin, razor-edged lips (less than .05 mm thick) are most likely juveniles.

Spire Height

The spire is the part of the shell that projects above the main body. The very tip of the spire consists of the protoconch. Although there is some variability in spire height within populations of olives, the relative proportion of spire length to body length is fairly constant when large numbers of individuals are examined. Some species have consistently high protracted spires (an angle less than 45°) and appear as very tall pointed shells. Other species have low or flattened spires (an angle greater than 90°). Some species of olives actually have indented spires that lie below the level of the main body whorl. Shells with indented spires sometimes have a callous of enamel (enamel plug) that partially or totally covers the spire.

Protoconch

This is an important specific character because it represents the embryonic shell of the olive before it was exposed to the open marine environment. The protoconch is formed within the egg and reflects the genotypic rather than the phenotypic form of the shell. Protoconchs within species are all nearly identical and like all volutaceans, the protoconch is a consistently good character to use in taxonomic studies of olive shells. Some species have very large protoconchs in proportion to the total shell size, while others have

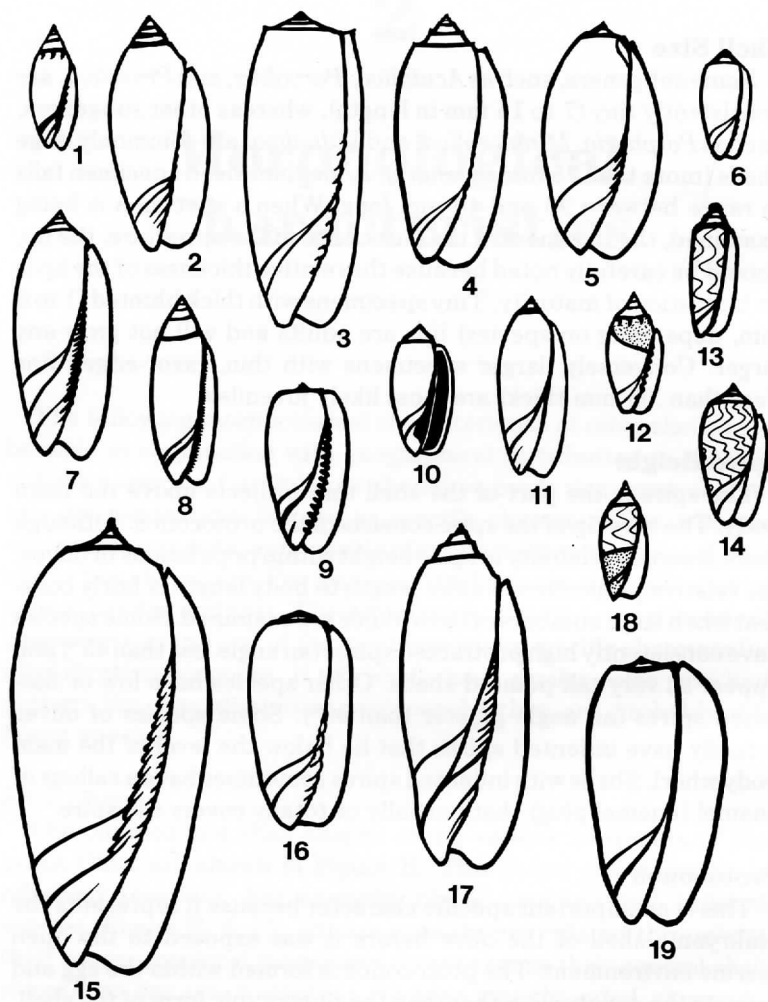


Figure B. Outlines of the Shapes of the Various *Oliva* Subgenera.

Figure B. (Facing page) Outlines of the shapes of the various subgenera of the genus *Oliva*. (1) *Acutoliva* Petuch and Sargent, new subgenus; (2) *Annulatoliva* Petuch and Sargent, new subgenus; (3) *Arctoliva* Petuch and Sargent, new subgenus; (4) *Cariboliva* Petuch and Sargent, new subgenus; (5) *Carmione* Gray, 1858; (6) *Galeola* Gray, 1858; (7) *Miniaceoliva* Petuch and Sargent, new subgenus; (8) *Multiplicoliva* Petuch and Sargent, new subgenus; (9) *Musteloliva* Petuch and Sargent, new subgenus; (10) *Neocylindrus* Fischer, 1883; (11) *Oliva* Bruguiere, 1789; (12) *Omogymna* von Martens, 1897; (13) *Parvoliva* Theile, 1929; (14) *Proxoliva* Petuch and Sargent, new subgenus; (15) *Porphyria* Röding, 1798; (16) *Rufoliva* Petuch and Sargent, new subgenus; (17) *Strephona* Mörch, 1852; (18) *Strephonella* Dall, 1909; (19) *Viduoliva* Petuch and Sargent, new subgenus. When identifying olive shells, first match the outline of the unknown specimen with one of the figures (1-19), then compare the specimen with the members of the appropriate subgenus. The color plates in the book are arranged alphabetically by subgenus, so that they may be used as a synoptic picture key.

tiny protoconchs. The shape also varies from bulbous, to rounded, to cylindrical and pointed, to keeled. Because this is such a specific character, the protoconch should be considered the most important means of differentiating species within genus and subgenus groups.

Aperture Width

The aperture is the actual opening of the ventral surface of the shell and consists of the space between the most recent whorl and the previous one. This slit-like opening is the outside of the shell cavity, which houses the internal organs of the animal, and is another relatively invariant characteristic. For example, some species have wide, flaring apertures while others have extremely narrow straight-sided apertures. This is a good character for subgeneric placement.

Columellar Plications

The plications or plicae consist of rib-like projections of shell on the columella next to the aperture and opposite the lip. They line the body whorl and are the means by which the animal anchors its retractor muscle within the cavity of the shell. Columellar plications differ greatly between species but not between individuals of the

same species. The plications can vary greatly between subgenera, from being extremely numerous as in *Multiplicoliva*, absent as in *Oliva* s.s., or often bifurcated as in *Strephona*.

Color Pattern

For this character, only the general pattern of shell markings should be looked at, e.g. the presence or absence of triangle networks, bands, flammules (amorphous blobs of color, usually elongated), etc. The triangle network is present in almost all groups of olives and cannot, as a general rule, be used to distinguish individual species. All members of the subgenus *Strephona*, for example, have triangle network patterns (the "tent patterns" of some authors) covering the body whorl. Reliance on this single shell pattern has created problems in the identification of Caribbean and Panamic olives because some authors have assigned all triangular-network patterned shells to either *Oliva reticularis* or *Oliva spicata*. The ubiquitousness of triangle-network patterns makes it impossible to use this feature to differentiate species. The size of the triangle markings, however, is often a good specific characteristic as some species consistently have tiny triangles while others have large, open triangles.

Shell Color

Shell color refers to the base color of the shell and some species consistently display the same base color under the color pattern. Base colors, however, are highly variable. Olives come in a large assortment of colors, including lavender, pale green, black and aqua. The most common base colors, however, are white, yellow, cream, tan, pink and buff.

Pigment layers in olive shells are thin and lie beneath the enamel. Olive shell color is usually produced by porphyrin compounds which derive from waste products in the animal's diet. Consequently, populations of the same species dining on radically different food can be differently colored. Thus, color should be used with great care as a specific characteristic. Olives also exhibit melanism and albinism. When looking at unidentified black or white olive specimens, care should be taken to first ascertain that they are not merely a color morph of a more familiar species. In the past many

color morphs were given full specific status. We have attempted to eliminate some of this synonymy and refer to these color varieties as infraspecific "color form" variations.

When identifying unknown olive species, always review these eight shell characteristics. If necessary, they can be listed in tabular form for each species, thus allowing easy comparison between species. Table 1 is an example of tabular comparison, actually a simplified morphometric analysis, for three members of the sub-genus *Strephona*.

Table 1. A comparison between three members of *Strephona*.

Characteristic	<i>Oliva maya</i>	<i>Oliva foxi</i>	<i>Oliva sayana</i>
1. Shell Shape	elongated	elongated	elongated
2. Shell Size	large, 40 mm	small, 25 mm	large, 40 mm
3. Spire Height	low	high	high
4. Aperture Width	narrow	narrow	narrow
5. Columellar Plications	large, simple	large, simple	bifurcated
6. Color Pattern	large triangles	triangles, zig-zags	triangles
7. Shell Color	bright yellow	rose-pink	tan
8. Protoconch	small	large	small

3

Evolutionary History of the Genus *Oliva*

The genus *Oliva* is a fairly recent addition to the superfamily Volutacea, appearing only in the past thirty million years. Although primitive olive-like shells, such as members of the genus *Eoancilla*, have been found in Late Cretaceous deposits in Texas, modern specimens of *Oliva* do not appear in the fossil record until late Eocene and Oligocene time. The earliest members of the Olividae probably evolved from smooth, elongated, Cretaceous volutid genera (i. e. *Myobarbium* or *Ptychosyca*). The oldest known true olive is *Agaronia mississippiensis* Conrad, 1848, found in the Eocene Jackson Formation in Mississippi, Alabama, and Arkansas. Although generally classified as an *Agaronia*, this Eocene species apparently belongs to an undescribed subgenus of *Oliva*. True olives of the subgenus *Strephonella*, as typified by *Oliva (Strephonella) brooksvillensis* (Mansfield, 1937) found in the Suwannee Formation in Florida, became widespread in the Americas during the Oligocene. Throughout the Paleocene, Eocene, and Oligocene, however, genera such as *Ancilla*, *Agaronia*, and *Baryspira* comprised the majority of olivid species found around the world.

An explosive increase in the number of species in the genus *Oliva* took place during Miocene time, about twenty million years ago. At this time large species radiations took place simultaneously in several places around the world, most notably in the southeastern United States and the Indonesian-Malaysian region of the southwestern Pacific. The first American members of the subgenus

Strephona [*O. eborea* Conrad, 1862 and *O. idonea* Conrad, 1839] appear at this time, as does the subgenus *Cariboliva* (as *O. canaliculata* Lea, 1845). In the Indonesian area, the first members of the subgenera *Acutoliva* (*O. djocdjocartae* Martin, 1885), *Rufoliva* (*O. junghuhni* Martin, 1880), and *Carmione* (*O. sondeiana* Martin, 1885) had already evolved, and the olivid fauna was beginning to take on a modern appearance. Most of these species radiations took place in shallow, intertidal waters, and these new olive groups may have ecologically overwhelmed the more primitive *Ancilla* and *Agaronia* olives. The primitive olivid groups retreated to deeper, offshore waters, or to cooler, non-tropical areas, leaving the shallow, tropical waters to the dominance of the genus *Oliva* and other closely related genera (i.e. *Olivella*, *Dactylidia*, and *Jaspidella*).

A second dramatic increase in the number of *Oliva* species took place during middle Pleistocene time, about one million years ago. Again, the two main regions of speciation were the southeastern United States and southwestern Pacific. Over sixty species of olives evolved in southern Florida alone, including the well-known *Oliva* (*Strephona*) *edwardsae* Olsson, 1967 and *Oliva* (*Strephona*) *murielae* Olsson, 1967 from the Bremont Formation. Numerous closely-related species also evolved at this time in the Caribbean region. A secondary species radiation was also taking place in the then isolated Gulf of California (Mexico), producing a large complex of taxa. One of these, *Oliva* (*Strephona*) *davisae* Durham, 1950, is still living in deep water in the Sea of Cortez region.

One possible mechanism for these Pleistocene speciation events was the radical changes in relative sea level caused by glacial advance and retreat. The associated alterations in oceanic area, temperature, and chemistry over relatively brief spans of time (thousands rather than millions of years) could have accelerated the rate of species differentiation which continues into Recent time, providing today's myriad of species, subspecies, and related forms.

4

Ecology of the Genus *Oliva*

Without exception, all members of the genus *Oliva* are physiologically stenohaline, requiring normal oceanic salinity conditions approximating 35‰. Because of their extreme stenohalinity, there are no known brackish water species. In 1981, high water levels in Lake Okeechobee necessitated a release of surplus water into the semi-enclosed St. Lucie Inlet-Indian River area (southeastern Florida). The sudden flood of fresh water greatly reduced the normal oceanic salinity and resulted in the death of the entire population of *O. (Strephona) sayana*. This complete mortality demonstrates the catastrophic effect of reduced salinity on members of this genus.

The majority of the genus is also stenothermal, and consequently, confined to tropical and sub-tropical oceans around the world. A few species, however, (i.e. *O. (Strephona) sayana* and *O. (Acutoliva) australis*) do range into temperate waters adjacent to sub-tropical provinces, but these are exceptions. Most of the deep-water olives live in cooler water conditions. These species evolved from shallow-water, tropical forms that moved into offshore waters and adapted to colder water temperatures. Only one shallow-water species, *O. (Strephona) peruviana*, is truly cold-temperate in its distribution. This unusual olive lives in waters influenced by the frigid Humbolt Current off the coast of western South America. There are no known subarctic or boreal *Oliva* species.

In addition to being stenohaline and stenothermal, the genus

Oliva is also stenotopic. The genus is only able to live on soft, muddy or sandy substrates, into which they burrow. Typical of volutaceans, the olives are well adapted for a burrowing lifestyle. A large, voluminous foot and frontal plow-shaped tissue extension (the propodium) enable the animal to move about freely through benthic sediments, rather like submarine moles.

Although universally preferring soft substrates, some *Oliva* species often prefer different types of sediments. For instance, *O. (Strephona) sayana* and *O. (Strephona) graphica* live in quartz sand areas along continental margins, while *O. (Strephona) maya* live in fine, carbonate sediments associated with coral reefs. Some species [i.e. *O. (Carmione) funebris*, *O. (Carmione) lecoquiana*, and *O. (Proxoliva) athenia*] prefer muddy, organic-rich intertidal sand flats abutting continental islands, while others [i.e. *O. (Rufoliva) baileyi*, *O. (Parvoliva) dubia*, and *O. (Acutoliva) bathyalis*] are found only on organic-rich muds in deep water adjacent to continental islands. A few species can tolerate a variety of substrate types, and often the color of the substrate is reflected in the shell color. Populations of *O. (Omogymna) sandwichensis* and *O. (Strephona) reticularis* living on black lava sand have dark-colored shells while populations of the same species living on white coral sand have light-colored shells.

All *Oliva* species are carnivorous, as is the entire Volutacea superfamily. They prefer live food and even share "kills" with other members of the colony. Olives spend most of their time buried under the substrate with only their siphons extending above the surface. When prey is sensed they are capable of emerging rapidly from the sand to quickly enclose the victim in a pouch created by folding their foot around the morsel. Within this pouch the live food is smothered in a coating of mucous. When dead, the food item is released from the pouch and the olive feeds by rasping bits of flesh with its radula. The radula, a ribbon of sharp teeth, is encased in a flexible proboscis that is extended for feeding and retracted when the animal is disturbed.

Although olives prefer live food, they will also take carrion. Ziegler and Porreca (1969) report that collectors sometimes entice buried olives to the surface with a variety of bait, including tulip shells, crabs, fish, sea urchins, beef, shrimp, and chicken. According to Olsson and Crovo (1968), *O. (Strephona) sayana* greatly pre-

fer small, smooth-shelled bivalve prey (*i.e.* *Donax*, *Laevicardium*, *Tellina*, and *Mulinia*). These bivalves may represent the normal prey regime of all olives.

5

The Systematic Arrangement of the Olividae

The volutacean family Olividae comprises three subfamilies, the Olivinae, the Olivellinae, and the Ancillinae. The subject of this book, the genus *Oliva*, is a member of the first subfamily, along with four other closely-related genera (i.e. *Agaronia*, *Anazola*, *Olivancillaria*, and *Utriculina*). The Olivinae, in general, is morphologically conservative, with its members having elongated, cylindrical, or fusiform shells and no operculum (the "trap door" attached to the foot that seals the aperture when the animal is retracted into the shell).

The subfamily Olivellinae encompasses twenty genera, all of which are tiny shells, less than 2.5 cm in length. Unlike the Olivinae, the Olivellinae, with the exception of a few genera such as *Jaspidella* and *Macgintiella*, all have opercula closing off the aperture. The Ancillinae comprises twenty genera, all of which have large, thin, inflated, bubble-like shells with wide apertures. This subfamily represents the most primitive group of the family, closely resembling the ancestral volute-like forms of the Cretaceous. Like the Olivellinae, most genera of the Ancillinae have opercula.

Another group, comprising the genera *Fulmentum*, *Melapium*, *Pseudoliva*, and *Zemira*, was previously considered to represent a fourth subfamily, the Pseudolivinae. Recent studies by Russian, South American, and French workers have shown, however, that

these genera actually belong to the Buccinidae, or whelk family, and appear to be closely related to the buccinid genera *Bullia* and *Cominella*. The genus *Plicoliva*, which was described by the senior author in 1979 and was originally thought to be a member of the Olivinae, is now considered to represent an aberrant *Enaeta*-type volutid group that is restricted to the Abrolhos Archipelago of Brazil. Within a modern systematic arrangement, these latter groups should not be included in the Olividae.

Table 2 shows a listing of the recognized genera of the Olividae, arranged by subfamily and the number of species in each.

Table 2. Genera of the Olividae

Subfamily	Genera	Species
Olivinae	<i>Agaronia</i> Gray, 1839	10
	<i>Anazola</i> Gray, 1858	7
	<i>Oliva</i> Bruguiere, 1789 (19 subgenera)	176
	<i>Olivancillaria</i> Orbigny, 1840	11
	<i>Utriculina</i> Gray, 1847	5
Olivellinae	<i>Belloлива</i> Peile, 1922	8
	<i>Callianax</i> H. and A. Adams, 1853	2
	<i>Cupidoliva</i> Iredale, 1924	3
	<i>Dactylidella</i> Woodring, 1928	12
	<i>Gemmoliva</i> Iredale, 1924	3
	<i>Jaspidella</i> Olsson, 1956	3
	<i>Lamprodoma</i> Swainson, 1840	7
	<i>Macgintiella</i> Olsson, 1956	2
	<i>Mansfieldella</i> Olsson and Harbison, 1953	2
	<i>Minioliva</i> , Olsson, 1956	6
	<i>Niteoliva</i> Olsson, 1956	10
	<i>Olivella</i> Swainson, 1831	65
	<i>Olivellopsis</i> Thiele, 1929	3
	<i>Olivina</i> Orbigny, 1841	2
	<i>Pachyoliva</i> Olsson, 1956	2
	<i>Pseudolivella</i> Gilbert, 1960	5
	<i>Ramoliva</i> Cotton and Godfrey, 1932	2
	<i>Toroliva</i> Olsson and Harbison, 1953	2
	<i>Zanoetella</i> Olsson, 1956	3
Ancillinae	<i>Alcocospira</i> Cossman, 1899	5
	<i>Amalda</i> H. and A. Adams, 1847	8
	<i>Ancilla</i> , Lamarck, 1799	18
	<i>Ancillaria</i> Risso, 1826	9

Table 2. Continued

Subfamily	Genera	Species
Ancillinae	<i>Ancillista</i> Iredale, 1936	6
	<i>Anolacia</i> Gray, 1857	2
	<i>Austrancilla</i> Habe, 1959	8
	<i>Baryspira</i> Fischer, 1883	10
	<i>Cymbancilla</i> Fischer, 1881	2
	<i>Eburna</i> Lamarck, 1801	6
	<i>Eoancilla</i> Stephenson, 1941	5
	<i>Gemaspira</i> Olsson, 1956	10
	<i>Gracilancilla</i> Thiele, 1925	4
	<i>Gracilispira</i> O.P. Olson, 1956	3
	<i>Orbignytesta</i> Klappenbach, 1962	1
	<i>Pinguispira</i> Finlay, 1927	8
	<i>Spinaspira</i> O.P. Olson, 1956	2
	<i>Spirancilla</i> Vokes, 1936	6
	<i>Sylvanocochlis</i> Melvill, 1903	2
	<i>Turrancilla</i> Martens, 1904	2

6

Zoogeography of the Living Olives

The best way to study the genus *Oliva* is to approach it from a zoogeographic viewpoint. Being volutaceans, the olive shells follow, for the most part, the Law of the Volutes, in that they have large embryonic shells and non-planktonic larvae or larvae that are free swimming for only a few days. For these reasons, many populations of olive shells become trapped on isolated island groups or in deep water pockets and are cut off from the main gene pools. This tendency for low dispersibility of the larvae has produced a plethora of different forms around the world, each confined to a different geographical area.

The most recent epoch, the Pleistocene, was a dynamic time, with tremendous glacial build-ups interspersed between long, warm, interglacial periods. During glacial times worldwide sea level dropped as much as two hundred meters, because much of the earth's moisture was trapped within the glaciers. Areas like the Gulf of California, the Red Sea, the Persian Gulf, the Sulu Sea and the Gulf of Mexico, may have become virtual inland seas or lakes, being separated from the main oceanic basins by newly-emerged land. During interglacial periods, such as the present, sea levels rose and flooded this new land, restoring the enclosed seas to their former morphology as gulfs or bays.

Two sets of species will be present in some areas; those that

evolved during these periods of glacially-induced isolation, and those that lived in the open ocean and recolonized when sea level again rose to former levels.

Another common pattern of geographically-related speciation in the genus *Oliva* is the invasion of deeper waters by shallow water stocks. If this takes place around isolated seamounts like Barbados and Hawaii, or deep basins like the Tongue-of-the-Ocean in the Bahamas and the trenches adjacent to the Sulu Sea of the Philippines, new deep-water species can evolve that are restricted to relatively small areas. This is a common pattern in the Philippine-Indonesian areas, where deep trenches and pockets offer new habitats to be exploited by shallow water forms. Once they adapt to the deep water ecology, they become isolated from the main gene pools in shallow water and often speciate into whole new lineages that are restricted to one single trench or basin.

These same deep trenches act as barriers to the crawl-away young of many olive species. Two islands can be only a few kilometers apart, but if they are separated by a trench, the embryonic olives from the shallow water areas of one island cannot cross to the other. During glacial periods, when sea levels were lower, the intervening trench may not have been deep enough to act as a barrier, and species from both islands would have mixed. During interglacial periods, when sea levels again rise, the trench will act as a barrier and the species will again be separated into two populations. This problem can be circumvented by species with short lived planktonic larvae. It is interesting to note that the olives with the widest distributions have the smallest protoconchs. This reflects the fact that they have small enough embryonic shells to allow them to stay suspended in the water column as veligers. Conversely, olives with large protoconchs are often restricted to one island or one deep basin, and have direct development.

The different species and species groups can be divided into zoogeographical regions. These regions often result from isolation during glacial epochs, other factors previously mentioned. The following analysis can be used to determine which species are found in different areas around the world. The tropical, subtropical and warm temperate regions of the world are here broken up into a hierarchical arrangement of Realms, Regions, Provinces and Sub-

Map A. (Facing Page) Zoogeographic subdivisions known to contain *Oliva* species. Eastern Atlantic Region, V=Verdesian Province; G=Guinean Province. INDO-PACIFIC REALM, Indian Ocean Region, E=Eritrean Province, L=Lemurian Province. MA=Madagascan Subprovince, B=Bengalian Subprovince. Indo-Western Pacific Region, I=Indo-Malaysian Province; PH=Philippine Subprovince; ME=Melanesian Subprovince. Australian Region, D=Damperian Province; F=Flindersian Province; S=Solanderian Province. Sino-Japonic Region, J=Japonic Province. Central Pacific Region, P=Polynesian Province; H=Hawaiian Province; M=Marquesan Province. Eastern Pacific Region, PA=Panamic Province; CO=Cortezian Subprovince; C=Cocos Subprovince; BA=Balboan Subprovince; PE=Peruvian Province. Western Atlantic Region, CL=Carolinian Province; CR=Caribbean Province; BR=Brazilian Province.

provinces. Each of these areas has its own distinctive, endemic molluscan fauna that sets it apart from other regions of the world. Our zoogeographical treatment of the genus *Oliva* is a compilation of the marine provincial arrangements of Schilder and Schilder (1938), Schilder (1965), and Briggs (1974).

Accompanying the zoogeographical breakdown of the various species groups are maps showing their ranges in the ocean. Some boundaries may be in error on some of the maps, because several of the species are poorly-known and might be more widely distributed. The genus *Oliva* is distributed throughout the following marine zoogeographic regions.

EASTERN PACIFIC REGION (Map A)

This region contains the **Panamic Province** (Baja California to northern Peru), and its subdivisions, the **Cortezian Subprovince** (the Gulf of California region, Sea of Cortez), the **Balboan Subprovince** (the Gulf of Panama region), and the **Cocos Subprovince** (Cocos Island only). The **Peruvian Province** is also included (from northern Peru to central Chile).

WESTERN ATLANTIC REGION (Map B)

This region contains the **Carolinian Province** (Cape Cod to Cape Canaveral, and Sanibel Island to Padre Island, Texas), and its subdivision, the **Tampan Subprovince** (from Appalachicola Bay to Sanibel Island), the **Caribbean Province** (Bermuda, southern



Map A. Zoogeographic Subdivisions Known to Contain *Oliva* Species.

tip of Florida, south to Surinam), and its subdivisions, the **Bermudan Subprovince** (Bermuda only), the Bahamian Subprovince (the Bahamas only), the **Yucatecan Subprovince** (the banks and platform surrounding the Yucatan Peninsula and the coast of Belize), the **Antillean Subprovince** (the Greater and Lesser Antilles), the **Aruban Subprovince** (the Netherlands Antilles, the islands of Curacao, Bonaire and Aruba, and the islands off Venezuela), and the **Colombian Subprovince** (the eastern coast of Panama to Isla Margarita, Venezuela, including the Gulf of Venezuela area). The **Brazilian Province** is also included (Map A).

EASTERN ATLANTIC REGION (Map A)

This region contains the **Guinean Province** (Mauretania south to the Angola-Namibian border), and the **Verdesian Province** (the Cape Verde Islands only).

INDO-PACIFIC REALM

CENTRAL PACIFIC REGION (Map A)

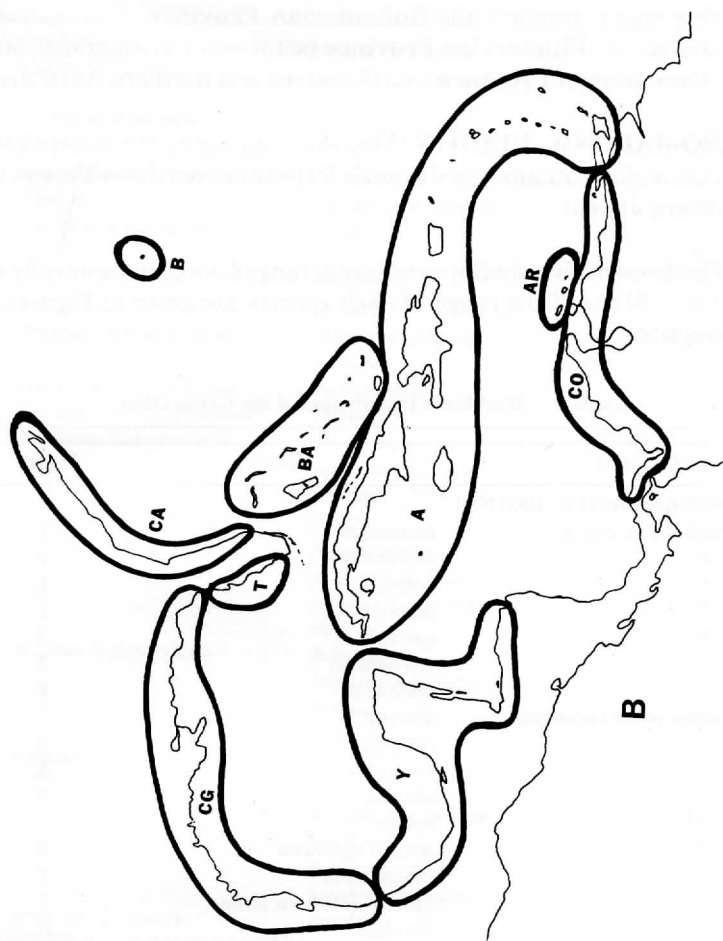
This region contains the **Hawaiian Province** (the Hawaiian Islands only), the **Marquesan Province** (the Marquesas Islands only), and the **Polynesian Province** (from Easter Island westward to Tonga).

INDO-WESTERN PACIFIC REGION (Map A)

This region contains the **Indo-Malaysian Province** (Fijis to Indonesia and northward to the Philippines), and its subdivisions, the **Melanesian Subprovince** (Melanesia and Papua New Guinea), and the **Philippine Subprovince** (the Philippines and the Sulu Sea area).

INDIAN OCEAN REGION (Map A)

This region contains the **Lemurian Province** (Central Indian Ocean islands, Maldives, Mauritius, Bay of Bengal, Arabian Sea, the East African Coast and Madagascar), and its subdivisions, the **Bengalian Subprovince** (the Bay of Bengal and the Andaman Islands), and the **Madagascan Subprovince** (Madagascar, the Comoros, and neighboring islands), and the **Eritrean Province** (Red Sea and the Persian Gulf).



Map B. Subprovinces of the Carolinian and Caribbean Provinces. CA=Carolinian Province, Atlantic Component; CG=Carolinian Province, Gulf of Mexico Component; T=Tampian Subprovince; B=Bermudan subprovince; BA=Bahamian Subprovince; Y=Yucatanian SubProvince; A=Antillean Subprovince; CO=Colombian Subprovince; AR=Aruban Subprovince.

AUSTRALIAN REGION (Map A)

This region contains the **Solanderian Province** (Queensland, Australia), the **Flindersian Province** (southwestern Australia), and the **Dampierian Province** (northwestern and northern Australia).

SINO-JAPONIC REGION (Map A)

This region contains the **Japonic Province** (northern Taiwan to southern Japan).

The known olive shell species are arranged zoogeographically in Table 3. Maps of the range of each species are given in Figures 1 through 32.

Table 3. Worldwide Distribution of the Genus *Oliva*.

Region/Province	Species	Figure
EASTERN PACIFIC REGION		
Panamic Province	<i>incrassata</i>	1
	<i>kaleontina</i>	2
	<i>polpasta</i>	1
	<i>porphyria</i>	1
	<i>spicata</i>	3
	<i>splendidula</i>	2
	<i>undatella</i>	4
	<i>davisae</i>	5
	<i>ionopsis</i>	5
	<i>kerstitchi</i>	5
Cortezian Subprovince	<i>obesina</i>	6
	<i>rejecta</i>	5
	<i>spicata melchersi</i>	3
	<i>subangulata</i>	7
	<i>subangulata corteziana</i>	7
	<i>venulata</i>	6
	<i>venulata cumingii</i>	6
	<i>venulata pindarina</i>	6
	<i>violacea</i>	7
	<i>julieta</i>	8
Balboan Subprovince	<i>olssoni</i>	8
	<i>radix</i>	9
	<i>truncata</i>	8
	<i>undatella ecuadoriana</i>	4

Table 3. Continued.

EASTERN PACIFIC REGION		
Cocos Subprovince	<i>foxi</i>	8
	<i>spicata deynzeræ</i>	3
Peruvian Province	<i>peruviana</i>	9
WESTERN ATLANTIC REGION		
Carolinian Province	<i>sayana</i>	10
Tampan Subprovince	<i>sayana sarasotensis</i>	10
Caribbean Province	<i>bifasciata</i>	11
	<i>nivosa</i>	13
	<i>reticularis</i>	10
	<i>scripta</i>	12
Bermudan Subprovince	<i>bifasciata jenseni</i>	11
	<i>olivacea</i>	11
Bahamian Subprovince	<i>bahamasensis</i>	14
Yucatanian Subprovince	<i>maya</i>	10
Antillean Subprovince	<i>antillensis</i>	15
	<i>barbadensis</i>	16
	<i>drangai</i>	16
	<i>finlayi</i>	14
	<i>jamaicensis</i>	14
	<i>jamaicensis brunnea</i>	14
	<i>jamaicensis zombia</i>	14
	<i>magdae</i>	14
Aruban Subprovince	<i>fulgurator</i>	16
	<i>fulgurator bullata</i>	16
	<i>reclusa</i>	16
	<i>vermiculata</i>	16
Colombian Subprovince	<i>bewleyi</i>	16
	<i>goajira</i>	10
	<i>scripta venezuelana</i>	12
	<i>tisiphona</i>	16
	<i>tisiphona oniska</i>	16
	<i>tisiphona schepmani</i>	16
Brazilian Province	<i>graphica</i>	9
EASTERN ATLANTIC REGION		
Guinean Province	<i>flammulata</i>	17
Verdesian Province	<i>flammulata verdensis</i>	17
INDO-PACIFIC REALM		
Widespread throughout the Indian and Pacific Oceans		
	<i>annulata</i>	18
	<i>caerulea</i>	18
	<i>lepida</i>	32
	<i>panniculata</i>	22

Table 3. Continued

Region/Province	Species	Figure
INDO-WESTERN PACIFIC REGION		
	<i>paxillus</i>	18
	<i>reticulata</i>	18
	<i>sericea</i>	18
	<i>sidelia</i>	22
	<i>todosina</i>	32
	<i>tricolor</i>	22
	<i>volvaroides</i>	40
CENTRAL PACIFIC REGION		
Hawaiian Province	<i>richerti</i>	19
	<i>sandwichensis</i>	19
Marquesan Province	<i>marquesana</i>	19
	<i>nitidula</i>	19
	<i>polita</i>	19
Polynesian Province	<i>duclosi</i>	24
	<i>hilli</i>	19
	<i>miniacea efasciata</i>	25
INDO-WESTERN PACIFIC REGION		
Widespread throughout the Western Pacific		
	<i>angustata</i>	20
	<i>athenia</i>	20
	<i>bulbiformis</i>	20
	<i>lecoquiana</i>	20
	<i>caldania</i>	20
	<i>carneola</i>	22
	<i>ceramensis</i>	20
	<i>clara</i>	20
	<i>concavospira</i>	26
	<i>dactyliola</i>	20
	<i>elegans</i>	20
	<i>faba</i>	20
	<i>fumosa</i>	31
	<i>funeralis</i>	22
	<i>galeola</i>	20
	<i>hanleyorum</i>	20
	<i>hirasei</i>	26
	<i>irisans</i>	20
	<i>keeni</i>	20
	<i>lentiginosa</i>	20
	<i>leucostoma</i>	22

Table 3. Continued.

Region/Province	Species	Figure
INDO-WESTERN PACIFIC REGION		
Widespread throughout the Western Pacific		
	<i>longispira</i>	20
	<i>miniacea miniacea</i>	25
	<i>mucronalis</i>	20
	<i>multiplicata</i>	26
	<i>mustelina</i>	26
	<i>natalia</i>	20
	<i>neostina</i>	20
	<i>oliva</i>	27
	<i>rufofulgurata</i>	22
	<i>pacifica</i>	29
	<i>rufula</i>	20
	<i>rufula tectiphora</i>	20
	<i>semmelinki</i>	20
	<i>sibogae</i>	22
	<i>similis</i>	20
	<i>tessellata</i>	22
	<i>vicdani</i>	20
	<i>vidua</i>	30
	<i>xenos</i>	20
INDO-MALAYSIAN PROVINCE		
Melanesian Subprovince		
	<i>aniomina</i>	20
	<i>avellana</i>	20
	<i>baileyi</i>	20
	<i>buloui</i>	20
	<i>buloui inscripta</i>	23
	<i>buloui stoneorum</i>	23
	<i>fumosa coccinea</i>	31
	<i>joyceae</i>	23
	<i>lepida solomonensis</i>	23
	<i>miniacea lamberti</i>	25
	<i>parkinsoni</i>	23
	<i>rubrolabiata</i>	19
	<i>vanuatuensis</i>	19
Philippine Subprovince		
	<i>bathyalis</i>	21
	<i>boholensis</i>	21
	<i>davaoensis</i>	21
	<i>esiodina</i>	21
	<i>fabrei</i>	21
	<i>grandicallosa</i>	21

Table 3. Continued.

Region/Province	Species	Figure
Philippine Subprovince	<i>insecta</i>	21
	<i>lenhilli</i>	21
	<i>mindanaoensis</i>	21
	<i>octavia</i>	21
	<i>picta</i>	21
	<i>raderi</i>	21
	<i>zamboangensis</i>	21
INDIAN OCEAN REGION		
Lemurian Province	<i>atalina</i>	19
	<i>bulbosa</i>	23
	<i>caroliniana</i>	27
	<i>leonardi</i>	24
	<i>macleaya</i>	30
	<i>oliva taeniata</i>	27
	<i>pica</i>	29
	<i>ponderosa</i>	29
	<i>tigrina</i>	23
	<i>tremulina</i>	28
	<i>tremulina nobilis</i>	28
	<i>williamsi</i>	19
Bengalian Subprovince	<i>andamanensis</i>	24
	<i>arctata</i>	24
	<i>fumosa kremerorum</i>	31
	<i>indomalaysica</i>	24
	<i>infrenata</i>	24
	<i>rufopicta</i>	24
	<i>smithi</i>	24
	<i>tremulina flammeacolor</i>	28
	<i>leonardhilli</i>	24
Madagascan Subprovince	<i>sairoosa</i>	24
AUSTRALIAN REGION		
Solanderian Province	<i>caldania queenslandica</i>	20
Flindersian Province	<i>australis pallescens</i>	20
Damperian Province	<i>australis</i>	20
	<i>caerulea ponderi</i>	24
	<i>kurzi</i>	24
	<i>lignaria</i>	20
	<i>westralis</i>	24
SINO-JAPONIC REGION		
Japonic Province	<i>hemiltona</i>	19
	<i>mustelina inornata</i>	19

FIGURE CAPTIONS

Figure 1. (Page 32) Ranges of Panamic Olives: *O. incrassata*, *O. polpasta*, and *O. porphyria*.

Figure 2. (Page 32) Ranges of Panamic Olives: *O. kaleontina* and *O. splendidula*.

Figure 3. (Page 33) Range of *O. spicata* in the Panamic Province: S=*O. spicata spicata*, M=*O. spicata melchersi*, and D=*O. spicata deynzeræ*.

Figure 4. (Page 33) Range of *O. undatella* in the Panamic Province: U=*O. undatella undatella*, and E=*O. undatella ecuadoriana*.

Figure 5. (Page 34) Range of Panamic Olives (Gulf of California): *O. davisæ*, *O. ionopsis*, *O. kerstitchi*, and *rejecta*.

Figure 6. (Page 34) Ranges of Panamic Olives (Gulf of California): *O. obesina*, *O. venulata cumingii*, *O. venulata pindarina*, and *O. venulata venulata*.

Figure 7. (Page 34) Ranges of Panamic Olives (Gulf of California): *O. violacea*, *O. subangulata subangulata*, and *O. subangulata corteziana*.

Figure 8. (Page 35) Ranges of Panamic Olives: T=*O. truncata* and *O. julieta*, F=*O. foxi*, and O=*O. olssoni*.

Figure 9. (Page 35) Ranges of South American Olives: R=*O. radix*, P=*O. peruviana*, and G=*O. graphica*.

Figure 10. (Page 36) Ranges of Caribbean and Carolinian Olives: S=*O. sayana*, SA=*O. sayana sarasotensis*, SF=*O. sayana* (fossil record), M=*O. maya*, R=*O. reticularis*, and G=*O. goajira*.

Figure 11. (Page 37) Ranges of *O. bifasciata* and *O. olivacea* in the Caribbean: B=*O. bifasciata bifasciata*, b=*O. bifasciata bollingi*, and JO=*O. bifasciata jenseni* and *O. olivacea*.

Figure 12. (Page 37) Range of *O. scripta* in the Caribbean: S=*O. scripta scripta* and V=*O. scripta venezuelana*.

Figure 13. (Page 38) Range of *O. nivosa* in the Caribbean.

Figure 14. (Page 38) Ranges of Caribbean Olives: B=*O. bahamensis* in the Bahamas, F=*O. finlayi* and *O. magdae* in Cuba, J=*O. jamaicensis* in Jamaica; Z = *O. jamaicensis zombia* in Haiti; BR = *O. jamaicensis brunnea* in Puerto Rico.

Figure 15. (Page 39) Range of *O. antillensis* in Hispaniola and the Virgin Islands.

Figure 16. (Page 39) Ranges of Caribbean Olives: Be = *O. bewleyi* and *O. tisiphona oniska*, T = *O. tisiphona tisiphona* and *O. tisiphona schepmani*, F = *O. fulgurator fulgurator*, *O. reclusa*, and *O. vermiculata*, Fb = *O. fulgurator bullata*, D = *O. drangai*, and Ba = *O. barbadensis*.

Figure 17. (Page 40) Ranges of West African Olives: F = *O. flammulata flammulata* and V = *O. flammulata verdensis*.

Figure 18. (Page 40) Ranges of widespread Indo-Pacific Olives: *O. annulata*, *O. caerulea*, *O. paxillus*, *O. reticulata*, *O. sericea* and *volvaroides*.

Figure 19. (Page 41) Ranges of Indo-Pacific Olives: A = *O. atalina* and *O. williamsi*, L = *O. hemiltona* and *O. mustelina*, R = *O. rubrolabiata* and *O. vanuatuensis*, H = *O. hilli*, S = *O. sandwichensis* and *O. richerti*, M = *O. marquesana*, *O. polita*, and *O. nitidula*.

Figure 20. (Page 41) Ranges of Indo-Pacific and Australian Olives: W = Widespread western Pacific species including: *O. angustata*, *O. athenia*, *O. bulbiformis*, *O. lecoquiana*, *O. caldania*, *O. ceramensis*, *O. clara*, *O. dactyliola*, *O. elegans*, *O. faba*, *O. galeola*, *O. hanleyorum*, *O. irisans*, *O. keeni*, *O. lentiginosa*, *O. longispira*, *O. mucronalis*, *O. natalia*, *O. neostina*, *O. rufula*, *O. rufula tectiphora*, *O. semmelinki*, *O. similis*, *O. vicdani*, *O. vidua*, *O. xenos*, *O. aniomina*, *O. avellana*, *O. baileyi*, and *O. buloui*; A = *O. australis australis* and *O. lignaria*, P = *O. australis pallescens*, and Q = *O. caldania queenslandica*.

Figure 21. (Page 42) Ranges of Olives restricted to the Philippines: *O. bathyalis*, *O. boholensis*, *O. davaoensis*, *O. esiodina*, *O. fabrei*, *O. grandicallosa*, *O. insecta*, *O. lenhilli*, *O. mindanaoensis*, *O. octavia*, *O. picta*, *O. raderi*, and *O. zamboangensis*.

Figure 22. (Page 42) Ranges of Olives restricted to the western Pacific: *O. pan-*

iculata, *O. sidelia*, *O. tricolor*, *O. funebris*, *O. carneola*, *O. leucostoma*, *O. rufogulgurata*, *O. sibogae*, and *O. tessellata*.

Figure 23. (Page 43) Ranges of widespread Indian Ocean and western Pacific Olives: B = *O. tigrina* and *O. bulbosa* and P = *O. buloui inscripta*, *O. buloui stoneorum*, *O. joyceae*, *O. lepida solomonensis*, and *O. parkinsoni*.

Figure 24. (Page 43) Ranges of Indo-Pacific Olives: L = *O. leonardhilli* and *O. sairoosa*, Le = *O. leonardi*, A = *O. andamanensis*, *O. arctata*, *O. indomalaysica*, *O. infrenata*, *O. rufopicta*, and *O. smithi*, W = *O. westralis* and *O. kurzi*, and *O. caerulea ponderi*, and D = *O. duclosi*.

Figure 25. (Page 44) Range of *Oliva miniacea* in the Pacific: M = *O. miniacea miniacea*, L = *O. miniacea lamberti*, and E = *O. miniacea efasciata*.

Figure 26. (Page 44) Ranges of western Pacific-Japonic Olives: *O. concavospira*, *O. hirasei*, *O. multiplicata*, *O. mustelina* and *O. mustelina inornata*.

Figure 27. (Page 45) Ranges of *O. oliva* and *O. caroliniana* in the Indo-Pacific: CA = *O. caroliniana*, O = *O. oliva oliva*, and T = *O. oliva taeniata*.

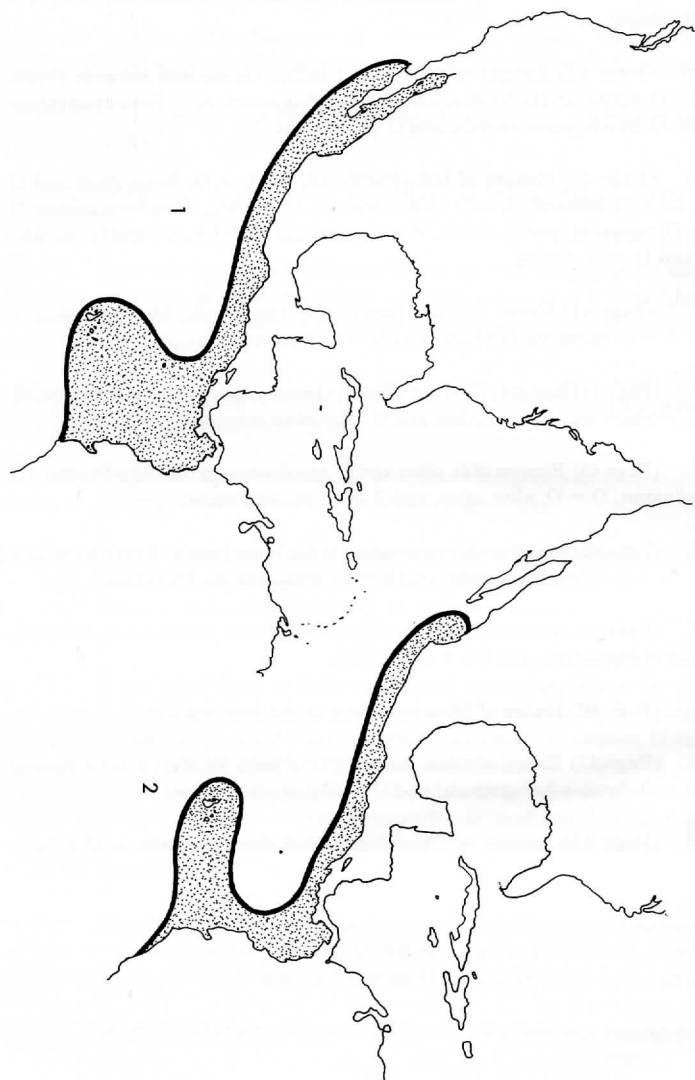
Figure 28. (Page 45) Range of *Oliva tremulina* in the Indo-Pacific: T = *O. tremulina tremulina*, N = *O. tremulina nobilis*, and F = *O. tremulina flammeicolor*.

Figure 29. (Page 46) Ranges of Indo-Pacific Olives: P = *O. ponderosa* and *O. pica*, O = *O. pica olympiadin*, and PA = *O. pacifica*.

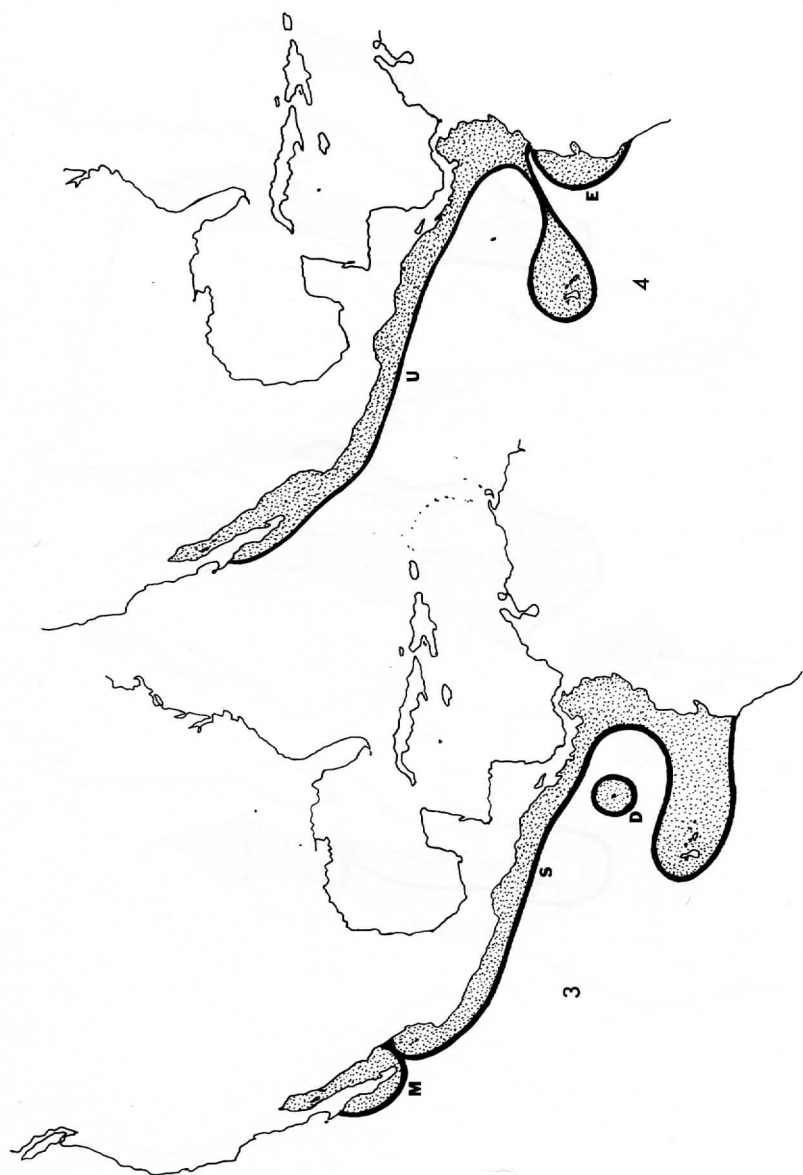
Figure 30. (Page 46) Range of *Oliva macleaya* in the Indo-Pacific.

Figure 31. (Page 47) Range of *Oliva fumosa* in the Indo-Pacific: F = *O. fumosa fumosa*, B = *O. fumosa kremerorum*, and C = *O. fumosa concinna*.

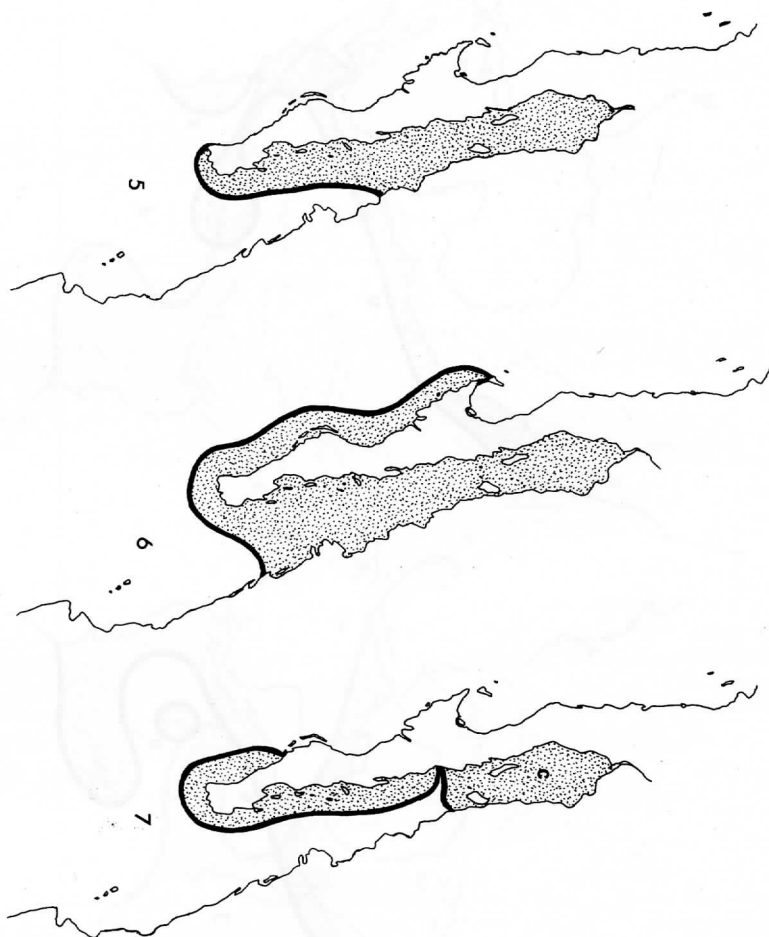
Figure 32. (Page 47) Ranges of *Oliva lepida* and *Oliva todosina* in the Indo-Pacific.



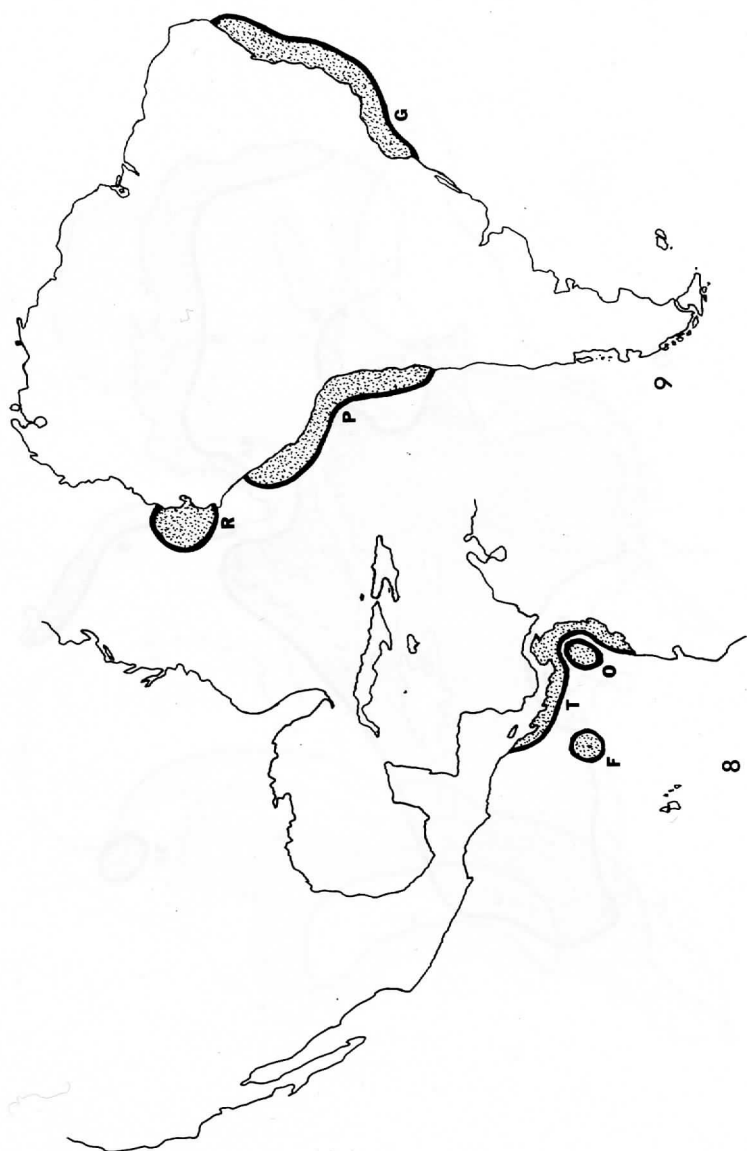
Figures 1 and 2.



Figures 3 and 4.



Figures 5, 6, and 7.



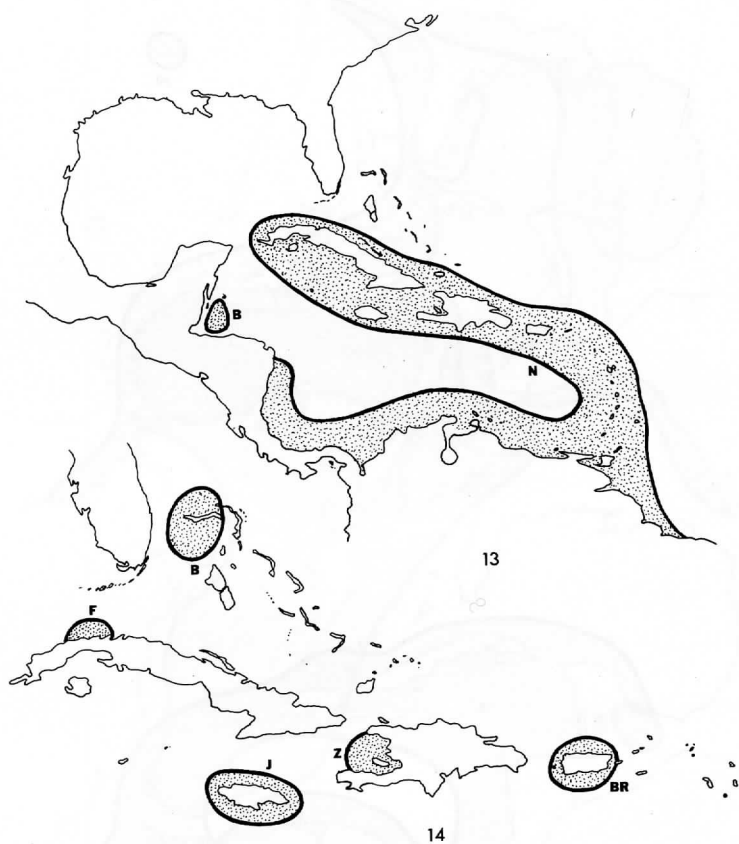
Figures 8 and 9.



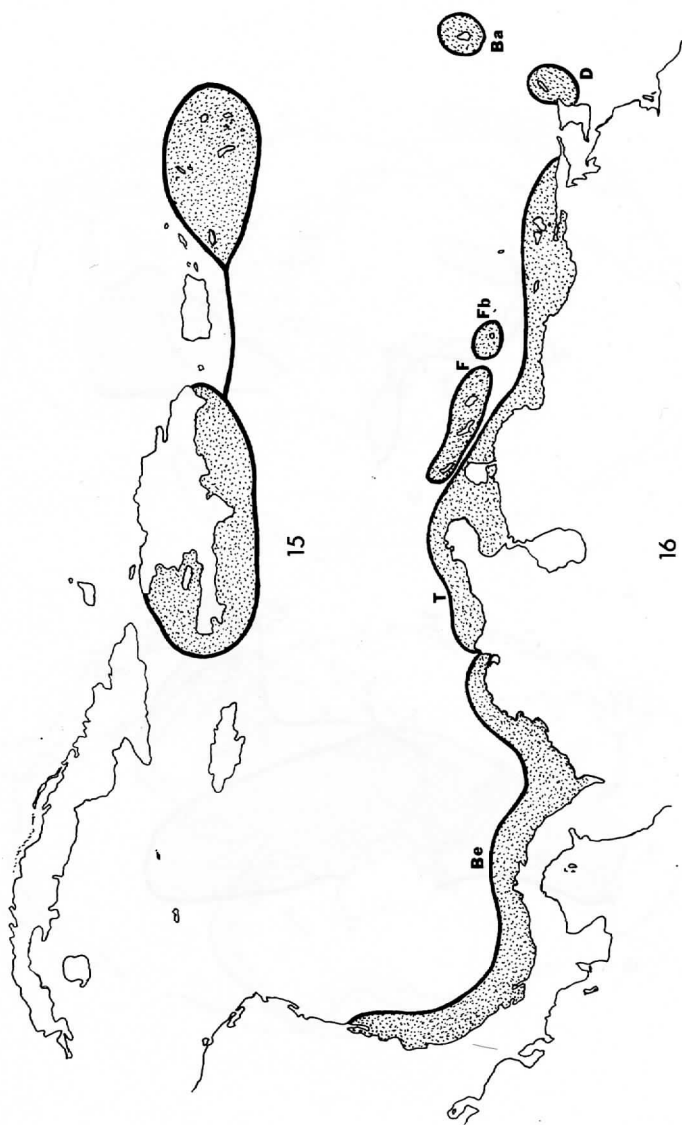
Figure 10.



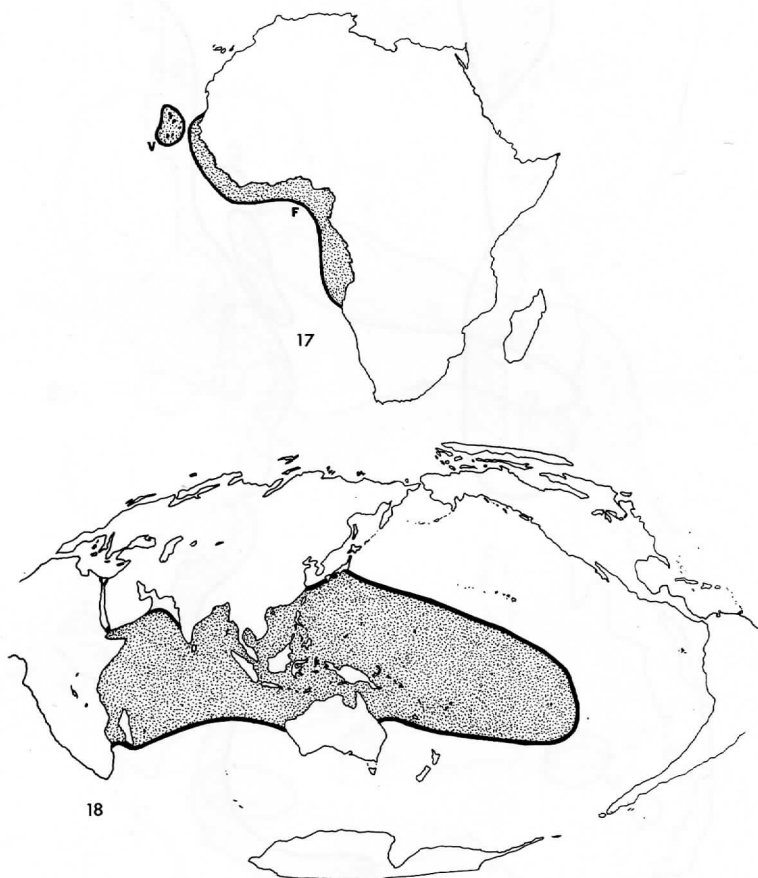
Figures 11 and 12.



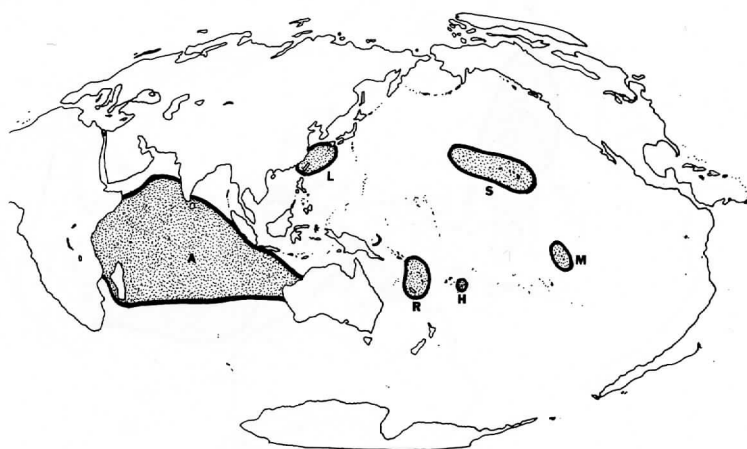
Figures 13 and 14.



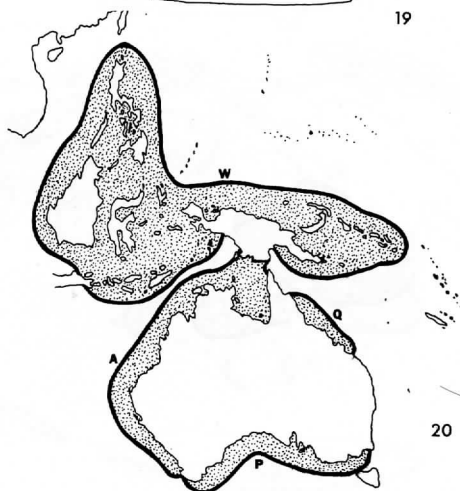
Figures 15 and 16.



Figures 17 and 18.

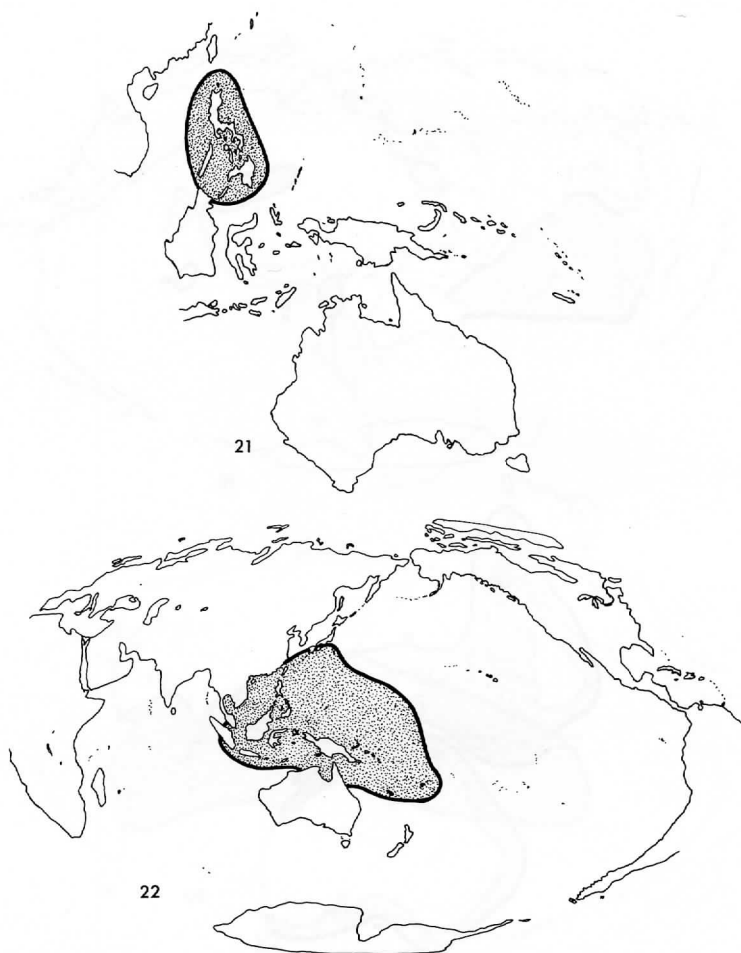


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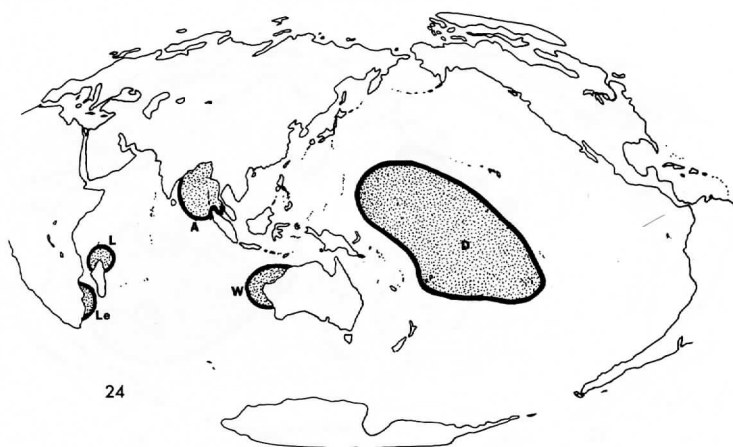
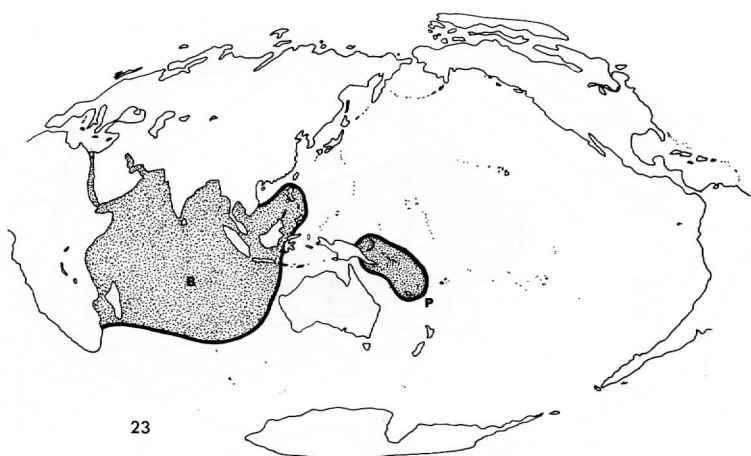


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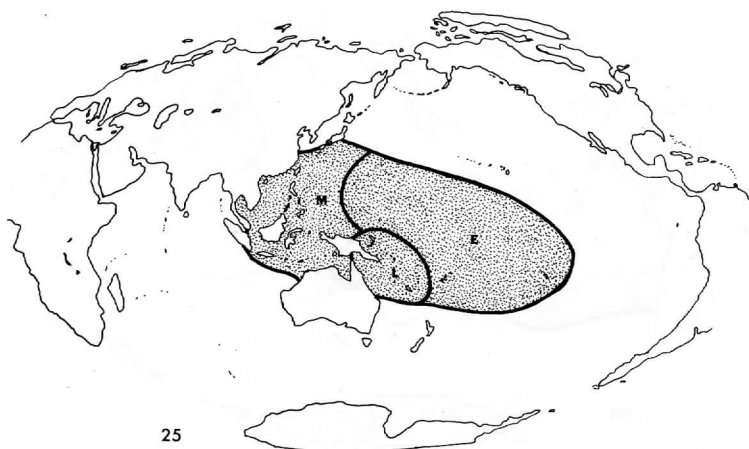
Figures 19 and 20.



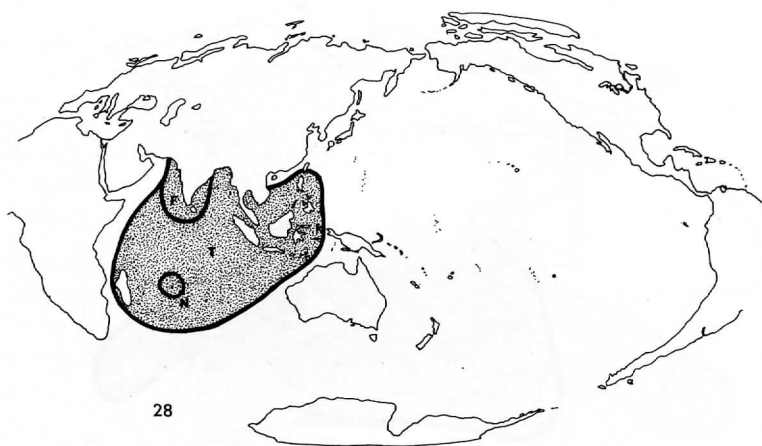
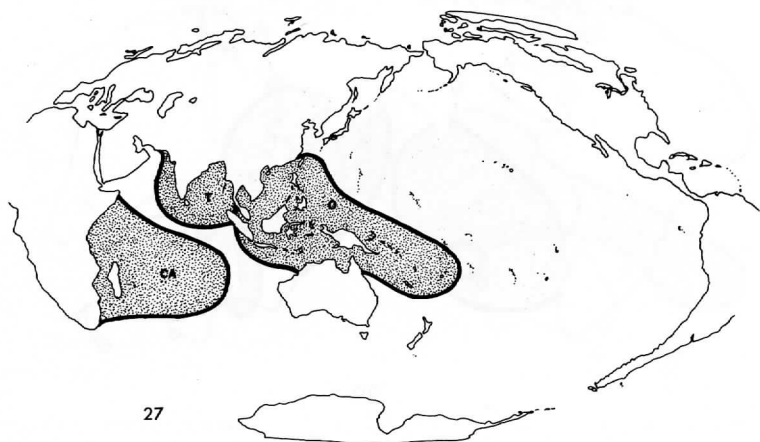
Figures 21 and 22.



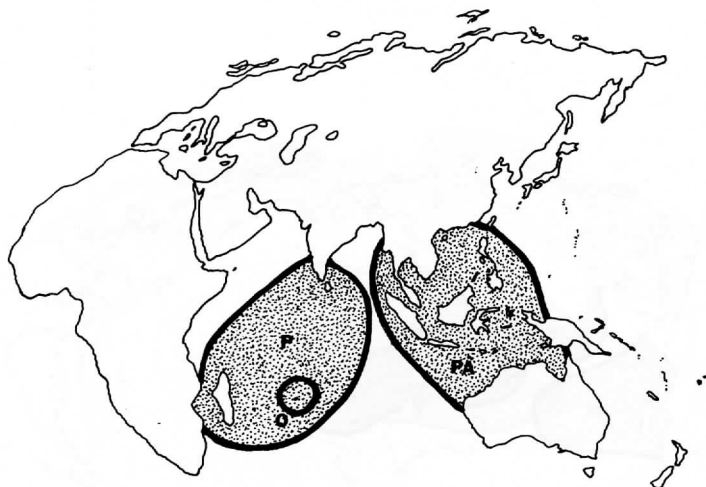
Figures 23 and 24.



Figures 25 and 26.



Figures 27 and 28.



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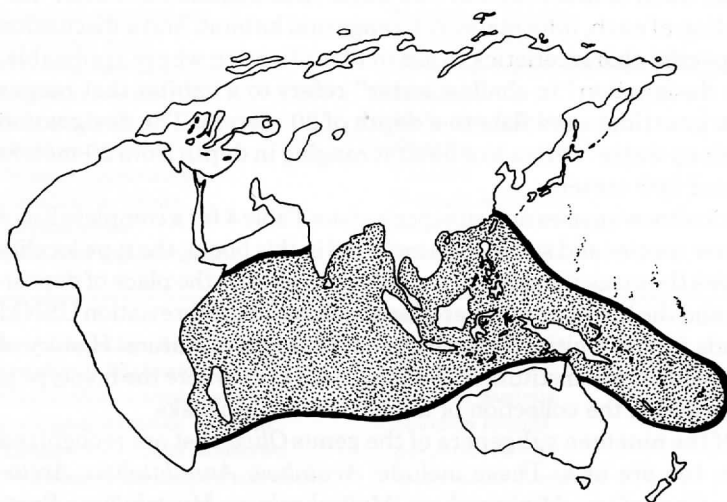


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Figures 29 and 30.



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Figures 31 and 32.

7

Synoptic Compendium of the Genus *Oliva*

Every known species, subspecies, and named color form of the genus *Oliva* is illustrated in this work. Also included is a brief description of each, information on range and habitat, and a discussion of specific characteristics to aid in identification where applicable. The designation "in shallow water" refers to a habitat that ranges from intertidal sand flats to a depth of 20 meters. The designation "in deep water" refers to a habitat ranging in depth from 20 meters to over 200 meters.

For all new species and subspecies (see Table 4 for a complete list of all new species and subspecies included in this book), the type locality follows the measurements of the holotype, as does the place of deposition and the holotype number (if applicable). The abbreviation USNM stands for the United States National Museum of Natural History of the Smithsonian Institution (Washington, D.C.), where the holotype is deposited in the collection of the Division of Mollusks.

Of the nineteen subgenera of the genus *Oliva* that are recognized here, ten are new. These include; *Acutoliva*, *Annulatoliva*, *Arctoliva*, *Cariboliva*, *Miniaceoliva*, *Multiplicoliva*, *Musteloliva*, *Proxoliva*, *Rufoliva*, and *Viduoliva*. All nineteen subgenera represent species radiations and groups of morphologically similar species. The use of subgenera in grouping the known olive species will aid in a more orderly placement of closely-related forms.

Table 4. New Taxa of the Genus *Olive*.

Species	Where Found
<i>(Strephona) antillensis</i>	Greater Antilles
<i>(Strephona) bahamasensis</i>	Bahamas
<i>(Strephona) barbadensis</i>	Barbados
<i>(Acutoliva) bathyalis</i>	Philippine Islands
<i>(Musteloliva) bohollensis</i>	Philippine Islands
<i>(Musteloliva) davaoensis</i>	Philippine Islands
<i>(Strephona) finlayi</i>	Cuba
<i>(Strephona) goajira</i>	Colombia
<i>(Musteloliva) grandicallosa</i>	Philippine Islands
<i>(Acutoliva) hilli</i>	Vava'u Islands
<i>(Viduoliva) indomalaysica</i>	Indonesia
<i>(Galeola) insecta</i>	Philippine Islands
<i>(Acutoliva) joyceae</i>	Solomon Islands
<i>(Acutoliva) kurzi</i>	Western Australia
<i>(Rufoliva) lenhilli</i>	Philippine Islands
<i>(Omogymna) leonardi</i>	Southeast Africa
<i>(Acutoliva) leonardhilli</i>	Madagascar
<i>(Strephona) magdae</i>	Cuba
<i>(Acutoliva) marquesana</i>	Marquesas Islands
<i>(Strephona) maya</i>	Yucutan, Mexico
<i>(Viduoliva) mindanaoensis</i>	Mindanao Island, southern Philippines
<i>(Strephona) olssoni</i>	Panama
<i>(Viduoliva) raderi</i>	Philippine Islands
<i>(Strephona) radix</i>	Ecuador
<i>(Proxoliva) vanuatuensis</i>	Vanuatu
<i>(Viduoliva) westralis</i>	Western Australia
<i>(Galeola) xenos</i>	Indo-Pacific
<i>(Viduoliva) zamboangensis</i>	Philippine Islands
New Subspecies	
<i>(Acutoliva) australis pallascens</i>	Southern Australia
<i>(Strephona) bifasciata jenseni</i>	Bermuda
<i>(Miniaceoliva) caerulea ponderi</i>	Western Australia
<i>(Annulatoliva) buloui inscripta</i>	Solomon Islands
<i>(Annulatoliva) buloui stoneorum</i>	Solomon Islands
<i>(Proxoliva) caldania queenslandica</i>	Queensland, Australia
<i>(Strephona) flammulata verdensis</i>	Cape Verde Islands
<i>(Miniaceoliva) fumosa kremerorum</i>	India
<i>(Strephona) jamaicensis zombia</i>	Haiti
<i>(Galeola) lepida solomonensis</i>	Solomon Sea
<i>(Rufoliva) rufula tectiphora</i>	Philippine Islands

Table 4. Continued.

Species	Where Found
<i>(Strephona) sayana sarasotensis</i>	Western Florida
<i>(Strephona) sayana texana</i>	Southern Texas
<i>(Cariboliva) scripta venezuelana</i>	Venezuela
<i>(Strephona) spicata deynzeræ</i>	Cocos Island
<i>(Strephona) subangulata corteziana</i>	Gulf of California
<i>(Miniaceoliva) tremulina flammeacolor</i>	India
<i>(Strephonella) undatella ecuadoriana</i>	Ecuador
New Names	
<i>Oliva (Miniaceoliva) hanleyorum</i> — new name for <i>cylindrica</i> Marrat, not <i>cylindrica</i> Sowerby	
<i>Oliva (Galeola) mucronalis</i> n.n. for <i>mucronata</i> Marrat, not <i>mucronata</i> d'Orbigny.	
<i>Oliva (Parvoliva) sibogæ</i> n.n. for <i>dubia</i> Schepman, not <i>dubia</i> Lea.	

Table 5 shows the relative abundance or availability of each species and subspecies, arranged by subgenus. This can be used as a guide when purchasing or exchanging specimens. Because the availability of many species depends on so many variables, these abundance indices are only approximate. Named color forms, because they are not taxonomically significant, are not listed here. Consult the text under the appropriate species or subspecies for descriptions of the the shells.

Table 5. Relative Abundance of Olive Shells.

Species	Abundance
Subgenus <i>Acutoliva</i> Petuch and Sargent, new subgenus	
<i>australis</i> Duclos, 1835	common
<i>australis pallescens</i> Petuch and Sargent, n. subsp.	common
<i>bathyalis</i> Petuch and Sargent, n. sp.	rare
<i>duclosi</i> Reeve, 1950	common

Table 5. Continued.

Species	Abundance
<i>esiodina</i> Duclos, 1835	uncommon
<i>hilli</i> Petuch and Sargent, n. sp.	uncommon
<i>joyceae</i> Petuch and Sargent, n.sp.	uncommon
<i>kurzi</i> Petuch and Sargent, n.sp.	uncommon
<i>lentiginosa</i> Reeve, 1850	common
<i>leonardhilli</i> Petuch and Sargent, n.sp.	uncommon
<i>marquesana</i> Petuch and Sargent, n. sp.	rare
<i>natalia</i> Duclos, 1844	rare
<i>nitidula</i> Duclos, 1835	uncommon
<i>panniculata</i> Duclos, 1835	common
<i>polita</i> Duclos, 1835	uncommon
<i>semmelinki</i> Schepman, 1911	uncommon
<i>williamsi</i> Melvill and Standen, 1897	uncommon
Subgenus <i>Annulatoliva</i> Petuch and Sargent, new subgenus	
<i>aniomina</i> Duclos, 1835	rare
<i>annulata</i> Gmelin, 1791	common
<i>boloui</i> Sowerby, 1887	uncommon
<i>buloui inscripta</i> Petuch and Sargent, n. subsp.	uncommon
<i>buloui stoneorum</i> Petuch and Sargent, n. subsp.	rare
<i>parkinsoni</i> Prior, 1975	uncommon
Subgenus <i>Arctoliva</i> Petuch and Sargent, new subgenus	
<i>arctata</i> Marrat, 1871	common
Subgenus <i>Cariboliva</i> Petuch and Sargent, new subgenus	
<i>scripta</i> Lamarck, 1811	common
<i>scripta venezuelana</i> Petuch and Sargent, n. subsp.	common
Subgenus <i>Carmione</i> Gray, 1858	
<i>avellana</i> Lamarck, 1811	uncommon
<i>bulbiformis</i> Duclos, 1835	common
<i>bulbosa</i> Röding, 1798	common
<i>caroliniana</i> Duclos, 1835	common
<i>dactyliola</i> Duclos, 1835	uncommon
<i>funeralis</i> Lamarck, 1811	common
<i>galeola</i> Duclos, 1835	uncommon
<i>keeni</i> Marrat, 1871	rare
<i>lecoquiana</i> Ducros de St. Germain, 1857	uncommon

Table 5. Continued.

Species	Abundance
<i>mucronalis</i> Petuch and Sargent, n. name for <i>mucronata</i> Marrat	uncommon
<i>picta</i> Reeve, 1850	rare
<i>similis</i> Marrat, 1867	uncommon
<i>tigrina</i> Lamarck, 1811	common
Subgenus <i>Galeola</i> Gray, 1858	
<i>andamanensis</i> Bridgman, 1909	uncommon
<i>carneola</i> Gmelin, 1791	common
<i>carneola kwajaleinensis</i> da Motta, 1985	
<i>ceramensis</i> Schepman, 1911	
<i>insecta</i> Petuch and Sargent, n. sp.	rare
<i>lepida</i> Duclos, 1835	common
<i>lepida solomonensis</i> Petuch and Sargent, n. subsp.	common
<i>sidelia</i> Duclos, 1835	common
<i>todosina</i> Duclos, 1835	common
<i>volvaroides</i> Duclos, 1835	common
<i>xenos</i> Petuch and Sargent, n. sp.	rare
Subgenus <i>Miniaceoliva</i> Petuch and Sargent, new subgenus	
<i>atalina</i> Duclos, 1835	uncommon
<i>caerulea</i> Röding, 1798	common
<i>caerulea ponderi</i> Petuch and Sargent, n. subsp.	rare
<i>fumosa</i> Marrat, 1871	common
<i>fumosa kremerorum</i> Petuch and Sargent, n. subsp.	uncommon
<i>fumosa concinna</i> Marrat, 1871	common
<i>hanleyorum</i> Petuch and Sargent, n. name for <i>cylindrica</i> Marrat	uncommon
<i>hirasei</i> Kira, 1959	common
<i>irisans</i> Lamarck, 1811	common
<i>lignaria</i> Marrat, 1867	common
<i>miniacea</i> Röding, 1798	common
<i>miniacea efasciata</i> Dautzenberg, 1927	common
<i>miniacea lamberti</i> Jousseaume, 1884	common
<i>pica</i> Lamarck, 1811	uncommon
<i>ponderosa</i> Duclos, 1835	common
<i>sairoosa</i> Kilburn, 1978	uncommon
<i>sericea</i> Röding, 1798	common
<i>tremulina</i> Lamarck, 1811	common
<i>tremulina flammeacolor</i> Petuch and Sargent, new subspecies	common

Table 5. Continued.

Species	Abundance
Subgenus <i>Multiplicoliva</i> Petuch and Sargent, new subspecies	
<i>labuanensis</i> Marrat, 1871	rare
<i>multiplicata</i> Reeve, 1850	common
<i>vicdani</i> da Motta, 1982	rare
Subgenus <i>Musteloliva</i> Petuch and Sargent, new subgenus	
<i>boholensis</i> Petuch and Sargent, n. sp.	rare
<i>concavospira</i> Sowerby, 1914	common
<i>davaoensis</i> Petuch and Sargent, n. sp.	uncommon
<i>grandicallosa</i> Petuch and Sargent, n. sp.	rare
<i>mustelina</i> Lamarck, 1811	common
<i>mustelina inornata</i> Marrat, 1870	common
<i>rufopicta</i> Weinkauff, 1878	rare
Subgenus <i>Neocylindrus</i> Fischer, 1883	
<i>tessellata</i> Lamarck, 1811	common
Subgenus <i>Oliva</i> Bruguiere, 1798	
<i>fabrei</i> Ducros de St. Germain, 1857	uncommon
<i>longispira</i> Bridgman, 1906	common
<i>oliva</i> Linnaeus, 1758	common
<i>oliva taeniata</i> Link, 1807	common
<i>smithi</i> Bridgman, 1906 *	uncommon
Subgenus <i>Omogymna</i> von Martens, 1897	
<i>leonardi</i> Petuch and Sargent, n. sp.	rare
<i>paxillus</i> Reeve, 1850	common
<i>richerti</i> Kay, 1979	rare
<i>sandwichensis</i> Pease, 1860	common
Subgenus <i>Parvoliva</i> Theile, 1929	
<i>rufofulgurata</i> Schepman, 1911	uncommon
<i>sibogae</i> Petuch and Sargent, n.n. for <i>dubia</i> Schepman	uncommon
Subgenus <i>Porphyria</i> Röding, 1798	
<i>porphyria</i> Linnaeus, 1758	common
Subgenus <i>Proxoliva</i> Petuch and Sargent, new subgenus	
<i>athenia</i> Duclos, 1835	uncommon
<i>caldania</i> Duclos, 1835	common

Table 5. Continued.

Species	Abundance
<i>caldania queenslandica</i> Petuch and Sargent, new subspecies	uncommon
<i>faba</i> Marrat, 1867	uncommon
<i>vanuatuensis</i> Petuch and Sargent, n. sp.	uncommon
Subgenus <i>Rufoliva</i> Petuch and Sargent, new subgenus	
<i>baileyi</i> Petuch, 1979	rare
<i>lenhilli</i> Petuch and Sargent, n. sp.	
<i>rufula</i> Duclos, 1835	common
<i>rufula tectiphora</i> Petuch and Sargent, n. subsp.	uncommon
Subgenus <i>Strephona</i> Mörch, 1852	
<i>antillensis</i> Petuch and Sargent, n. sp.	uncommon
<i>bahamasensis</i> Petuch and Sargent, n. sp.	rare
<i>barbadensis</i> Petuch and Sargent, n. sp.	rare
<i>bewleyi</i> Marrat, 1870	uncommon
<i>bifasciata</i> Küster, 1878	common
<i>bifasciata bollingi</i> Clench, 1937	common
<i>bifasciata jenseni</i> Petuch and Sargent, n. subsp.	uncommon
<i>davisae</i> Durham, 1950	uncommon
<i>drangai</i> Schwengel, 1951	rare
<i>finlayi</i> Petuch and Sargent, n. sp.	rare
<i>flammulata</i> Lamarck, 1811	common
<i>flammulata verdensis</i> Petuch and Sargent, n. subsp.	uncommon
<i>foxi</i> Stingley, 1984	uncommon
<i>fulgurator</i> Röding, 1798	uncommon
<i>fulgurator bullata</i> Marrat, 1871	rare
<i>goajira</i> Petuch and Sargent, n. sp.	rare
<i>graphica</i> Marrat, 1870	uncommon
<i>incrassata</i> Lightfoot, 1786	common
<i>ionopsis</i> Berry, 1969	uncommon
<i>jamaicensis</i> Marrat, 1870	uncommon
<i>jamaicensis brunnea</i> Marrat, 1870	common
<i>jamaicensis zombia</i> Petuch and Sargent, n. subsp.	uncommon
<i>julieta</i> Duclos, 1833	uncommon
<i>kaleontina</i> Duclos, 1835	uncommon
Subgenus <i>Strephona</i> Mörch, 1852	
<i>kerstitchi</i> da Motta, 1985	uncommon
<i>magdae</i> Petuch and Sargent, n. sp.	rare
<i>maya</i> Petuch and Sargent, n. sp.	uncommon

Table 5. Continued.

Species	Abundance
<i>nivosa</i> Marrat, 1870	common
<i>obesina</i> Duclos, 1835	common
<i>olivacea</i> Marrat, 1870	uncommon
<i>olssoni</i> Petuch and Sargent, n. sp.	rare
<i>peruviana</i> Lamarck, 1811	common
<i>polpasta</i> Duclos, 1835	common
<i>radix</i> Petuch and Sargent, n. sp.	rare
<i>reclusa</i> Marrat, 1871	uncommon
<i>rejecta</i> Burch and Burch, 1962	common
<i>reticularis</i> Lamarck, 1811	common
<i>sayana</i> Ravenel, 1834	common
<i>sayana sarasotensis</i> Petuch and Sargent, n. subsp.	uncommon
<i>sayana texana</i> Petuch and Sargent, n. subsp.	uncommon
<i>spicata</i> Röding, 1798	common
<i>spicata deynserae</i> Petuch and Sargent, n. subsp.	uncommon
<i>spicata melchersi</i> Menke, 1851	uncommon
<i>splendidula</i> Sowerby, 1825	common
<i>subangulata</i> Philippi, 1848	uncommon
<i>subangulata corteziana</i> Petuch and Sargent, new subspecies	uncommon
<i>tisiphona</i> Duclos, 1844	common
<i>tisiphona oniska</i> Duclos, 1844	rare
<i>tisiphona schepmani</i> Weisbord, 1962	rare
<i>truncata</i> Marrat, 1867	uncommon
<i>venulata</i> Lamarck, 1811	common
<i>venulata cumingii</i> Reeve, 1830	uncommon
<i>venulata pindarina</i> Duclos, 1835	common
<i>vermiculata</i> Gray, 1858	rare
<i>violacea</i> Marrat, 1867	uncommon
Subgenus <i>Strephonella</i> Dall, 1909	
<i>undatella</i> Lamarck, 1811	common
<i>undatella ecuadoriana</i> Petuch and Sargent, n. subsp.	common
Subgenus <i>Viduoliva</i> Petuch and Sargent, new subgenus	
<i>angustata</i> Marrat, 1868	uncommon
<i>clara</i> Marrat, 1871	uncommon
<i>elegans</i> Lamarck, 1811	common
Subgenus <i>Viduoliva</i> Petuch and Sargent, new subgenus	
<i>hemiltona</i> Duclos, 1835	rare

Table 5. Continued.

Species	Abundance
<i>indomalaysica</i> Petuch and Sargent, n. sp.	uncommon
<i>infrenata</i> Marrat, 1871	rare
<i>leucostoma</i> Duclos, 1835	common
<i>macleaya</i> Duclos, 1835	common
<i>mindanaoensis</i> Petuch and Sargent, n. sp.	common
<i>neostina</i> Duclos, 1835	common
<i>octavia</i> Duclos, 1844	uncommon
<i>pacifica</i> Marrat, 1871	common
<i>raderi</i> Petuch and Sargent, n. sp.	uncommon
<i>reticulata</i> Röding, 1798	common
<i>rubrolabiata</i> 1902	uncommon
<i>tricolor</i> Lamarck, 1811	common
<i>vidua</i> Röding, 1798	common
<i>westralis</i> Petuch and Sargent, n. sp.	uncommon
<i>zamboangensis</i> Petuch and Sargent, n. sp.	uncommon

8

Systematics

Phylum: Mollusca

Class: Gastropoda

Order: Caenogastropoda

Superfamily: Volutacea

Family: Olividae

Genus: *Oliva* Bruguiere, 1789

Subgenus *Acutoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells small for genus, generally 25 mm or less in length, elongated, slender, fusiform, with high spires; color patterns composed of varying amounts of fine triangles and often, prominent mid-body band of large flammules; subsutural flammules large, prominent; apertures narrow; columellar areas poorly developed with large coarse plicae.

TYPE SPECIES: *Oliva panniculata* Duclos, 1835, Recent, tropical Indo-Pacific.

SPECIES IN ACUTOLIVA

Oliva (Acutoliva)australis Duclos, 1835 (Plate 1, Figures 1, 2)

Description: Shell large for subgenus, thickened, ovate in out-

line; spire elevated; color pale blue or gray, overlaid with fine darker spots.

Discussion: This species ranges from western and northern Australia to southern Papua New Guinea. It is found in shallow water.

Size: Approximately 30 to 35 mm. in length.

Oliva (Acutoliva) australis pallescens Petuch and Sargent, new subspecies (Plate 1, Figures 3, 4)

Description: Shell large for subgenus, thickened, ovate in outline; spire elevated; color pale cream-tan to white overlaid with reddish tan cloudings and pale spots; wide band posterior to fasciole of solid reddish brown color; interior of aperture white; columellar area white with ten to thirteen coarse, well developed plicae.

Holotype: Length 26 mm, width 11 mm, on sand flats near Eucla, Western Australia, low tide. Deposited in the collection of the Australian National Museum, Department of Malacology.

Etymology: *pallescens*, in reference to the pale color of this subspecies.

Discussion: This new subspecies differs from typical *O. australis* in being smaller, stockier, less elongated, and having a reddish tan, pale color pattern that may range to white in some specimens. The fascicular band on the anterior part of the columella of *O. australis australis* is composed of broken, dark brown dashes, while the fascicular band of *O. australis pallescens* is of a solid red-brown color. The subsutural flammules of the new subspecies also differ from the typical *O. australis* in being larger and of the red-brown color. B.R. Wilson and Keith Gillett pictured this subspecies in *Australian Shells* in 1972 (Page 106, Plate 71, Figure 1b) and mentioned that the relationship of the two color forms needs investigation. *Oliva australis pallescens* is found in the cold waters along the southwestern and southern coasts of Australia. Typical *O. australis*, with the more slender shells and bluish color pattern, are found in the subtropical to tropical waters of western and northern Australia and southern Papua New Guinea (Figure 20).

Oliva (Acutoliva) bathyalis Petuch and Sargent, 1985 (Plate 1, Figures 5, 6)

Description: Shell small for subgenus, thin, fragile, with slightly rounded sides; spire low; color pale cream overlaid with a faint network of pale tan cloudings; some specimens with a mid-body band of pale bluish-brown flammules; area posterior to fasciole with row of large reddish-brown spots; protoconch large in proportion to shell; aperture white; columellar area white with 12 to 15 well developed, narrow plicae.

Holotype: Length 14 mm, width 6 mm, trawled by commercial fishermen from 250 meters depth, off the southern coast of Balabac Island, Philippines. USNM 841428.

Etymology: *bathyalis*, from the depths, in reference to the fact that this is the deepest water *Oliva* species known to date.

Discussion: *Oliva bathyalis* is closest to *O. semmelinki* but differs in being a smaller, more delicate shell with a lower spire and a larger protoconch, by having a much paler color pattern lacking in triangle markings, and by having a white aperture instead of a purple one. This new species is the deepest dwelling of the olive shells. *O. bathyalis* inhabits muddy sand areas in deep water pockets in the southern Philippines.

Size: 14 mm in length.

Oliva (Acutoliva) duclosi Reeve, 1850 (Plate 1, Figures 9, 10, 13, 14)

(Synonyms: *duclosiana* Jay, 1850; *jaspidea* Duclos, 1835 not Fischer, 1807)

Description: Shell dark yellow, overlaid with dense network of fine black triangles, with black being the dominant color.

Range: Polynesia, in shallow water (Figure 24).

Size: Approximately 30 mm in length.

Oliva (Acutoliva) duclosi color form *stainforthi* Reeve, 1850 (Plate 1, Figures 11, 12)

Description: Similar to typical *duclosi* but with larger triangles and patches of orange, dark yellow or cream. Some specimens with a discernable dark central band. The overall appearance is lighter in color than the typical form.

Range: Polynesia and eastern Melanesia, in shallow water. (Figure 24).

Size: Approximately 30 mm in length.

Oliva (Acutoliva) esiodina Duclos, 1835 (Plate 1, Figures 15, 16)

Description: Shell cream-yellow overlaid with reddish bordered triangles, which form a loose netted pattern.

Discussion: This species was considered by some workers to be a subspecies of *O. duclosi*. The consistently distinctive characteristics have prompted us to place *O. esiodina* as a full distinct species as was intended by its original author. This species is endemic to the central Philippines and it is found in shallow water.

Size: 15 mm to 25 mm in length.

Oliva (Acutoliva) hilli Petuch and Sargent, new species, (Plate 1, Figures 17, 18, 19, 20)

Description: Shell of medium size for subgenus, slightly inflated, with rounded sides; spire low, with early whorls covered over with white enamel; color pale yellow overlaid with diffuse network of pinkish-tan zig-zags and large triangles; main color pattern, in turn, peppered with random array of large, dark brown dots and crescent shaped flammules; subsutural flammules large, dark purple-brown; interior of aperture white; columellar area white, with 10 to 13 small, poorly-developed plicae.

Holotype: Length 16 mm, width 7 mm, on white sand bottom, one meter depth behind reef, Neiafu, Vava'u Islands, Kingdom of Tonga. USNM 841435.

Etymology: Named for Leonard Hill, of Miami, Florida, who recognized the species as new and kindly donated the type material.

Discussion: *Oliva hilli* most closely resembles *O. lentiginosa*, but differs in being a smaller, stockier shell with a lower spire, by having an enameled spire, and by having a color pattern that lacks a central, mid-body band, but has instead, large, dark brown spots. This new species appears to be endemic to the Vava'u Islands.

Size: 16 mm in length.

Oliva (Acutoliva) joyceae Petuch and Sargent, new species, (Plate 1, Figures 21, 22, 23, 24)

Description: Shell small for subgenus, thin, very slender and elongated; spire high; color bright pink or pinkish-orange overlaid with darker pink or orange zig-zag net pattern; mid-body band of brown blotches present on some specimens; interior of aperture bright pink; columellar area white with 10 to 15 plicae; protoconch large in proportion to shell, dark orange-pink; aperture very narrow.

Holotype: Length 14 mm, width 6 mm, trawled from 26 meters depth, on sand bottom, off Gavutu Island, Florida Islands, Solomon Islands. USNM 841438.

Etymology: Named for Mrs. Joyce Stone, who collected the type lot through her private trawling efforts in the Solomon Islands.

Discussion: *Oliva joyceae* is closest to *O. semmelinki* but differs in being a smaller and much more slender shell with a larger protoconch. *Oliva semmelinki* has a purple aperture while *O. joyceae* has a bright pink aperture. The aperture of *O. semmelinki* is wider and more flaring than the narrow aperture of *O. joyceae*. Both *O. joyceae* and *O. semmelinki* occur together in deeper waters in the Solomon Islands and in the Papua New Guinea area. Of the two closely related species, *O. semmelinki* has a wider range, extending into Indonesia and the Philippines, while *O. joyceae* appears to be restricted to New Guinea, the islands of the Solomon Sea, and the Solomon Islands.

Size: 15 mm in length.

Oliva (Acutoliva) kurzi Petuch and Sargent, new species, (Plate 2, Figures 17, 18)

Description: Shell average size for subgenus, slender, with protracted spire; base color white, completely overlaid with dense pattern of fine, light brown zig-zags and net-like reticulations; edge of suture bordered with evenly-spaced large brown blotches; faint band of small, light brown flammules around mid-body of some specimens; fasciole marked with evenly-spaced, crescent-shaped brown flammules; aperture white.

Holotype: Length 17 mm, width 8 mm, Australian National

Museum. Paratypes in Petuch, Sargent, and Hill collections.

Etymology: Named for Mr. Richard M. Kurz, Wauwatosa, Wisconsin, who generously donated the type specimen.

Type Locality: In 1 meter of water, sand bottom, 2 kilometers north of Broome, Western Australia.

Range: Known only from northwestern Australia, in shallow water.

Discussion: *Oliva kurzi* is closest to the western Indian Ocean *O. williamsi*, but differs in having a reticulated color pattern of interlocking zig-zags instead of the simple zebra-like pattern of vertical flammules seen in *O. williamsi*. *Oliva kurzi* is also close to *O. panniculata* but again differs in having an obvious reticulated, net-like color pattern. This new species occurs in the same area as the other Western Australian endemics, *O. caerulea ponderi* and *O. westralis*.

***Oliva (Acutoliva) lentiginosa* Reeve, 1850 (Plate 1, Figures 7, 8)**

Description: Shell white, overlaid with a very faint network of fine purple triangles; band around mid-body composed of darker purple triangles; overall white or light colored shell.

Discussion: Restricted to the Western Pacific, from the Philippines to the Ryukyu Islands, in shallow water.

Size: 25 mm to 30 mm in length.

***Oliva (Acutoliva) leonardhilli* Petuch and Sargent, new species, (Plate 2, Figures 1, 2)**

Description: Shell large for subgenus, slightly inflated, with rounded sides and a high, protracted spire; color bright lavender-purple, overlaid with darker purple mottlings and copious amounts of tiny, scattered, dark brown speckles; columellar fasciole with large purple and white checkers; aperture white.

Holotype: Length 23 mm, width 9 mm, 3 meter depth on sand bottom behind reef, Tulear Bay, Madagascar, Malagasy Republic. USNM 841464.

Etymology: Named for Mr. Leonard Hill of Miami, Florida, who recognized this species as being new and who kindly donated the holotype.

Discussion: *Oliva leonardhilli* is similar to *O. panniculata* but differs in being a larger, more inflated shell, with a shoulder. The new species also lacks the dark mid-body band of *O. panniculata*. In addition *O. leonardhilli* has a distinctive bright lavender coloration and a purple checkered columellar fasciole. *Oliva leonardhilli* appears to be endemic to northern Madagascar, where it is relatively common in Tulear Bay.

Size: 23 mm in length.

Oliva (Acutoliva) marquesana Petuch and Sargent, 1985
(Plate 2, Figures 3, 4, 5, 6)

Description: Shell small for subgenus, very elongated, fusiform; spire elevated; color yellow, overlaid with two distinct types of patterns separated at mid-body line; from mid-body line to anterior tip, pattern is dark brown with large yellow triangles; from mid-body line to suture, pattern is composed of a network of extremely fine brown triangles; demarcation between the two patterns is very sharp; interior of aperture tan; columellar area white with 8 to 10 small, poorly-developed plicae.

Holotype: Length 11 mm, width 5 mm, trawled by fisheries research vessel from 150 meters depth off southern coast of Fatu Hiva Island, Marquesas Islands, French Polynesia. USNM 841443.

Etymology: Named for the Marquesas Islands, the type locality.

Discussion: The split color pattern of *O. marquesana* is unique in the subgenus. This new species is closest to *O. polita*, also from the Marquesas Islands, but differs in being a much more elongated shell with a higher spire, and by having the dual color pattern, which includes the network of very fine triangles. *Oliva marquesana* is endemic to deep water areas offshore of the Marquesas Islands. It may be a deep water derivative of *O. polita* much as *O. (Omogymna) richerti* is a deep water derivative of *O. (Omogymna) sandwichensis*.

Size: 11 mm in length.

Oliva (Acutoliva) natalia Duclos, 1844 (Plate 2, Figures 11, 12)

Description: Shell with low spire, rounded sides; color bright orange with scattered large white triangles and white subsutural area; aperture white; columella white with 10 to 12 large, very coarse plications; protoconch large, mammilate.

Discussion: The bright orange coloration, lower spire, large protoconch and larger columellar plications easily distinguish this species from *O. panniculata*. *O. natalia* ranges from the Philippines to the Fijis and it is found in shallow water.

Size: approximately 15 mm in length.

Oliva (Acutoliva) nitidula Duclos, 1835 (Plate 2, Figures 9, 10)

Description: Shell white, overlaid with network of very fine brown triangles and tiny dark brown speckles; anterior half of shell darker brown.

Discussion: *O. nitidula* is a smaller, darker, stockier shell than *O. panniculata*. This species is endemic to the Marquesas Islands and Society Islands in French Polynesia, where it inhabits shallow sandy areas.

Size: Approximately 20 mm in length.

Oliva (Acutoliva) panniculata Duclos, 1835 (Plate 2, Figures 15, 16, 17, 18)

Description: Shell slender with a very protracted spire; color white with faint cloudings of pinkish-tan and overlaid with a very faint network of fine tan triangles; mid-body with a prominent band of dark brown flammules; aperture white.

Discussion: This species is found in shallow water from Polynesia and Micronesia into Indonesia and Melanesia, northward to Japan.

Size: Approximately 25 mm in length.

Oliva (Acutoliva) panniculata color form *ozodona* Duclos, 1835 (Plate 2, Figures 13, 14)

Description: Shell salmon and pale blue, overlaid with gray mottlings and network of fine gray triangles; mid-body with prominent dark gray band interrupted with large, round, white spots; aperture gray-brown.

Discussion: This form is found in shallow water and it is res-

tricted to Melanesia and the Philippines.

Size: 20 mm in length.

Oliva (Acutoliva) polita Duclos, 1835 (Plate 2, Figures 7, 8)

Description: Shell yellowish-white overlaid with large, dark brown triangles.

Discussion: *O. polita* is found in shallow water and it is endemic to the Marquesas Islands.

Size: Approximately 20 mm in length.

Oliva (Acutoliva) semmelinki Schepman, 1911 (Plate 3, Figures 1, 2)

Description: Shell yellow overlaid with dense, fine network of reddish-brown triangles; zig-zag patches of brown triangles scattered over body; aperture purple or lavender within.

Discussion: *O. semmelinki* is found in deep water in depths from 50 to 100 meters. This species ranges from the Philippines and Indonesia to Papua New Guinea and the Solomon Islands.

Size: Approximately 25 mm in length.

Oliva (Acutoliva) williamsi Melvill and Standen, 1897 (Plate 3, Figures 3, 4)

Description: Shell white with prominent, longitudinal, undulating stripes of reddish-brown color.

Discussion: This distinctive species is restricted to the Indian Ocean, from India Madagascar. *O. williamsi* is a shallow water species.

Size: Approximately 25 mm in length.

Subgenus *Annulatoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells medium sized for genus, thickened, with pronounced shoulders; some varieties coniform; spires elevated; colors generally shades of yellow, salmon-pink, or light tan, often overlaid with cloudings of purple, tan, or pinkish-brown; triangle or netted pattern absent from most species.

TYPE SPECIES: *Oliva annulata* Gmelin, 1791 Recent, tropical Indo-Pacific.

SPECIES IN ANNULATOLIVA

Oliva (Annulatoliva) aniomina Duclos, 1835, (Plate 3, Figures 5, 6)

Description: Shell slender, bright yellow-orange with zig-zag longitudinal flammules of purple-brown; some specimens peppered with fine brown dots.

Discussion: This deep water species is endemic to Papua-New Guinea and the Solomon Islands. *O. aniomina* is closest to *O. buloui inscripta*. *O. aniomina* is a slender species with a length to width ratio of approximately 2.4 to 1 as compared to approximately 2 to 1 or stockier for *O. buloui*.

Size: Approximately 20 to 35 mm in length.

Oliva (Annulatoliva) annulata Gmelin, 1791 (Plate 3, Figures 9, 10)

Synonyms: *leucophaea* Gmelin, 1791; *aurata* Link, 1807; *cruenta* Dillwyn, 1817; *cruenta* Reeve, 1850; *baltheata* Dillwyn, 1817; *cinculata* Röding, 1798

Description: Shell large for subgenus, somewhat elliptical in shape, but swollen at the shoulder; spire high and protracted; typical variety with pinkish-cream or yellowish-ink color, sub-sutural spots or mottlings of a darker shade of the ground color; aperture salmon-orange.

Discussion: *Oliva annulata annulata* comes in a variety of forms that differ both in color and shape. Often one form will show variation into another form within the same specimen. Groups of specimens from identical populations may show almost all of the named variations. These color varieties may result from dietary differences, or simply from random genetic differences, much the same as the color variations that can be found in a litter of kittens. All of the color forms listed below, with the exception of form *guttata*, share the same geographical range and habitat as does the typical *O. annulata*. This species is widespread throughout the Indo-Pacific and is found in shallow water.

Size: Approximately 40 mm to 50 mm in length.

Oliva (Annulatoliva) annulata color form *alba* Sowerby, 1825, (Plate 3, Figures 7, 8)

Description: Pure white or albinistic variety; white aperture.

Oliva (Annulatoliva) annulata color form *amethystina* Röding, 1798, (Plate 3, Figures 11, 12)

Description: Bright salmon-pink, with bright purple spots.

Oliva (Annulatoliva) annulata color form *carnicolor* Dautzenberg, 1927. (Plate 3, Figures 13, 14)

Description: Solid, deep pinkish-orange variety.

Oliva (Annulatoliva) annulata color form *guttata* Fischer, 1807, (Plate 3, Figures 15, 16)

Description: Pinkish-cream ground color, with large evenly spaced dark pink spots; dark brown to black subsutural markings.

Discussion: This variety has been obtained only from Taiwan and may represent a valid subspecies. We have only been able to obtain two specimens, which is not enough for us to make a judgement on this matter.

Oliva (Annulatoliva) annulata color form *intricata* Dautzenberg, 1927, (Plate 3, Figures 18, 19)

Description: Pinkish-cream color, overlaid with dense cloudings of reddish-tan spots and peppered with black spots over the entire body; aperture bright orange-yellow.

Oliva (Annulatoliva) annulata form *mantichora* Duclos, 1835, (Plate 3, Figures 20, 21)

Description: Short, squat, coniform variety; with a swollen shoulder or raised cord around the posterior third of the body whorl. This form may come in any of the color forms that have been mentioned.

Oliva (Annulatoliva) annulata color form *nebulosa* Dautzen-

berg, 1927, (Plate 3, Figures 17)

Description: Pinkish-cream colored with variable amounts of brown or pinkish-tan mottling or cloudings. Often found in the *mantichora* variety.

Oliva (Annulatoliva) buloui Sowerby, 1887, (Plate 4, Figures 1, 2)

Description: Shell, short, squat, somewhat coniform; deep orange-red ground color, overlaid with faint red flammules and mottlings, dark purple-brown oblique flammules on anterior half of body whorl.

Discussion: This species is found offshore in deeper waters and is restricted to Papua-New Guinea and the Solomon Islands.

Size: Average 15 mm but may rarely reach 25 mm in length.

Oliva (Annulatoliva) buloui inscripta Petuch and Sargent, new subspecies, (Plate 4, Figures 3, 4, 5)

Description: Shell small for subgenus, thick, squat, ovate in outline; spire only moderately elevated; color dark tan-orange and greenish-brown, overlaid with a dense, reticulated pattern of thin, brown longitudinal lines, large brown dots, and large, distinct, orange triangles; aperture white; enamel on spire whorls dark brown; subsutural area above shoulder khaki-green with tiny brown speckles.

Holotype: Length 22 mm, width 11 mm, trawled from 30 meters depth, on muddy sand bottom off Lungga River, Guadalcanal Island, Solomon Islands. USNM 841440.

Etymology: *inscripta*, in reference to the fine reticulated, inscribed, color pattern of this new subspecies.

Discussion: *Oliva buloui inscripta* differs from typical *O. buloui* in being a shorter, squatter shell, with a lower spire, by having a dark khaki-green and tan base color, and by having the entire shell, from the anterior tip to the shoulder, covered with longitudinal lines and large triangles. The greenish and brown-speckled shoulder and subsutural area is also characteristic of this new subspecies. *O. buloui inscripta* is endemic to deeper water areas in the southern Solomon Islands, the southernmost tip of the range of *O. buloui*.

Size: Approximately 22 mm in length.

Oliva (Annulatoliva) buloui stoneorum Petuch and Sargent, new subspecies, (Plate 4, Figures 6, 7, 8)

Description: Shell small for subgenus, thick, squat, ovate in outline; spire only moderately elevated; color light yellow orange, covered with evenly-spaced large pale purple-tan spots; spire whorls partially covered with bright red-orange enamel; aperture white; columellar area white with 6 to 10 small plicae.

Holotype: Length 20 mm, width 10 mm, trawled from 40 meters depth off Gavutu Island, Florida Islands, Solomon Islands. USNM 841453.

Etymology: Named for Delmer and Joyce Stone, who collected the type lot while dredging from their Chinese junk in the Solomon Islands.

Discussion: This beautiful new subspecies of *O. buloui* differs from the typical form in having a consistently different color pattern composed of a bright yellow-orange background covered with regularly spaced purple spots. *O. buloui stoneorum* also lacks the red-orange color, and the purple oblique stripes on the anterior half of the body whorl. This new subspecies inhabits deeper water than does *O. buloui buloui*.

Hinton, 1981 (*Guide to the Shells of Papua-New Guinea*, p34, Figures 9, 9a) illustrates this new subspecies of *O. buloui* and comments on its resemblance to some varieties of *O. annulata*. Future research may prove this to be a full species. *Oliva buloui stoneorum* is endemic to the Solomon Sea area and the Solomon Islands.

Size: Approximately 20 mm in length.

Oliva (Annulatoliva) parkinsoni Prior, 1975 (Plate 4, Figures 9, 10)

Description: Shell with a characteristic sharply angled cord on shoulder; cream-colored overlaid with dense mottling of deep red or orange-brown.

Discussion: Endemic to the Solomon Sea area and the Solomon Islands. *O. parkinsoni* is found in moderately deep water.

Size: Approximately 20 mm in length.

Oliva (Annulatoliva) parkinsoni unnamed color form, (Plate 4, Figures 11, 12)

Description: Pale cream-yellow form.

Discussion: The specimen in our possession was collected at a depth of 100 meters off New Britain Island.

Size: 19 mm in length.

Subgenus *Arctoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells medium size for genus, thin, very elongated, with straight sides; spires flattened, characteristically deeply canaliculate; edges of sutures raised, blade-like; columellar plications large, well developed. Confined to the Bay of Bengal region.

TYPE SPECIES: *Oliva arctata* Marrat, 1871. Recent, Bay of Bengal.

SPECIES IN ARCTOLIVA

Oliva (Arctoliva) arctata Marrat, 1871, (Plate 4, Figures 13, 14, 18, 19)

(Synonym: *zeigleri* da Motta, 1981)

Description: Color yellow-orange overlaid by dense pattern of dark brown dots and zig-zag flammules; two wide chocolate brown bands, one at shoulder and one around mid-body; sub-sutural area pale greenish yellow, without pattern; blade-like edges of sutures flare outward; aperture deep purple-blue; columellar area white with pale orange blotch at anterior end; shape cylindrical and elongated.

Discussion: Restricted to the Mergui Archipelago of Burma and the western coast of Thailand in the Bay of Bengal. *O. arctata* is found offshore in deeper water.

Size: Average 40 mm in length but may reach 60 mm.

Oliva (Arctoliva) arctata dark color form, (Plate 4, Figure 15)

Description: Essentially the same as typical *O. arctata* but

covered with dark brown patches. This variation was referred to as variety B by da Motta (1981).

Subgenus *Cariboliva* Petuch and Sargent, new subgenus.

DIAGNOSIS: Shells medium size for genus, elongated, with straight sides; spires flattened or elevated, deeply canaliculate; color patterns composed of networks of small triangles; columellar plications numerous, fine. This subgenus converges on the shell morphology of the subgenus *Arctoliva*. The species of *Cariboliva* are confined to the Caribbean region.

TYPE SPECIES: *Oliva scripta* Lamarck, 1811, Recent, Caribbean Sea.

SPECIES IN CARIBOLIVA

Oliva (Cariboliva) scripta Lamarck, 1811, (Plate 4, Figures 22, 23)

(Synonym: *caribaeensis* Dall and Simpson, 1901)

Description: Tan, overlaid with loose pattern of brown zig-zags and triangles; two bands of large brown zig-zags sometimes present; aperture lavender; shape cylindrical and elongate.

Discussion: Ranges from Cuba and the Greater Antilles to the Netherlands Antilles. *O. scripta* is found in shallow water.

Size: Approximately 45 mm in length.

Oliva (Cariboliva) scripta color form *trujilloi* Clench, 1938, (Plate 4, Figures 24, 25)

Description: Pale orange-tan color form; occasionally more slender and lighter in weight than the typical *O. scripta*. Most specimens of this form that we have seen were taken dead and were simply faded. It is important to note that when any *Oliva* species is left out in the sun and the weather, it will fade and develop a reddish or pinkish cast to its normal color pattern.

Oliva (Cariboliva) scripta venezuelana Petuch and Sargent, new subspecies, (Plate 4, Figures 20, 21)

Description: Shell of medium size for genus, heavy, thickened, squat and rotund, with straight sides; spire flattened, truncated; color yellow-tan to greenish, overlaid with obscuring pattern of brown cloudings and longitudinal zig-zag lines; some specimens with two bands of dark brown zig-zags encircling the body whorl; interior of aperture white; columellar area white with 15 to 17 small, rounded plicae.

Holotype: Length 45 mm, width 22 mm, trawled by commercial shrimpers from 30 meters depth off Punto Fijo, Paraguana Peninsula, Gulf of Venezuela, Venezuela. USNM 841451.

Etymology: Named for the Gulf of Venezuela, the type locality.

Discussion: This new northern South American subspecies of the widespread Caribbean *O. scripta* differs from the nominate subspecies in several ways; it is a much wider, broader shell in proportion to shell length, it has a distinctive color pattern of coalesced brown cloudings instead of the concise triangles of *O. scripta scripta*. *O. scripta venezuelana* also has a white aperture instead of purple, and it has a much wider sutural canal with the posterior edge of the outer body whorl being blade-like and flared. *Oliva scripta venezuelana* ranges from the Goajira Peninsula of Colombia and Venezuela to off Margarita Island, Venezuela, and is confined to coastal waters.

Size: Approximately 40 mm in length.

Subgenus *Carmione* Gray, 1858

TYPE SPECIES: *Oliva inflata* Lamarck, 1811 = *O. bulbosa* Röding, 1798. Recent, western Indian Ocean.

SPECIES IN CARMIONE

Oliva (Carmione) avellana Lamarck, 1811 (Plate 5, Figures 1, 2)

Description: Pale yellow-cream, gold-tan or gray, overlaid with dense network of very faint tan triangles and dots; two bands of dark brown flammules; aperture pale reddish-brown.

Discussion: *O. avellana* can be distinguished from *O. bulbiformis*

by its reddish-brown aperture and its more elongated, cylindrical shape. *O. bulbiformis* has an ovate, almost round, shape and a white aperture. *Oliva avellana* is restricted to the Solomon Sea area from eastern Papua New Guinea to and around the Solomon Islands.

Size: Approximately 30 to 35 mm in length.

Oliva (Carmione) avellana color form *blanda* Marrat, 1867 (Plate 4, Figures 26, 27)

Description: Color form with slate gray background, two wide, dark gray bands and a purplish-brown aperture.

Oliva (Carmione) avellana form *calosoma* Duclos, 1835 (Plate 6, Figures 5, 6)

Description: Color white with very faint purple spotting; two diffuse bands of scattered, purple-brown flammules; spire protracted and enameled over with a white deposit; aperture purplish.

Discussion: *O. calosoma* has been considered to be a separate species by some authors, however, we have received several lots of *O. avellana* from areas in the Solomon Islands that range from the rare, slender, white *calosoma* to the dark gray *blanda* form. Form *calosoma* is restricted to New Guinea and the Solomon Islands, where it is found most commonly on Guadalcanal.

Size: Approximately 25 mm in length.

Oliva (Carmione) avellana form *propinqua* Marrat, 1870 (Plate 7, Figures 7, 8)

Description: Bright yellowish-green overlaid with three wide bands of dark purple flammules; purple blotches and flammules with large, conspicuous, green triangles; aperture dark purple-brown.

Discussion: This form is found in shallow water in the Philippine Islands.

Size: Approximately 25 mm in length.

Oliva (Carmione) avellana unnamed color form (Plate 5, Figures 3, 4)

Description: Pure white with dark brown flecks; aperture pink.

Found primarily around Guadalcanal Island, Solomon Islands. This form can be distinguished from form *calosoma* which has a purple aperture and is much more slender and elongated.

Oliva (Carmione) bulbiformis Duclos, 1835 (Plate 5, Figures 5, 6)

Description: Very inflated and obese, some specimens almost round in shape; color yellowish-tan, gold or gray, overlaid with a dense network of dark gray triangles and dots; two bands of black flammules; aperture white or light gray.

Discussion: The color and pattern of this species is extremely variable with some specimens being golden in color and heavily banded and others appearing a uniform dark gray. However, the shape and structure of this species is very constant, being much more obese and having a lower, flatter spire than *O. avellana*.

O. bulbiformis is found primarily in the Philippines and Papua New Guinea, however; its range also extends into the Solomon Sea area where there is some overlap with the range of *O. avellana*. *O. bulbiformis* is a shallow water species.

Size: Approximately 20 to 30 mm in length.

Oliva (Carmione) bulbiformis unnamed color form (Plate 5, Figures 7, 8)

Description: Bright orange-yellow or golden color form, dark distinct black bands may be present or totally absent. This form is found uncommonly in both the Philippine and Papua New Guinea areas.

Oliva (Carmione) bulbosa Röding, 1798 (Plate 5, Figures 9, 10)

(Synonyms: *gibbosa* Deshayes, 1844; *alba* Johnson, 1915; *ventricosa* Dillwyn, 1817; *ovum-ralli* Ford, 1889; *bicincta* Lamarck, 1822; *crassa* Mörch, 1852)

Description: Very inflated, heavy; color white, yellowish or tan, overlaid with numerous pale gray dots; aperture pale brown, purple brown or white; columellar fasciole with pronounced ridges, which may, or may not be stained with a reddish brown color.

Discussion: *Oliva bulbosa* is an extremely variable species in both shape and color. Many color forms have been given names by early workers, however; most of these forms are found throughout the range of this species, occurring in almost every population. The authors have had the opportunity to examine lots of thousands of specimens that were collected commercially in many parts of their range. *Oliva bulbosa* is found throughout the western Indian Ocean from Natal, South Africa to western Indonesia, in shallow water.

Size: Average length 30 to 40 mm. Dwarf populations of 25 mm or less are common along the coast of East Africa and in the Red Sea.

Oliva (Carmione) bulbosa color form *aurata* Link, 1807 (Plate 5, Figures 13, 14)

Description: Solid, bright golden-orange color form.

Oliva (Carmione) bulbosa color form *bicingulata* Lamarck, 1811 (Plate 5, Figures 11, 12)

Description: White or grayish-tan with gray spots and two wide, dark brown bands.

Oliva (Carmione) bulbosa color form *fabagina* Lamarck, 1811 (Plate 5, Figures 15, 16)

Description: Color form with large dark brown, irregular patches.

Oliva (Carmione) bulbosa color form *immaculata* Vanatta, 1915 (Plate 5, Figures 21, 22)

Description: Pure white color form; albinistic.

Oliva (Carmione) bulbosa color form *inflata* Lamarck, 1811 (Plate 5, Figures 17, 18)

Description: White with fine gray spots and two wide, bright orange bands.

Oliva (Carmione) bulbosa color form *lacertina* Quoy and Gaimard, 1825. (Plate 5, Figures 19, 20)

Description: Uniform greenish-brown or gray with large, dark brown or black, widely-spaced, longitudinal, undulating zig-zags. The name is derived from this pattern, which reminded the authors of the pattern exhibited by certain species of European lizards of the genus *Lacerta*.

Oliva (Carmione) bulbosa color form *tuberosa* Röding, 1798 (Plate 6, Figures 1, 2)

Description: White or grayish, with gray spots and small brown flammules; heavy and inflated, often heavily callused and crassate. Specimens falling into this description are generally gerontic adults, hereby providing an example of the erroneous practice of placing taxonomic distinctions (names) on forms. A single specimen can start out as a typical *O. bulbosa* and can become *tuberosa* as it matures.

Oliva (Carmione) bulbosa color form *undata* Lamarck, 1811 (Plate 6, Figures 3, 4)

Description: White, overlaid with distinct, evenly-spaced, dark brown, pinkish-tan or golden zig-zags to form a netted pattern.

Oliva (Carmione) caroliniana Duclos, 1835 (Plate 6, Figures 7, 8, 9)

Description: White with numerous dark brown spots and two bands of dark brown blotches; some specimens without bands, some with large, dark brown zig-zag flammules; suture sharply defined with sharp-edged shoulder; aperture purple.

Discussion: *Oliva caroliniana* is restricted to the Indian Ocean, from Cape Province, South Africa to the Maldive Islands. This is a shallow water species.

Size: Approximately 25 to 30 mm in length.

Oliva (Carmione) caroliniana color form *scitula* Marrat, 1870 (Plate 6, Figures 10, 11)

Description: Color rusty reddish-tan with brown spots; bands reduced; shoulder and suture more rounded than in the typical form. This form is restricted to southernmost Mozambique and

South Africa.

Oliva (Carmione) dactyliola Duclos, 1835 (Plate 6, Figures 12, 13, 18)

(Synonym: *funnebralis* Tryon, 1883 not *funnebralis* Lamarck, 1811)

Description: Olive green or yellowish, overlaid with dark green speckles and triangles; aperture white; columella white with pale salmon-orange patch at anterior end.

Discussion: *Oliva dactyliola* is one of many nondescript "green olive" species that are differentiated by very subtle, but consistent characteristics. It is closest to *O. lecoquiana* but differs by being a larger, more elongated shell that is generally lighter in color. *Oliva dactyliola* ranges from the Philippine Islands and Indonesia to the Fijis, in shallow water.

Size: Approximately 30 mm in length.

Oliva (Carmione) dactyliola color form *valentina* Duclos, 1844 (Plate 7, Figures 18, 19)

Description: Color orange to mustard yellow, overlaid with loose

pattern of reddish-brown zig-zags and triangles; spire covered with large, thick, bright orange callus; aperture pale lavender; columella white with large orange patch at anterior end.

Discussion: This rare, shallow water form is restricted in range to Papua New Guinea and the Solomon Islands.

Size: Approximately 35 mm in length.

Oliva (Carmione) funnebralis Lamarck, 1811 (Plate 6, Figures 19, 20)

(Synonym: *avellana* Marrat, 1871 not *avellana* Lamarck, 1811)

Description: Extremely variable in color and pattern, ground color of yellow, tan, light green or dark khaki green, overlaid with dense pattern of black zig-zag flammules; some specimens with two black bands around body whorl; some specimens completely black; spire callused-over with black or dark green enamel; aperture and columella white.

Discussion: *Oliva funnebralis* was considered by Lamarck to be a dark, funeral-looking shell. In spite of its variability of color

and pattern, structurally this is a very consistent species, which makes it relatively easy for the experienced malacologist and/or collector to identify. This species ranges from Sri Lanka and the Bay of Bengal to Indonesia, the Philippines and the Fijis. It is found in shallow water.

Size: Approximately 30 mm in length.

Oliva (Carmione) funebris unnamed color form (Plate 6, Figures 14, 15)

Description: Green with darker green zig-zags. Common in the Philippines. This could possibly be *O. labradorensis* Röding, 1798, which again, would only represent a color variety of *O. funebris*.

Oliva (Carmione) galeola Duclos, 1835 (Plate 6, Figures 16, 17)

Description: Bright yellow, overlaid with green reticulated pattern. Two bands of dark green-brown blotches around mid-body; aperture white; columella white with pale orange patch at anterior end; spire covered with bright yellow callus.

Discussion: This species differs from *funebris* by being a larger, more cylindrical and slender shell and by having a bright yellow ground color and yellow spire enamel. The spire of *funebris* is almost always dark or black. *Oliva galeola* is restricted in range to the Philippines and Indonesia.

Size: Approximately 35 to 40 mm in length.

Oliva (Carmione) galeola color form *lutea* Marrat, 1871 Plate 6, Figures 21, 22)

Description: Color creamy-white or yellowish with scattered green dots; spire flattened and calloused over with white enamel; aperture pale purple-brown.

Discussion: A typical specimen of form *lutea* is more slender than the average *O. galeola*, however, many specimens are found that exhibit characteristics intermediate to both forms. These are found in lots collected in the same localities.

Size: Approximately 35 mm in length.

Oliva (Carmione) keeni Marrat, 1871 (Plate 6, Figures 23, 24)

Description: Color dark olive green, overlaid with close-packed, dark green ziz-zag flammules; two bands of dark green blotches on body whorl; spire callused-over and completely flat, giving a truncated appearance to the shell.

Discussion: *Oliva keeni* has the flattest spire of any known olive and it is one of the rarest of the *Oliva* species. This species is found in shallow water from the Philippines and Indonesia to Papua New Guinea.

Size: Approximately 45 to 50 mm in length.

Oliva (Carmione) lecoquiana Ducros de St. Germain, 1857 (Plate 7, Figures 1, 2)

Description: Shell very inflated and obese, spire elevated; color dark khaki green and brown, overlaid with dense pattern of brown dots and zig-zags; dark brown to black band around mid-body on some specimens; columella appears flattened in center and provides a convex protrusion into the aperture.

Discussion: This species ranges from the Philippines and Indonesia to the Fijis. This species has been collected by the senior author in shallow water along the northern coast of Viti Levu Island in the Fijis. *Oliva lecoquiana* is a rare species.

Size: Approximately 25 mm in length.

Oliva (Carmione) mucronalis Petuch and Sargent, new name for *mucronata* Marrat, 1871 not *mucronata* d'Orbigny, 1850 (a fossil) (Plate 7, Figures 3, 4)

Description: Dark gray-green covered with a dense pattern of dark gray ziz-zags; columellar fasciole dark brown; spire completely covered with thick, gray-green callus; mucronated.

Discussion: This species is the smallest of the subgenus ranging from approximately 15 to 20 mm in length. It is easily distinguished from *funeralis* by being more ovate in shape. Gerontic adults may develop a light orange-white edge on the lip of the body whorl. This species is found in deeper water and ranges from the Philippines and Indonesia to the Fijis.

Size: Adult specimens from 15 to 20 mm in length.

***Oliva (Carmione) picta* Reeve, 1850 (Plate 7, Figures 5, 6)**

Description: Bright blue-green, overlaid with widely-spaced, dark purple ziz-zag flammules; aperture white.

Discussion: Inhabits shallow water and is restricted in range to the Philippine Islands. *Oliva picta* is one of the rarest of the living olive shells.

Size: Approximately 25 mm in length.

***Oliva (Carmione) similis* Marrat, 1867 (Plate 7, Figures 9, 10)**

Description: Shell elongated with rounded shoulder; color mustard yellow copiously covered with small, purple-brown dots; aperture purple-brown; protoconch dark purple-brown.

Discussion: This rare, shallow water species ranges from the Philippines and Indonesia to New Guinea and the Solomon Islands.

Size: Approximately 40 mm in length. A dwarf population with adults approximately 25 mm in length, occurs in the Solomon Islands.

***Oliva (Carmione) tigrina* Lamarck, 1811 (Plate 7, Figures 11, 12)**

Description: Yellowish-gray with abundant, large gray-green spots and zig-zag flammules; some specimens covered with patches of milky enamel; aperture pale purple or gray.

Discussion: The typical form of *O. tigrina* ranges throughout the Indian Ocean from east Africa to Sri Lanka and the Maldives Islands. This species is also found from the Philippines and Indonesia to Papua New Guinea. Specimens from the eastern portion of the range generally appear to be somewhat more obese (See the discussion under form *holoserica*). This is a common species in the western portion of its range and it is commonly collected with *O. bulbosa* in shallow water.

Size: Approximately 50 mm in length.

***Oliva (Carmione) tigrina* color form *fallax* Johnson, 1910 (Plate 7, Figures 15, 16)**

Description: Solid black or dark brown color form; white band around columellar fasciole. Most commonly found in East

Africa. However, we have one specimen that was collected on the Island of Bali in Indonesia.

Oliva (Carmione) tigrina color form *glandiformis* Marrat, 1871 (Plate 7, Figure 17)

Description: This color form appears to be intermediate between the typical *O. tigrina* and color form *fallax*. The color is dark brown or black with large patches of milky bluish or grayish white.

Oliva (Carmione) tigrina form *holoserica* Marrat, 1871 (Plate 7, Figures 13, 14)

Description: Shell very inflated and obese; color medium bluish or greyish green or yellow, overlaid with darker green spots and scattered brown patches; spire partially covered with dark purple-brown callus; aperture white.

Discussion: This shorter, squat form of *O. tigrina* was initially described from the eastern portion of the range of the species and was thought to be a distinct species in itself. Further investigation has shown that some East African populations also come closer to this description than to the typical form, thus relegating *holoserica* to being simply a named form of *O. tigrina*.

Size: Approximately 40 to 45 mm in length.

Subgenus *Galeola* Gray, 1858

TYPE SPECIES: *Oliva carneola* Gmelin, 1791. Recent, tropical Indo-Pacific.

SPECIES IN GALEOLA

Oliva (Galeola) andamanensis Bridgman, 1909 (Plate 8, Figures 1, 2)

Description: Deep mustard yellow, overlaid with pale reddish-purple zig-zags; edge of suture with bright red stripe; spire whorls completely covered with white callus with faint red stripe; aperture bright purple.

Discussion: *Oliva andamanensis* is a rare, deep water species

that is endemic to the Andaman Islands in the Bay of Bengal.

Size: Approximately 22 mm in length.

Oliva (Galeola) carneola Gmelin, 1791 (Plate 8, Figures 3, 4)

Description: Shell small, stout, cylindrical; spire covered completely with a white or light colored callus; color extremely variable, typical form bright orange-red with one or two pale mid-body bands; aperture white.

Discussion: *Oliva carneola* comes in one of the widest arrays of brilliant color variations available in any species of marine gastropod. Unfortunately, many overenthusiastic early workers have named most of them, basing their findings on such insignificant characteristics as the number of bands, the color of the shell or the shape of the color pattern, even when specimens were taken from the same population. Of the many named forms of this species, only two populations may have any taxonomic significance. These are *O. carneola violacea* from Rabaul, New Guinea and a unique banded population from the Kwajalein Atoll Lagoon. This species ranges from the Philippine Islands and Indonesia eastward to Micronesia and Polynesia. *Oliva carneola* is a shallow water species.

Size: Approximately 10 to 20 mm in length.

Oliva (Galeola) carneola color form *adpersa* Dautzenberg, 1927 (Plate 8, Figures 5, 6)

Description: Color form with scattered, small white triangles on a reddish or purplish background.

Oliva (Galeola) carneola color form *aurora* Fischer, 1807 (Plate 8, Figures 7, 8)

Description: Bright, solid yellow color form.

Oliva (Galeola) carneola color form *bizonalis* Dautzenberg, 1927 (Plate 8, Figures 9, 10)

Description: Red, orange or yellow, with two well-defined, white mid-body bands.

Oliva (Galeola) carneola color form *candidula* Dautzenberg, 1927 (Plate 8, Figures 13, 14)

Description: Red or brown with a faint, partial central band.

Oliva (Galeola) carneola color form *coccinata* Dautzenberg, 1927 (Plate 39, Figures 7, 8)

Description: Bright, solid red color form.

Oliva (Galeola) carneola color form *trichroma* Dautzenberg, 1927 (Plate 8, Figures 15, 16)

Description: Color form with amorphous bands of orange, purple, white and yellow.

Oliva (Galeola) carneola color form *unizonalis* Dautzenberg, 1927 (Plate 8, Figures 17, 18)

Description: Red or orange with a single, wide, mid-body band.

Oliva (Galeola) carneola color form *violacea* Prior, 1975 (Plate 8, Figures 19, 20)

Description: Bright lavender to purple with two paler mid-body bands.

Discussion: All of the specimens that we have examined from the type locality, near Rabaul, New Guinea, exhibit this peculiar coloration.

Oliva (Galeola) carneola Gmelin, 1791 albino color form (Plate 8, Figures 21, 22)

Description: Pure white color form.

Oliva (Galeola) carneola kwajaleinensis da Motta, 1985 (Plate 8, Figures 11, 12)

Description: Bright yellow in color; two white mid body bands; area under bands heavily corded to produce raised rings around body whorl.

Discussion: This new subspecies is found in the lagoon on Kwa jalein Atoll in the Marshall Islands.

Oliva (Galeola) ceramensis Schepman, 1911 (Plate 8, Figures

23, 24)

Description: Shell small for subgenus; tan in color, covered with a dense pattern of fine, brown, close-knit reticulations; spire covered with a thick, white or yellowish callus; aperture purple.

Discussion: Most specimens trawled from deep water (over 50 meters). This species ranges from the Philippines and Indonesia to the Solomon Islands.

Size: Approximately 10 to 15 mm in length.

Oliva (Galeola) insecta Petuch and Sargent, new species (Plate 8, Figures 27, 28, 29, 30)

Description: Shell small for subgenus, ovate with rounded sides; color pale tan overlaid with widely-spaced, brown, longitudinal zig-zag flammules in a zebra pattern; some specimens with two rows of small, dark brown spots; spire covered with dark purple-brown callus; aperture purple.

Holotype: Length 14 mm, width 5 mm, trawled by fishermen from 100 meters depth in Davao Bay, Mindanao Island, Philippines. USNM 841437.

Etymology: *insecta*, in reference to its small, bug-like appearance.

Discussion: *Oliva insecta* is closest to *ceramensis*, but differs in being a smaller shell with a loose zig-zag pattern instead of a reticulated pattern. The purple spire callus of *insecta* also differs from the whitish callus of *ceramensis*. *Oliva insecta* is restricted to deep water in the Philippines, where it occurs together with the wider-ranging *ceramensis*. Due to its habitat, *O. insecta* is difficult to obtain.

Size: Approximately 6 to 8 mm in length.

Oliva (Galeola) lepida Duclos, 1835 (Plate 8, Figures 39, 40)

Description: Shell elongate with rounded sides; spire elevated, covered with callus; color white, overlaid with reddish-brown or pinkish, zig-zag flammules; band of blotches around mid-body; aperture white or pale lavender.

Discussion: Ranges from east Africa to Indonesia and the Philippines, eastward to the Fijis, in shallow water.

Size: Approximately 15 to 20 mm in length.

Oliva Galeola lepida color form *eridona* Duclos, 1814 (Plate 8, Figures 25, 26)

Description: Shell long and slender; color solid yellow or solid reddish-brown; spire elevated, with large callus, same color as shell; aperture white; columella with 30 to 40 fine, well-developed plications.

Discussion: Former *eridona* is restricted to the southern coast of Papua New Guinea.

Size: Approximately 22 mm in length.

Oliva (Galeola) lepida unnamed color form (Plate 8, Figures 31, 32)

Description: Pink and red color form.

Oliva (Galeola) lepida solomonensis Petuch and Sargent, new subspecies (Plate 8, Figures 35, 36)

Description: Shell of average size for subgenus, slender, elongated, with straight sides; color white or light gray, overlaid with pattern of fine brown triangles and zig-zags; prominent, dark brown band around mid body; spire only moderately elevated, with thick white or purple callus; aperture purple or white.

Holotype: Length 16 mm, width 7 mm, collected at 1 meter depth on sand flat off Nimoa Island, Calvados Chain, Louisiade Archipelago, Solomon Sea. USNM 841455.

Etymology: Named for the Solomon Sea, the type locality.

Discussion: This new subspecies differs from the typical *lepida* in being consistently smaller, much more slender and elongated, by having a lower spire and by being darker in color. *O. lepida solomonensis* is restricted to the islands in the Solomon Sea.

Size: Approximately 10 mm in length.

Oliva (Galeola) sidelia Duclos, 1835 (Plate 8, Figures 37, 38)

(Synonym: *athenia* of Zeigler and Porreca, 1969 not *athenia* Duclos)

Description: Shell bright yellow, overlaid with a pattern of close-packed reddish-brown zig-zags and fine triangles; spire low, completely covered by thick, white callus; aperture pale

lavender.

Discussion: Ranges from the Bay of Bengal to the Philippines and eastward to the Fijis, in shallow water.

Size: Approximately 20 mm in length.

Oliva (Galeola) sidelia color form *grata* Marrat, 1871 (Plate 8, Figures 33, 34)

Description: Yellow-orange overlaid with dark brown blotches, triangles, and reticulations; large yellow triangles are characteristic of this form; aperture deep purple.

Discussion: Most commonly found in the Philippines.

Oliva (Galeola) todosina Duclos, 1835 (Plate 9, Figures 1, 2, 3, 4)

Description: Shell stocky and cylindrical; spire flat, covered with callus; color yellow-cream or white, with reddish-brown zig-zags and two wide, brown bands; aperture lavender; subsutural area white.

Discussion: Ranges from East Africa to the Fijis, in shallow water.

Size: Approximately 20 mm in length.

Oliva (Galeola) todosina unnamed color form (Plate 9, Figures 5, 6)

Description: Pinkish-yellow with fine, pink, netted pattern; no bands.

Oliva (Galeola) volvaroides Duclos, 1835 (Plate 9, Figures 7, 8)

Description: Shell stocky and cylindrical; spire moderately elevated and covered with a thick, heavy callus; color tan or yellow with a diffuse, "smeared" pattern of pale brown flammules; faint band around mid-body sometimes present.

Discussion: Ranges from East Africa to Micronesia, Polynesia and Japan, in shallow water. Differs from *todosina* in having a higher spire; differs from *sidelia* by being more rotund and cylindrical and by lacking the triangle color pattern.

Size: Approximately 15 mm in length.

Oliva (Galeola) volvaroides unnamed color form (Plate 9, Figures 11, 12)

Description: White with bright purple flammules. Most often collected in the Ryukyu Islands and southern Japan.

Oliva (Galeola) volvaroides unnamed color form (Plate 9, Figures 9, 10)

Description: White with bright pink flammules. Most often collected in the Ryukyu Islands.

Oliva (Galeola) volvaroides unnamed color form (Plate 9, Figures 13, 14)

Description: Common, solid dark brown color form.

Oliva (Galeola) volvaroides unnamed color form (Plate 9, Figures 15, 16)

Description: Common, solid golden-yellow color form.

Oliva (Galeola) xenos Petuch and Sargent, new species (Plate 9, Figures 17, 18)

Description: Shell small for subgenus, cylindrical; color pale tan, overlaid by very fine reddish-brown reticulations and longitudinal zig-zag flammules; two rows of large, prominent, dark brown blotches around body whorl, one at shoulder, one around mid-body; spire flat, covered with thick, white callus; aperture pale lavender-white.

Holotype: Length 19 mm, width 8 mm, collected on sand bottom at 12 meters depth in Austria Sound, Santa Isabel Island, Solomon Islands. USNM 841448.

Etymology: "*Xenos*" strange, in reference to the unusual color pattern of the new species.

Discussion: *Oliva xenos* is closest in resemblance to *O. insecta*, but differs in having a finer, reticulated color pattern and two rows of large, prominent brown blotches. The spire callus of *insecta* is purple, while that of *xenos* is white. *Oliva xenos* also tends to be a more slender shell and it is found in much shallower water. This new species is found at shallow to moderate depths

(approximately 10 to 20 meters) and ranges from the Philippines to the Solomon Islands.

Size: Approximately 10 mm in length.

Subgenus *Miniaceoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells large for genus, elongated with rounded sides and shoulders; spires elevated, some species with protracted, scalariform spires, others with spires covered by calluses; apertures generally wide, flaring, often brightly colored with reds, purples or blues.

TYPE SPECIES: *Oliva miniacea* Röding, 1798. Recent, tropical western Pacific to Polynesia.

SPECIES IN MINIACEOLIVA

Oliva (Miniaceoliva) atalina Duclos, 1835 (Plate 9, Figures 19, 20)

Description: White with pale purple dots and scattered black blotches; spire white; aperture white.

Discussion: This species is easily distinguished from *caerulea* by its white aperture, and from *ponderosa* by being a much smaller, elongate shell, with a higher spire. *O. atalina* ranges from Madagascar and the Mascarene Islands to Western Australia and western Indonesia. This species is most commonly collected on Mauritius. It inhabits shallow to moderate depths.

Size: Approximately 40 mm in length.

Oliva (Miniaceoliva) caerulea Röding, 1798 (Plate 9, Figures 25, 26)

(Synonyms: *caeruleus* H. and A. Adams, 1853; *episcopalis* Lamarck, 1811)

Description: White, covered with a dense pattern of blue, purple and orange dots and light zig-zag flammules; spire callus with black flammules; interior of aperture deep purple-blue.

Discussion: Ranges from East Africa and the Red Sea to Polynesia. This is a shallow water species.

Size: Approximately 40 to 50 mm in length.

Oliva (Miniaceoliva) caerulea color form *emelioidina* Duclos, 1844 (Plate 9, Figures 27, 28)

Description: Shorter and more obese than typical form; spire higher and more pointed; color pattern more subdued than typical *O. caerulea*; aperture purple. This form is most commonly obtained from the area around Mauritius.

Oliva (Miniaceoliva) caerulea color form *lugubris* Lamarck, 1811 (Plate 9, Figures 21, 22)

Description: Color tan or orange-tan with large black blotches and flammules; aperture purple.

Oliva (Miniaceoliva) caerulea color form *philippensis* Bartsch, 1918 (Plate 9, Figures 29, 30)

Description: Almost completely covered with black; most common in the south central Philippines.

Oliva (Miniaceoliva) caerulea ponderi Petuch and Sargent, new subspecies (Plate 38, Figures 1, 2)

Description: Shell heavy, obese, large for species; color salmon-pink to creamy-white, overlaid with dark brown and reddish-brown zig zag flammules and elongated dots; body whorl pitted under dark markings, spire conical with large purple blotches; fasciole buff; aperture deep purple within, white along outer edge.

Holotype: Length 57 mm, width 27 mm, collected in shallow water, Port Headland, Western Australia. Australian National Museum.

Etymology: Named for Dr Winston Ponder, Curator of Malacology, Australian National Museum.

Discussion: *O. caerulea ponderi* is unique by having the body whorl pitted under many of the dark markings. All specimens that we have seen are much larger on the average than the typical *caerulea*. This subspecies is restricted to the western coast of Australia.

Size: 55 to over 60 mm in length.

Oliva (Miniaceoliva) fumosa Marrat, 1871 (Plate 10, Figures 1, 2)

Description: Shell cylindrical, stocky for subgenus, spire height moderate to low; ground color white to grayish tan, overlaid with darker brown spots and triangles, in many specimens the pattern is clouded and ill-defined; body whorl may have two wide bands of dark brown or black patches; aperture white.

Discussion: Similar to *tremulina*, but is shorter, stockier and more cylindrical in shape with a lower spire. *O. fumosa* rarely exceeds 60 mm in length. The white aperture distinguishes *O. fumosa* from *O. miniacea* which has a bright red-orange aperture. *O. fumosa* is also confused with some color forms of *O. irisans*, particularly form *ornata*. In this case the spire should be examined. *O. irisans* has a spire that is completely callused over so that the sutures are not visible or are barely visible under the enamel and *O. fumosa* has a spire that is not callused, but has sharply defined sutures extending to the protoconch. This species coexists with *tremulina*, *irisans* and *miniacea* throughout wide portions of its range. *Oliva fumosa* ranges from the Bay of Bengal, to Indonesia and the Philippines and eastward to the Fijis. This is a shallow water species.

Size: Average approximately 50 mm in length, but may reach a maximum length of about 60 mm.

Oliva (Miniaceoliva) fumosa concinna Marrat, 1871 (Plate 10, Figures 5, 6)

Description: Shorter, squatter and more ovate than the nominate subspecies. *O. fumosa concinna* has several color forms, with the classic *concinna* being solid dark brown or black. It is the earliest taxon for the subspecies and must be used.

Discussion: This is the subspecies from the southern Melanesian areas of Papua New Guinea, Vanuatu (the New Hebrides) and the Solomon Islands. This situation is the reverse of the norm. In this case the author described a color form that turned out to be a taxonomically significant subspecies.

Size: Average approximately 45 mm in length.

Oliva (Miniaceoliva) fumosa concinna color form *chrysoides*

Dautzenberg, 1927 (Plate 10, Figures 7, 8, 12)

Description: Solid golden orange color form.

Oliva (Miniaceoliva) fumosa concinna color form *oldi* Zeigler, 1969 (Plate 10, Figures 9, 10)

Description: Medium to dark bluish or greenish gray, overlaid with black or dark gray net pattern and two bands of black patches. This is the most common color form in the Solomon Islands.

Oliva (miniaceoliva) fumosa concinna light color form (Plate 39, Figures 1, 2, 3, 4)

Description: Pinkish to creamy white in color, overlaid with numerous brownish to purplish spots; aperture white to pale lavender.

Discussion: This form is restricted to Vanuatu and the Solomon Islands. Several lots of particularly large, handsome specimens have been received recently from Guadalcanal Island.

Size: 40 to 60 mm in length.

Oliva (Miniaceoliva) fumosa kremerorum Petuch and Sargent, new subspecies, (Plate 10, Figures 3, 4)

Description: Shell of average size for subgenus, slender, with high spire: shoulder sloping, almost nonexistent; color orange-cream overlaid with dense pattern of tan zig-zags and dots; body whorl encircled with two bands of darker tan patches; edge of suture marked with large dark brown and yellow dashes; spire whorls partially covered with dark tan callus; aperture white; columella and fasciole stained dark tan.

Holotype: Length 52 mm, width 22 mm, trawled by commercial fishermen from 20 meter depth off Madras, India, Bay of Bengal. USNM 841460.

Etymology: Named for Lee and Jan Kremer of Crystal Lake, Illinois, without whose support this work could not have been published.

Discussion: *Oliva fumosa kremerorum* is the western subspecies of *O. fumosa fumosa*. It differs from the nominate subspecies in being a more slender shell with a higher spire and in

having the columellar area stained tan instead of bright orange. This new subspecies is confined to the Bay of Bengal.

Size: Average length 40 to 60 mm in length.

Oliva (Miniaceoliva) hanleyorum Petuch and Sargent, new name for *O. cylindrica* Marrat, 1867 not *cylindrica* Sowerby, 1850 (a fossil) (Plate 10, Figures 11, 17, 18)

Description: Light blue-green to creamy white, overlaid with purple-brown zig-zag flammules and triangles; two bands of large brownish-gray blotches around body whorl, one at shoulder, one around mid-body; spire flat, without callus; subsutural area clear, without color pattern; aperture deep bluish-purple.

Discussion: Restricted to the Philippines and Indonesia, in shallow water.

Etymology: Named for Edward and Jacqueline Hanley, of Ft. Myers, Florida, who kindly donated specimens for our study.

Size: Approximately 40 to 50 mm in length.

Oliva (Miniaceoliva) hirasei Kira, 1959 (Plate 10, Figures 13, 14, 15, 16)

Description: Ground color bright creamy-yellow, yellow-orange to brownish-orange, overlaid with brown zig-zag flammules and dots; some specimens tan with dark brown, longitudinal zig-zags in zebra pattern; often with two bands of large brown blotches; subsutural area clear, without color pattern, bright yellow or yellow-orange; aperture white; some specimens with dark subsutural, concentric line.

Discussion: Ranges from southern Japan to the Philippines and Indonesia, in shallow water.

Size: Average 40 to 50 mm but may occasionally reach 60 mm in length.

Oliva (Miniaceoliva) irisans Lamarck, 1811 (Plate 11, Figures 1, 2)

(Synonym: *cryptospira* Ford, 1891)

Description: Extremely variable in color, generally white or gray with dark brown or purple-brown zig-zag flammules and dots with two bands of brown blotches; spire moderately elevated,

completely covered with a characteristic thick, pointed callus; aperture white, but may be lavender in some specimens from the southern portions of its range. This species is consistently elongated and cylindrical in shape.

Discussion: Lamarck's type is the solid golden-orange color form of the normally brown and white shell. Because *irisans* is the earliest taxon that has been applied to this species, it must be resurrected and used. The bright orange color form, which is most commonly found in the central Philippines, was named *cryptospira* by Ford, this name must be relegated to synonymity. This species has been called *lignaria* by many recent authors, including Zeigler and Porreca, 1969, but it differs from the true *lignaria*, which is an Australian species, by being a larger shell, with a lower and more heavily callused spire and by having a white or lavender aperture as compared to the deep purple aperture of *O. lignaria*. It is interesting to note that the Australian authors including Hinton, Wilson and Gillett all made the correct identification of these species. *O. irisans* ranges from the Ryuku Islands through the Philippines and Indonesia to northern Australia.

Size: Averages 50 to 60 mm in length but may occasionally exceed 70 mm.

Oliva (Miniaceoliva) irisans color form *albescens* Johnson, 1915 (Plate 11, Figures 3, 4)

Description: Pure white, albinistic color form.

Oliva (Miniaceoliva) irisans color form *fordi* Johnson, 1910 (Plate 11, Figures 5, 6)

Description: Solid dark brown or black color form.

Oliva (Miniaceoliva) irisans color form *ornata* Marrat, 1867 (Plate 11, Figures 7, 8, 9)

Description: White to grayish-tan with variable amounts of purple-brown or black triangles, blotches, dots or zig-zag flammules; aperture white, but may be lavender or light purple in specimens from Australia, Indonesia or the southern Philippines.

***Oliva (Miniaceoliva) lignaria* Marrat, 1867 (Plate 11, Figures 10, 11)**

Description: This is a typically slender, cylindrical, high-spired shell; color gray-green or bluish-green, overlaid with a dense pattern of reddish-brown or gray zig-zags and dots, two wide bands of brown or grayish blotches; spire without callus or semi-callosed; aperture deep purple.

Discussion: Like *irisans*, this species was named for one of its color forms. "Lignaria," meaning coal-like, refers to the dark brown or black form of this species. *O. lignaria* is smaller and much more slender than *irisans*. Its deep purple aperture and the higher spire without the callus further distinguish *lignaria* from its larger relative. This species is restricted to northwestern and northern Australia and the southern coast of Papua New Guinea. *O. lignaria* is a common shallow water species.

Size: Approximately 40 mm in length.

***Oliva (Miniaceoliva) lignaria* dark color form (Plate 11, Figures 12, 13, 14)**

Description: This melanistic color form, which is frequently found within populations, is similar to Marrat's type for the species.

***Oliva (Miniaceoliva) miniacea* Röding, 1798 (Plate 11, Figures 15, 16)**

(Synonyms: *erythrostoma* Lamarck, 1811; *magnifica* Ducros de St. Germain, 1857; *miniata* Link, 1807; *messaris* Marrat, 1871; *zeilanica* Johnson, 1910; *porphyritica* Marrat, 1871)

Description: Extremely variable, most commonly cream-yellow or yellow-orange, overlaid with a pattern of brown reticulations and triangles; two conspicuous bands of dark brown blotches around body whorl, one at shoulder, one around mid-body; aperture characteristically bright orange-red. Shell large, may be stout or elongated, spire of moderate height.

Discussion: This is another species which has many named forms and subspecies, these will be discussed below. *Oliva miniacea* ranges from southern Japan, southeast to Thailand, southward through the Philippines and Indonesia to Queens-

land, Australia and eastward to Polynesia. This is a shallow water species.

Size: *O. miniacea* is one of the largest of the *Oliva* reaching a maximum length of almost 100 mm. The average adult ranges from 50 to 70 mm in length, while some dwarf populations may reach a mature length of less than 40 mm.

Oliva (Miniaceoliva) miniacea color form *aurantiaca* Schumacher, 1817 (Plate 12, Figure 10)

Description: Color form with bright orange flammules and bands.

Oliva (Miniaceoliva) miniacea color form *azemula* Duclos, 1835 (Plate 12, Figures 4, 5)

Description: Shell thin, very narrow, and dwarfed (average 40 mm); color white or pale lilac with purple zig-zags and cloudings. Restricted to the Philippines.

Oliva (Miniaceoliva) miniacea color form *johnsoni* Higgins, 1919 (Plate 12, Figures 1, 2)

Description: Dark brown or black with large irregular white patches or triangles.

Oliva (Miniaceoliva) miniacea color form *marrati* Johnson, 1910 (Plate 12, Figures 3, 9)

Description: Solid black or dark brown color form.

Oliva (Miniaceoliva) miniacea color form *masaris* Duclos, 1835 (Plate 12, Figure 11)

Description: Brown or orange-tan with white spots and small triangles.

Oliva (Miniaceoliva) miniacea color form *titea* Duclos, 1844 (Plate 13, Figures 1, 2)

Description: Pure white, albinistic color form, aperture white.

Oliva (Miniaceoliva) miniacea color form *saturata* Dautzenberg, 1927 (Plate 12, Figures 6, 7)

Description: Covered with a network of fine triangle markings, similar to the typical pattern but darker, more saturated color.

Oliva (Miniaceoliva) miniacea color form *sylvia* Duclos, 1835 (Plate 12, Figure 8)

Description: Solid orange-red color form. Except for the pure white variety, this is the rarest of the *miniacea* color forms.

Oliva (Miniaceoliva) miniacea efasciata Dautzenberg, 1927 (Plate 13, Figures 3, 4)

Description: White with purple flammules and two broken bands of purple blotches; aperture pale orange; smaller than typical *miniacea*.

Discussion: This subspecies is restricted to the eastern part of the range of *miniacea*. It is found only in shallow water in Micronesia and Polynesia. The pattern and shape of this subspecies is rather constant throughout its range. The average adult size is only 40 to 60 mm and smaller, dwarf populations are found on Truk Island and several other areas in the Kingdom of Tonga.

Oliva (Miniaceoliva) miniacea lamberti Jousseaume, 1884 (Plate 13, Figures 5, 6)

Description: Shell slightly smaller than typical *miniacea*, brilliantly colored with two bright purple bands and bright blue and orange longitudinal flammules; columellar fasciole bright purple; aperture deep red-orange.

Discussion: Restricted to southern New Guinea and northern Queensland, Australia, in shallow water.

Oliva (Miniaceoliva) pica Lamarck, 1811 (Plate 13, Figures 7, 8)

Description: Shell ovate with rounded sides; white overlaid with bright pink and pinkish-tan mottling and very large dark brown blotches and longitudinal flammules; aperture white.

Discussion: Restricted to northeastern Madagascar and the islands of the central Indian Ocean, in shallow water.

Size: Approximately 55 mm in length.

Oliva (Miniaceoliva) pica color form *olympiadina* Duclos, 1844 (Plate 13, Figures 9, 10)

Description: Pinkish white covered with a dense, reticulated pattern of bright pink and pinkish-tan; two bands of small, dark brown dots and flammules, one at shoulder, one around mid-body; aperture white. This form is restricted to the islands of Mauritius and La Reunion.

Oliva (Miniaceoliva) ponderosa Duclos, 1835 (Plate 13, Figures 12, 13)

Description: Pale cream-white covered with loosely scattered purple spots and flammules; interior of aperture pale salmon. Shell very heavy, thickened and ponderous in adult specimens.

Discussion: Ranges throughout the western Indian Ocean from East Africa to Sri Lanka, in shallow water.

Size: Approximately 50 to 65 mm in length.

Oliva (Miniaceoliva) ponderosa color form *albina* Melvill and Standen, 1897 (Plate 13, Figure 11)

Description: Pure white color form, sometimes with a few scattered, pale purple dots. Although *albina* was thought to have been an albino color form of *sericea*, it appears that Melvill and Standen's taxon refers to this form of *ponderosa*. The specimen figured on Plate 11, Figure 10 in Zeigler and Porreca (1969) is a gerontic *ponderosa*.

Oliva (Miniaceoliva) sairoosa Kilburn, 1978 (Plate 9, Figures 23, 24)

Description: Shell small for subgenus, elongated with a moderate to low spire; color greenish-yellow or grayish, overlaid with a reticulated pattern composed of densely-packed gray and brown speckles; two wide bands of gray or brown on body whorl, one around shoulder, one around mid-body; subsutural area above shoulder without color pattern, bright yellow to gray; aperture bluish to dark indigo toward the center, outer edge chocolate brown in some specimens; columella white, with 13 large, sharp, highly raised plications.

Discussion: *Oliva sairoosa* appears to be closest to *O. atalina*,

from which it can be easily distinguished by its blue aperture. The aperture of *O. atalina* is white. *Oliva sairoosa* is much smaller and has a thinner lip than *O. caerulea* and its columellar plications are much larger, sharper and more pronounced than those of *caerulea*.

Oliva sairoosa is a relatively unknown species. However, it is relatively abundant within its limited range in northern Madagascar. All of the specimens that we have seen have been collected in Tulear Bay.

Size: Approximately 35 mm in length.

***Oliva (Miniaceoliva) sericea* Röding, 1798 (Plate 14, Figures 1, 2)**

(Synonym: *textilina* Lamarck, 1811)

Description: Shell large, heavy, ovate; color cream or yellowish-white, overlaid with very dense network of tiny black or dark gray triangles; two wide bands of tiny black zig-zag flammules and triangles encircle the body whorl, one at the shoulder and one at mid-body; aperture pale yellowish-pink.

Discussion: This species has several named color forms that were described by using very subtle variations in the color pattern. Most of these forms can be found in all populations of the species. *Oliva sericea* ranges from the eastern Indian Ocean to Indonesia and the Philippines, northward to the Ryukyu Islands and eastward to Polynesia. This is a shallow water species.

Size: One of the largest of the *Oliva*, average adult length 50 to 70 mm but may exceed 90 mm.

***Oliva (Miniaceoliva) sericea* color form *granitella* Lamarck, 1811 (Plate 14, Figures 7, 8)**

Description: Color form with numerous gray speckles and small spots (resembling the texture of granite rock), bands reduced or almost absent.

***Oliva (Miniaceoliva) sericea* color form *sabulosa* Marrat, 1868 (Plate 14, Figures 3, 4)**

Description: Pale color form with large areas of cream-white ground color unmarked by color pattern. These are usually

gerontic specimens with large areas of white on the outer edge of the lip of the body whorl.

Oliva (Miniaceoliva) sericea unnamed color form (Plate 14, Figures 5, 6)

Description: Color form with pattern of very large triangles.

Oliva (Miniaceoliva) tremulina Lamarck, 1811 (Plate 15, Figures 1, 2)

(Synonyms: *hepatica* Lamarck, 1811; *obtusaria* Lamarck, 1822)

Description: White, yellowish-cream or creamy pink ground color, overlaid with network of small, grayish-brown triangles; two wide bands of brown blotches and large yellowish triangles around body whorl, one at shoulder, one around mid-body; large, black, amorphous flammules scattered over body whorls of some specimens; some specimens mottled with bluish-gray; aperture white.

Discussion: Ranges from East Africa and Madagascar to Indonesia and the southernmost Philippines, in shallow water.

Size: Some specimens may exceed 100 mm in length. The average adult size is from 60 to 70 mm.

Oliva (Miniaceoliva) tremulina color form *nobilis* Reeve, 1850 (Plate 15, Figures 3, 4)

Description: Shell elongated with high protracted spire; color white overlaid with pale purple-tan mottlings and numerous large, conspicuous, dark brown longitudinal flammules; aperture white.

Discussion: Restricted to Mauritius and the Mascarene Islands, in shallow water.

Size: Averages slightly larger than the typical *tremulina*, with many adults reaching 80 to 90 mm.

Oliva (Miniaceoliva) tremulina color form *zeilanica* Lamarck, 1811 (Plate 15, Figures 8, 9)

Description: Shell smaller than the typical *tremulina*, average length 35 to 40 mm; color dark gray and khaki green with darker gray-brown mottlings and bands; aperture pale purple.

Discussion: Ranges from Indonesia to the southern Philippines.

Oliva (Miniaceoliva) tremulina flammeacolor Petuch and Sargent, new subspecies (Plate 15, Figures 5, 6, 7)

Description: Shell shaped like typical *tremulina*, same size; color bright orange-red overlaid with dark red-brown mottlings, dots and triangles; two wide dark brown or black bands around body whorl, one at shoulder, one around mid-body; spire whorls orange-red with large, close packed, dark brown flammules; aperture uniform pale orange.

Holotype: Length 68 mm., width 28 mm., trawled by fishermen from 30 meter depth off Madras, India. USNM 841458.

Etymology: *flammeacolor*, in reference to the bright orange-red color of this new subspecies.

Discussion: *Oliva tremulina flammeacolor* differs from typical *tremulina* by having a darker, denser color pattern with a bright red-orange base color, by having dark flammules on the spire, and by having a pale orange aperture. This new subspecies also differs from *O. miniacea* by having all of the structural characteristics of typical *tremulina* and by having a uniformly pale orange aperture, which is markedly different from the bright orange aperture of *miniacea*, which is deep orange toward the inside of the shell and lighter orange or yellowish along the inside edge of the lip. *Oliva tremulina flammeacolor* is restricted to southern India. It is found from shallow water to depths of 20 to 30 meters.

Size: Average adult length 50 to 70 mm.

Subgenus *Multipicoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells very slender and elongated, fusiform, with elevated, protracted spires; spire whorls covered with thick layer of enamel, giving each spire whorl a convex outline; color patterns generally composed of network of triangle marks; anterior half of shell always more darkly colored than posterior half; apertures very narrow; columella with very numerous, thin, fine plications, as many as 60 in some specimens.

TYPE SPECIES: *Oliva multiplicata* Reeve, 1850. Recent, southwestern Pacific.

SPECIES IN MULTIPLICOLIVA

Oliva (Multiplicoliva) labuanensis Marrat, 1871 (Plate 16, Figures 1, 2, 3)

Description: Color deep orange-brown or pinkish-brown, sometimes with very faint spiral bands; anterior half of shell much darker red-brown or pink; spire enamel darker colored; aperture lavender-purple; between 60 and 70 fine columellar plications.

Discussion: The shell of this species is basically unpatterned and bicolored. *Oliva labuanensis* inhabits deep water (approximately 100 meters depth) and it is restricted to Indonesia and eastern Malaysia.

Size: Approximately 45 mm in length.

Oliva (Multiplicoliva) multiplicata Reeve, 1850 (Plate 16, Figures 4, 5, 7, 8)

Description: Pink and lavender, with variable amounts of bright creamy-yellow and brown triangle markings and dark brown spots; anterior half of shell with darker brown flammules; aperture purple; spire enamel yellow or pink; columella with 50 to 60 thin plications.

Discussion: Ranges from southern Japan to Indonesia. Most commonly trawled off Taiwan at 50 to 100 meters depth.

Size: Approximately 40 mm in length.

Oliva (Multiplicoliva) multiplicata red color form (Plate 16, Figure 6)

Description: Bright red and pink color form, with dark red enamel on the spire whorls.

Oliva (Multiplicoliva) vicdani da Motta, 1982 (Plate 16, Figures 11, 12)

Description: Shell very fusiform in outline, acuminate; color variable, bright red to peach-orange with variable amounts of

white or yellow triangle markings and brown spots; anterior half of shell darker; some specimens with band of brown flammules around mid-body; aperture white; columella with 25 to 30 plications.

Discussion: Ranges from the southern Philippines to the Solomon Islands. *Oliva vicdani* is usually found at depths of approximately 150 meters.

Size: Approximately 25 mm in length.

Subgenus *Musteloliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells cylindrical, squat, barrel-shaped, with low or flattened spires; spires often covered by callus; colors drab, usually brown tan or olive-green, covered with zig-zag flammules; columellar plications usually large and well produced, almost knoblike.

TYPE SPECIES: *Oliva mustelina* Lamarck, 1811. Recent of the southwestern Pacific.

SPECIES IN MUSTELOLIVA

Oliva (Musteloliva) boholensis Petuch and Sargent, new species (Plate 16, Figures 17, 18)

Description: Shell average size for subgenus, squat, rotund; spire elevated, protoconch exerted; color pale tan, overlaid with loose pattern of scattered, purple-brown zig-zag flammules; spire whorls partially covered with a purple-brown glaze; aperture and columella white; columellar plications weak, poorly-developed; anterior tip of columella with pale orange patch.

Holotype: Length 28 mm, width 15 mm, trawled by commercial fishermen from 120 meters depth off Balicasag, Bohol Island, Philippines. USNM 841430.

Etymology: Named for Bohol Island, the type locality.

Discussion: *Oliva boholensis* is closest to *concauospira*, but differs in being a smaller, flatter shell with a paler, more diffuse color pattern, by having poorly-developed columellar plications, and by having an elevated, exerted spire with a conspicuous purple-brown colored enamel. This species is endemic to the

deeper waters of the central Philippines.

Size: Approximately 20 mm in length.

Oliva (Musteloliva) concavospira Sowerby, 1914 (Plate 16, Figures 23, 24, 25, 26)

Description: Tan with pattern of close-packed, longitudinal, brown zig-zag flammules, two bands of darker zig-zags, one at shoulder and one around mid-body; spire sunken into an enamel filled depression, producing characteristic concavity; aperture and columella white; columellar plications very prominent and knoblike.

Discussion: Ranges from southern Japan to Indonesia and the Philippines. *O. concavospira* is a deep water species.

Size: Average adult length 25 to 30 mm, but may reach 35 mm.

Oliva (Musteloliva) davaoensis Petuch and Sargent, new species (Plate 16 Figures 15, 16)

Description: Shell elongated, cylindrical; spire flattened with exserted protoconch; color pale cream-white or yellowish, overlaid with brown zig-zag flammules and two bands of large brown blotches, one at shoulder, one around mid-body; aperture and columella white; columellar plications well-developed, knoblike; spire enamel white with small brown patches.

Holotype: Length 27 mm, width 17 mm, trawled by commercial fishermen from 150 meters depth in Davao Bay, Mindanao Island, Philippines. USNM 841431.

Etymology: Named for Davao Bay, the type locality.

Discussion: *Oliva davaoensis* is closest to *concavospira* but differs in being a smaller shell with straighter sides, by having a lighter-colored shell, and by having a flat spire with a raised protoconch. This species is endemic to the deeper waters of the southern Philippines.

Size: Approximately 20 to 25 mm in length.

Oliva (Musteloliva) grandicallosa Petuch and Sargent, new species (Plate 16, Figures 9, 10)

Description: Shell small for subgenus, cylindrical, with a very

rounded shoulder; color dark tan, overlaid with dark brown zig-zag flammules and large dark brown patches; columellar plications well-developed; aperture white; spire covered with a conspicuous, prominent, thick callus; callus pointed in center, colored tan with large, purple-brown flammules.

Holotype: Length 22 mm, width 10 mm, trawled by commercial fishermen from 100 meters depth off Siasi Island, Sulu Sea, Philippines. USNM 841434.

Etymology: *grandicallosa*, in reference to its unique, characteristic, thick spire callus.

Discussion: The unique spire callus of *Oliva grandicallosa* separates this species from all related forms. This new species is closest to *O. concavospira* and *O. boholensis*, but differs by being smaller, more slender, darker in color and by having the unique spire callus. As far as is known, *Oliva grandicallosa* is endemic to the deeper waters in the Sulu Sea region of the Philippines.

Size: This species is the smallest member of the subgenus, averaging 15 mm in length.

***Oliva (Musteloliva) mustelina* Lamarck, 1811 (Plate 16, Figures 21, 22)**

Description: Shell cylindrical, spire flat; cream-yellow or light tan ground color, overlaid with dense, coalescing pattern of brown zig-zag flammules; subsutural flammules darker than rest of shell; spire whorls partially covered with yellow callus; aperture purple; columellar plications well developed. High spired specimens may be rarely found in the Malaysia area.

Discussion: *Oliva mustelina* ranges from southern Japan to the Bay of Bengal and eastward to Papua New Guinea. It inhabits shallow water.

Size: Approximately 35 to 40 mm in length.

***Oliva (Musteloliva) mustelina inornata* Marrat, 1870 (Plate 16, Figures 19, 20)**

(Synonym: *lan-berti* Bert, 1984)

Description: Shell cylindrical, stocky, spire flat; color uniform grayish-tan, often with yellow or orange patches near edge of lip and suture; some specimens with pale brown bands; aperture

purple; columellar plications poorly-developed; enamel on spire whorls yellow; subsutural flammules absent.

Discussion: *Oliva mustelina inornata* differs from typical *mustelina* in being a slightly stockier shell with less developed columellar plications. The primary, or most apparent difference is the pure gray-brown color and the complete absence of the zig-zag color pattern of the nominate subspecies. It is important to note that this is not just another color form, as these characteristics are consistent throughout the population. This new subspecies appears to be endemic to Taiwan, where it is collected at depths ranging from intertidal to approximately 35 meters.

Size: Average adult length 30 mm.

Oliva (Musteloliva) rufopicta Weinkauff, 1878 (Plate 16, Figures 13, 14)

Description: Shell small for subgenus, with very rounded shoulders, and elevated spire; color yellow-tan and pale green, overlaid with dense pattern of reddish-brown zig-zags; subsutural area with large, black flammules; aperture purple; columellar plications poorly developed.

Discussion: Restricted to the Bay of Bengal, in particular, the Mergui Archipelago of Burma. *Oliva rufopicta* is found offshore in deeper water.

Size: Approximately 25 mm in length.

Subgenus *Neocylindrus* Fischer, 1883

TYPE SPECIES: *Oliva tessellata* Lamarck, 1811. Recent, western Pacific.

SPECIES IN NEOCYLINDRUS

Oliva (Neocylindrus) tessellata Lamarck, 1811 (Plate 17, Figures 1, 2, 3, 4)

Description: Shell small, squat, cylindrical; spire low to moderately raised and covered with a thick yellow callus; color creamy-yellow with widely-spaced, large, purple-brown or red spots; aperture and columella bright purple; anterior tip of

columella white.

Discussion: This species is found in shallow water and ranges from the Bay of Bengal, to the Philippines, Indonesia and Queensland Australia, and eastward to Papua New Guinea and the Solomon Islands.

Size: Averages 15 to 20 mm in length. Some populations of giants may contain individuals which exceed 30 mm.

Subgenus *Oliva Bruguiere*, 1789

TYPE SPECIES: *Oliva oliva* (Linnaeus, 1758). Recent, Indo-Pacific.

SPECIES IN OLIVA

Oliva (Oliva) fabrei Ducros de St. Germain, 1857 (Plate 17, Figures 5, 6, 7, 8)

Description: Shell inflated, obese, with very high, protracted spire; protoconch black; color khaki green or gray, overlaid with dark gray or black mottling and spots; some specimens with two bands of large black blotches, one around shoulder, one around mid-body; aperture brown; columella white, with only a few poorly-developed plicae.

Discussion: The obese shape and protracted spire of this species are unique among the Indo-Pacific *Oliva*, and is somewhat reminiscent of the Caribbean *O. fulgurator*, which is a larger white or red species. *Oliva fabrei* is restricted to the Philippines, in shallow water.

Size: Approximately 25 to 30 mm in length.

Oliva (Oliva) longispira Bridgman, 1906 (Plate 17, Figures 9, 10, 11, 12)

(Synonym: *gratiosa* Vanatta, 1915)

Description: Shell very elongated with very high, protracted spire; color pale green and reddish-brown, overlaid with dense, mottled pattern of brown dots and triangles; aperture dark purple-brown; columella white, devoid of plicae. Some specimens may be white with brown dots and triangles.

Discussion: Throughout its range, *O. longispira* is found together with *O. oliva*, on the same mud flats in shallow water. This species ranges from the southern Philippines and Indonesia to New Guinea and the Solomon Islands.

Size: Approximately 30 mm in length.

Oliva (Oliva) oliva (Linnaeus, 1758) (Plate 17, Figures 18, 19)

(Synonyms: *ispida* Röding, 1798; *fenestrata* Johnson, 1915; *ispidula* Fischer, 1807; *oliva* Dillwyn, 1817; *variabilis* Gray, 1858; *aurea* Martini, 1773; *mica* Röding, 1798; *ornata* Röding, 1798; *punctata* Röding, 1798; *umbrosa* Röding, 1798; *ispidula* Marrat, 1871; *samarensis* Johnson, 1915)

Description: Shell variable in shape, usually fusiform, with rounded sides and low spire; color ranges from white, yellow, orange, cream or white, to brown and black, overlaid with dark brown or black zig-zags, triangles, blotches, and/or dots; aperture dark brown; columella white with distinct, although poorly-developed plications.

Discussion: There are two definite subspecies of this shell, one from the southwestern Pacific, and one from the Indian Ocean. The typical *oliva* is from the southwestern Pacific and comes in a number of named color forms. The typical *O. oliva* ranges from the Ryukyu Islands south to the Philippines and Indonesia, and eastward throughout Melanesia and northern Australia. This species is found in shallow water.

Size: Approximately 15 to 30 mm in length.

Oliva (Oliva) oliva color form *flaveola* Duclos, 1835 (Plate 17, Figures 22, 23)

Discussion: Bright orange-yellow color form, usually solid colored with no markings. Both subspecies of *Oliva oliva* can be found in this color form.

Oliva (Oliva) oliva color form *jayana* Ducros de St. Germain, 1857 (Plate 17, Figure 13)

Description: Golden-tan to dark brown with fine pattern of triangles and dots.

Oliva (Oliva) oliva color form *dealbata* Röding, 1798 (Plate 17, Figures 20, 21)

(Synonym: *lacteana* Dautzenberg, 1927)

Description: Milky-white or bluish color form.

Oliva (Oliva) oliva color form *oriola* Lamarck, 1811 (Plate 17, Figures 14, 15)

Description: Solid black with white columella.

Oliva (Oliva) oliva color form *tigridella* Duclos, 1835 (Plate 17, Figures 16, 17)

Description: Yellow, tan or whitish, with dark brown or black longitudinal flammules in zebra pattern.

Oliva (Oliva) oliva taeniata Link, 1807 (Plate 17, Figures 26, 27)

Description: Shells larger and much more inflated than the typical *oliva*; some adults cylindrical in form, with low spire and rounded shoulder; exterior enamel tends to be duller, even in fresh-collected specimens; columellar plications usually absent, replaced by large, smooth, white columellar callus; triangle-net color pattern (such as found on form *jayana* of the typical subspecies) absent, replaced by simple dots, small flammules and/or bands.

Discussion: Even though *broderipi* is the best taxon for this subspecies, since it was based upon shell characteristics and not simply color variation, Link's taxon is the earliest, and must be used. Classical *oliva taeniata* are white, yellow or gray, with gray or brown speckles and a wide, black, dark gray or dark brown band around the shoulder. Besides the color forms listed below, *oliva taeniata* also comes in solid orange and black forms. This subspecies is confined to the Indian Ocean from Pakistan to Thailand, in shallow water.

Size: Approximately 30 to 35 mm in length.

Oliva (Oliva) oliva taeniata color form *algida* Vanatta, 1915 (Plate 18, Figures 3, 4)

Description: Gray with darker spots; shoulder band absent.

Oliva (Oliva) oliva taeniata form *broderipi* Ducros de St. Germain, 1857. (Plate 18, Figures 1, 2)

Description: Shell very inflated, tumid, with well-developed shoulder; color usually yellow with a few scattered spots.

Oliva (Oliva) oliva taeniata color form *candida* Lamarck, 1811 (Plate 18, Figures 5, 6)

Description: Pale orange-pink or flesh, without spots, aperture pinkish.

Oliva (Oliva) oliva taeniata color form *martini* Dautzenberg, 1927 (Plate 18, Figures 24, 25)

Description: Pure white with bright orange band around shoulder.

Oliva (Oliva) oliva taeniata color form *stellata* Duclos, 1835 (Plate 18, Figures 7, 8)

Description: Pale blue-gray with widely scattered black spots.

Oliva (Oliva) smithi Bridgman, 1906 (Plate 18, Figures 11, 12)

Description: Shell small, stocky, obese, with relatively low spire; color cream-white, ivory-white, or pale bluish-gray, with scattered, very large and prominent, dark brown zig-zags; protoconch large, dark brown; aperture white; columella poorly-developed, without plicae.

Discussion: Restricted to deeper waters in the Bay of Bengal (30 meters depth).

Size: Approximately 15 mm in length.

Subgenus *Omogymna* von Martens, 1897

DIAGNOSIS: This group of stocky little shells has an unusual, obliquely-split, two-part enamel on the body whorl. This feature is unique in the Olividae. Characteristically, there is a line that appears near the posterior edge of the lip, near the suture, and runs along the shoulder, eventually dipping anteriorly and intersecting the aper-

ture somewhere mid-way along the columella. This line is variable within each species and separates two distinct color patterns on each shell.

TYPE SPECIES: *Oliva paxillus* Reeve, 1850

SPECIES IN OMOGYMNA

Oliva (Omogymna) leonardi Petuch and Sargent, new species (Plate 39, Figures 11, 12)

Description: Shell small for subgenus, thin, delicate, slender, with high spire; color pale pinkish-tan to white with faint pinkish flammules; edge of suture marked with small, dark red flammules; mid-body ornamented with single row of large, evenly-spaced brown dots; separation line between two enamels at mid-body level, curving slightly posteriorly at edge of lip; interior of aperture white; columella white, with 7 to 10 large white teeth; protoconch large, bulbous, white or pale pink.

Holotype: Length 13 mm, width 4 mm, trawled from 30 meter depth off Durban, Natal, Republic of South Africa. USNM841461. Paratypes in the Petuch, Sargent and Hill collections.

Etymology: Named for Mr. Leonard Hill of Miami, Florida, who generously donated the type material.

Discussion: *Oliva leonardi* is somewhat similar to the widespread *O. paxillus*, but differs in being a smaller, more slender shell with a much paler, almost nonexistent color pattern. The line that separates the two types of enamel on the body whorl of *Omogymna* species is located around the mid-body of *O. leonardi*, while it is located along the suture and shoulder area of *O. paxillus*. In this feature, *O. leonardi* resembles species in the subgenus *Strephonella*. *O. leonardi* is apparently restricted to deep water areas off Natal, South Africa and possibly Mozambique.

Size: Average length approximately 10 to 15 mm.

Oliva (Omogymna) paxillus Reeve, 1850 (Plate 18, Figures 9, 10)

Description: Pinkish-white with dense mottling of salmon-pink; mid-body with band of pinkish-tan blotches and line of

brown and white dots; color pattern posterior to dividing line paler, with few salmon-pink mottlings; aperture bright yellow; protoconch purple or pink.

Discussion: This species ranges from East Africa to western Polynesia, in shallow water.

Size: Average adult size 20 to 22 mm in length. A dwarf population, less than 15 mm in length, is found on Guam.

Oliva (Omogymna) paxillus color form *thomasi* Crosse, 1861 (Plate 39, Figures 13, 14)

Description: Light to medium chocolate brown in color, somewhat more obese than the typical *paxillus*.

Discussion: This form represents the easternmost portion of the range of *O. paxillus*. Some characteristics appear to be similar to *O. sandwichensis*, which is endemic to Hawaii. Form *thomasi* ranges throughout French Polynesia, which is over 1000 miles from the Hawaiian Islands. Needless to say, this relationship bears further study.

Oliva (Omogymna) richerti Kay, 1979 (Plate 18, Figure 15)

Description: Shell more slender and elongated than other members of the subgenus; spire protracted; color cream-white with reddish-brown triangle markings, some quite large; aperture white.

Discussion: *Oliva richerti* is one of the rarest of the olive shells. This species is endemic to deep waters (100 meters) around the Hawaiian Islands.

Size: Approximately 35 mm in length.

Oliva (Omogymna) sandwichensis Pease, 1860 (Plate 18, Figures 13, 14, 16, 17)

Description: Shell larger, stockier, and more obese than *paxillus*; color pattern also darker, denser, without mid-body band or brown dots; subsutural flammules larger and darker than those of *paxillus*; aperture yellowish, with two dark brown stripes inside.

Discussion: This species is endemic to the Hawaiian Islands, in shallow water.

Size: Average adult length 25 mm. Some specimens may reach over 32 mm in length.

Subgenus *Parvoliva* Theile, 1929

TYPE SPECIES: *Oliva dubia* Schepman, 1911 = *Oliva sibogae* Petuch and Sargent

SPECIES IN PARVOLIVA

Oliva (Parvoliva) rufofulgurata Schepman, 1911 (Plate 18, Figures 20, 21)

Description: Cream-yellow, overlaid with zebra pattern of longitudinal, undulating, reddish-brown zig-zag lines; aperture pale lavender; protoconch large, purple-red.

Discussion: Ranges from the Philippines and Indonesia to the Solomon Islands, in deep water (100 meters).

Size: 15 to 20 mm in length.

Oliva (Parvoliva) rufofulgurata unnamed color form (Plate 18, Figures 22, 23)

Description: Color form from the Solomon Islands with lines straight at oblique angle, without undulations.

Oliva (Parvoliva) sibogae Petuch and Sargent, new name for *dubia* Schepman, 1911 not *dubia* Lea, 1833 (a fossil) (Plate 18, Figures 18, 19)

Description: Shell very slender and elongated; spire low, with very large protoconch; only three whorls in adults; color pale cream-tan overlaid with wavy reddish-brown longitudinal lines that run entire length of shell; suture with small, dark brown flammules; aperture pale lavender.

Etymology: Named for the *Siboga*, the research vessel on whose cruises the first specimens of this deep water species were collected. We would like to have renamed this species after its original author, Schepman, who we felt contributed greatly to our knowledge of the *Oliva*. However, *schepmani* had already

been used by Weisbord to name a Venezuelan fossil olive.

Discussion: This species ranges from the Philippines and Indonesia to the Solomon Islands, in deep water (100 to 200 meters depth).

Size: Approximately 10 to 15 mm in length. This is one of the smallest of the olive shells.

Subgenus *Porphyria* Röding, 1798

TYPE SPECIES: *Oliva porphyria* (Linnaeus, 1758). Recent, Gulf of California and eastern Pacific.

SPECIES IN PORPHYRIA

Oliva (Porphyria) porphyria (Linnaeus, 1758) (Plate 19 , Figures 1, 2, 11)

(Synonyms: *panamensis* Montfort, 1810; *leveriana* Perry, 1811; *tentoria* Link, 1807; *porphyracea* Perry, 1811; *porphyritica* Martini, 1773; *porphyria* Röding, 1798)

Description: Bright salmon-pink and purple, overlaid with concise network of dark red-brown triangles, zig-zags and patches; subsutural area with white and brown flammules; aperture bright orange-yellow; columellar area salmon-orange and brown with numerous flattened, but well-developed plications; entire anterior tip of shell deep purple-blue; spire whorls partially covered with purple or white callus; shell large, obese, ovoid in shape.

Discussion: *O. porphyria* ranges from the Gulf of California south to Ecuador and northern Peru, in shallow water.

Size: This is the largest of the olive shells. The average adult length is approximately 90 to 100 mm. The maximum is about 120 mm, however, specimens exceeding 110 mm are uncommon.

Subgenus *Proxoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells small for genus, elongated, cylindrical, with low spires; protoconchs tiny; color patterns like *Parvoliva*, with zig-zags in zebra pattern or reticulated with small triangles; columellar plications usually well-developed.

TYPE SPECIES: *Oliva caldania* Duclos, 1835. Recent, southwestern Pacific.

SPECIES IN PROXOLIVA

Oliva (Proxoliva) athenia Duclos, 1835 (Plate 19, Figures 7, 8, 9, 10)

(Synonyms: *egira* Duclos, 1844; *edelona* Duclos, 1844)

Description: Khaki-green, overlaid with network of brown triangles and, in turn, overlaid with large, dark brown, zig-zag flammules; aperture purple; shells stocky and obese, much wider and more inflated than the similar-colored *faba*.

Discussion: *Oliva athenia* ranges from the Philippines and Indonesia to the Fijis, in shallow water.

Size: The average adult length is approximately 25 mm.

Oliva (Proxoliva) caldania Duclos, 1835 (Plate 19, Figures 3, 4)

(Synonym: *brettinghami* Bridgman, 1909)

Description: Yellow-green with reddish-brown zebra pattern of longitudinal zig-zag lines; aperture dark brown; shell, small, stocky with spire of moderate height.

Discussion: Ranges from the Philippines and Indonesia to the Fijis, in shallow water.

Size: Approximately 15 to 18 mm in length.

Oliva (Proxoliva) caldania unnamed color form (Plate 19, Figures 20, 21)

Description: Bright yellow, with orange band around shoulder.

Oliva (Proxoliva) caldania queenslandica Petuch and Sargent, new subspecies (Plate 19, Figures 5, 6)

Description: Smaller and more slender than the typical *caldania*; color pale blue-gray overlaid with very pale tan zig-zags; subsutural area and shoulder darker blue-gray; aperture white, with two or three large, brown patches along inside edge of lip; columella white, with numerous, well-developed plicae.

Holotype: Length 13 mm, width 6 mm, trawled by scallop

boats from 50 meter depth off Cape Moreton, Queensland, Australia. Deposited in the collection of the Department of Malacology of the Australian National Museum.

Etymology: Named for Queensland, Australia, the type locality.

Discussion: Besides differing from typical *caldania* in size and shape, *caldania queenslandica* differs in having a blue undercolor and a white aperture. The dark, blue-gray shoulder band is also characteristic. This subspecies was pictured in *Australian Shells*, by Wilson and Gillett in 1972 (Page 108, Plate 71, Figure 1b.). This new subspecies is restricted to deeper waters off southern Queensland, and is the southernmost olive species to be found along the eastern coast of Australia.

Size: Approximately 10 to 12 mm in length.

***Oliva (Proxoliva) faba* Marrat, 1867 (Plate 19, Figures 12, 13, 14, 15, 16, 17, 18, 19)**

Description: Shell slender, elongated, with straight sides; color green or yellow, overlaid with purple-brown zig-zags and triangle markings, often fusing into dense reticulated pattern; some specimens with large, dark brown patches and spots; suture bordered by band of prominent white and brown checkers; aperture purple; columellar area white with numerous, large, raised, well-developed plications.

Discussion: *Oliva faba* ranges from the Philippines and Indonesia to the Fijis, in shallow water.

Size: Average adult, approximately 20 mm in length.

***Oliva (Proxoliva) vanuatuensis* Petuch and Sargent, new species (Plate 19, Figures 22, 23, 24, 25)**

Description: Shell average size for subgenus, cylindrical, with straight sides; spire low; color white with scattered, very fine, pale tan, longitudinal zig-zag lines and brown dots; large areas of shell often pure white; protoconch pale tan; aperture white; columellar area white with large plications; edge of suture pure white, without subsutural flammules.

Holotype: Length 14 mm, width 6 mm, 2 meter depth on white sand bottom, off south coast of Santo Island, Vanuatu (New

Hebrides). USNM 841447.

Etymology: Named for Vanuatu, the type locality.

Discussion: *Oliva vanuatuensis* is closest to the widespread Indo-Malaysian *faba* in size, but differs in being a stockier shell with a lower spire and by lacking the dark reticulated color pattern and subsutural flammules of the latter. *Oliva faba* has a purple or purple-brown aperture which differs from the white aperture of *vanuatuensis*. This new species is endemic to southern Vanuatu, in shallow water.

Size: Approximately 15 mm in length.

Subgenus *Rufoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells of medium size for genus, cylindrical, with straight sides and conspicuously rounded shoulders; colors in shades of browns and yellows, with banded patterns; spires very flattened, often covered with enamel; columellar plications small, generally well-developed. Generally a deeper water group.

TYPE SPECIES: *Oliva rufula* Duclos, 1835. Recent of the southwestern Pacific.

SPECIES IN RUFOLIVA

Oliva (Rufoliva) baileyi Petuch, 1979 (Plate 20, Figures 3, 4)

Description: Bright yellow-tan, overlaid by separate, regular, oblique, reddish-tan, spiral stripes in a pattern resembling a barber's pole; spire whorls covered with thick, bright purple callus; aperture pale lavender; columella white.

Discussion: Restricted to deeper waters in the Solomon Islands. This is one of the rarest olive species.

Size: Approximately 25 to 30 mm in length.

Oliva (Rufoliva) lenhilli Petuch and Sargent, new species (Figure 33)

Description: Shell average size for subgenus, cylindrical in shape, with flattened spire; color bright cream-yellow overlaid

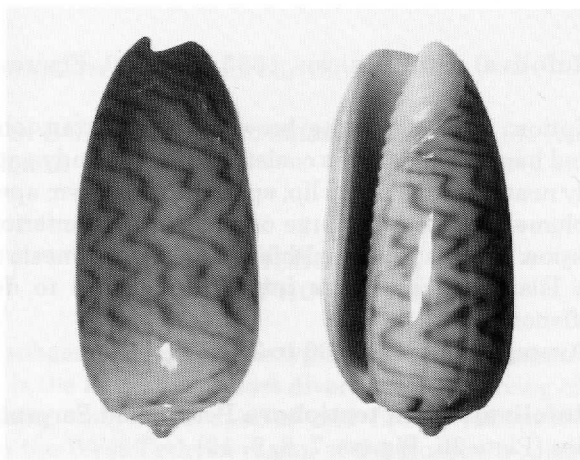


Figure 33. Holotype of *Oliva (Rufoliva) lenhilli* Petuch and Sargent, new species, from 160 meters depth off Bohol Island, Philippines.

with widely-spaced undulating, thin, reddish-brown vertical lines; lines run entire length of shell, producing zebra-like pattern; edge of suture marked with evenly spaced, small, reddish-brown flammules; spire whorls uncalloused; fasciole marked with row of evenly-spaced, thin, reddish-brown flammules that correlate with the zebra pattern on body whorl; aperture pale tan.

Holotype: Length 27 mm, width 11 mm, Molluscan Paleontology Collection, Florida Atlantic University.

Etymology: Named for Mr. Leonard ("Len") Hill, Miami, who generously donated the holotype.

Type Locality: Brought up in tangle nets from 160 meters depth off Bohol Island, Philippines.

Range: At present, known only from deep water in the central Philippines.

Discussion: *Oliva lenhilli* is closest to *O. baileyi* in both shape and the bright yellow-tan base color, but differs in having an overlaying color pattern of undulating lines instead of broad bands. *Oliva baileyi* also has a calloused spire covered by purple enamel, while the spire of *O. lenhilli* is uncalloused. The undulating line pattern of *O. lenhilli* resembles the color pattern of the unrelated *O. (Parvoliva) rufofulgurata*.

Oliva (Rufoliva) rufula Duclos, 1835 (Plate 20, Figures 1, 2, 5, 6)

Description: Dark chocolate brown with pale tan, oblique stripes and bands; bands often coalesce to form cloudy patches, especially near the edge of the lip; spire whorls brown; aperture white; columella white, with large orange patch at anterior tip.

Discussion: Ranges from the Philippines and Indonesia to the Solomon Islands. *Oliva rufula* inhabits moderate to deeper waters offshore.

Size: Average adult length 30 to 35 mm.

Oliva (Rufoliva) rufula tectiphora Petuch and Sargent, new subspecies (Plate 20, Figures 7, 8, 9, 10)

Description: Shell cylindrical, with rounded shoulder; color reddish-brown with large, scattered, yellow-tan triangles; aperture white.

Holotype: Length 29 mm, width 13 mm, trawled by commercial fishermen from 200 meter depth off the north coast of Siasi Island, Sulu Sea, Philippines. USNM 841456.

Etymology: Bearing tents, in reference to the abundant yellow triangles that are characteristic of this subspecies.

Discussion: *Oliva rufula tectiphora* is a deep water subspecies of *rufula* and differs in being a smaller, more slender shell with finer and more numerous columellar plications. The most noticeable difference is seen in the color pattern, which on *rufula tectiphora* is composed of various-sized triangles, while on typical *rufula* it is composed of bands. *Oliva rufula tectiphora* has been collected in the southern Philippines and New Guinea.

Size: Average adult length 25 to 30 mm or slightly smaller than the typical *rufula*.

Subgenus *Strephona* Mörch, 1852

TYPE SPECIES: *Oliva flammulata* Lamarck, 1811. Recent, eastern Atlantic.

**A DETAILED LOOK AT
THE STREPHONA COMPLEX**

The subgenus *Strephona* as typified by *O. flammulata* from west Africa, is the largest and most diverse group of living olive shells, comprising forty-three species and fifteen subspecies. Originating in the West Tethyan region of the Eocene tropical seas, the genus is today confined to the Americas and West Africa. The living *Strephona* species fall into two major subdivisions, the Atlantic and the eastern Pacific groups.

Throughout most of Cenozoic time North and South America were separated by a narrow waterway that connected the Atlantic and Pacific Oceans across what is today Panama. At the end of the Pliocene epoch (approximately 3 million years ago), the Isthmus of Panama began to form and finally closed off the connecting waterway about 1.6 million years ago. The ancestral *Strephona* species were then cut off from each other as the Atlantic and Pacific became separate oceans. Since that time, the separated gene pools on either side of the Isthmus diverged and speciated to produce different, although similar appearing, species swarms. Due to island endemism and the abundance of islands on the Caribbean side, the Atlantic *Strephona* group evolved more species and subspecies than did the Pacific group.

Based on shell morphology, the Atlantic *Strephona* species break up into six groups; the *reticularis* group, the *bifasciata* group, the *nivosa* group, the *tisiphona* group, the *sayana* group, and the West African type *Strephona* group, exemplified by *flammulata*. The eastern Pacific *Strephona* species break up into five groups; the *splendidula* group, the *spicata* group, the *incrassata* group, the *kaleontina* group and the *polpasta* group. All of these groups represent species radiations that resulted from the geographical and bathymetric isolation of species with low vagility.

THE ATLANTIC STREPHONA COMPLEX

The best-known group of Atlantic *Strephona* species is the *reticularis* group. Centered around *Oliva reticularis*, it comprises four species, three subspecies and several interesting named color forms. All members of this group are characterized as being ovate shells with rounded outlines, and by having variable amounts of triangle net color patterns. Most widespread is *O. reticularis*, being found throughout the Bahamas, the West Indian Island Arc, and mainland Central America. One species of this group, *O. antillensis* is confined to the Greater Antilles and the Virgin Islands. Two others, *O. fulgurator* and *O. reclusa*, are confined to the Netherlands Antilles islands of Aruba, Curacao, and Bonaire, and to the small coral islands off Venezuela. *Oliva fulgurator* has a single subspecies, *O. fulgurator bullata*, that is endemic to the isolated Los Roques Atoll off the coast of Venezuela.

The largest *Strephona* group in the Atlantic is the *bifasciata* group. All members of this group have slender, cylindrical, elongated shells with fairly straight sides. The members of this group are found primarily offshore in deeper water. Many of these species are endemic to isolated seamounts and deep water pockets. Ten species, three subspecies and several named color forms make up this group. These include *O. olivacea* and *O. bifasciata jenseni*, which are endemic to Bermuda; *Oliva bifasciata*, which is found throughout the Caribbean region and is the most widespread Atlantic species; *O. bifasciata bollingi*, which is endemic to southern and southeastern Florida; *Oliva graphica*, which is endemic to southern Brazil; *O. bahamasensis*, which is endemic to deep water in the central Bahamas; *O. barbadensis*, which is endemic to deep water surrounding the Barbados seamount; *O. drangai*, which is endemic to Tobago; *O. goajira*, which is endemic to the Goajira Peninsula of Colombia; and *O. finlayi* and *O. magdae* which are both endemic to deep water off Cuba.

The *sayana* group is primarily a Carolinian species complex. It is comprised of two species, two subspecies and one named color form. Although these are basically temperate water animals that are capable of tolerating cold winter temperatures, one tropical offshoot

has evolved from the ancestral Pliocene *O. carolinensis*. This species, *O. maya*, is confined to the northern and eastern tip of the Yucatan Peninsula of Mexico.

Oliva sayana, the most widespread species of the group, has a split distribution. During the Pleistocene, the Florida Peninsula was submerged, and the species spread across the northern part of the State in an uninterrupted range from the Gulf of Mexico to what is now, Cape Hatteras. Since the Pleistocene, however, the range of *sayana* has been divided by the emergence of Florida. This has resulted in two separate populations, one in the Gulf of Mexico and one along the southeastern coast of the United States. This species cannot tolerate the tropical carbonate environment of the southern tip of Florida, therefore the peninsula acts as a barrier to dispersal. A subspecies has evolved at the southeasternmost end of the range of the Gulf of Mexico population of *Oliva sayana*. This has been named *O. sayana sarasotensis*. *Oliva sayana* is also known as a Pleistocene fossil from Bermuda, but it is extinct there in the Recent. Another subspecies, *O. sayana texana*, has evolved at the extreme southwestern end of the range.

The northern coast of South America provides the range for an unusual and poorly-known complex of species and subspecies centered around *Oliva tisiophona*. In many ways, this group resembles the Panamic *O. spicata* and *O. incrassata* groups. The members of the *tisiophona* group appear to be closer to the Pacific *Strephona*, than they do to the species in the other Atlantic groups. This group is comprised of two species and two subspecies; *O. tisiophona* which ranges from the Goajira Peninsula of Colombia to Cumana, Venezuela; the subspecies *tisiophona oniska*, which is found in deeper water off the Magdalena River and Santa Marta, Colombia; the subspecies *tisiophona schepmani*, which is confined to deep water off the Golfo de Triste and Margarita Island, Venezuela; and *Oliva bewleyi*, which ranges from Panama to Santa Marta, Colombia.

The fifth western Atlantic *Strephona* species complex centers around *Oliva nivosa*, and like the *bifasciata* group, contains olives with elongated forms with straight or slightly rounded sides. Unlike members of the *bifasciata* group, species in the *nivosa* complex have flattened spires and intricate, fine-netted color patterns.

Three species and two subspecies make up this group; *O. nivosa*, which ranges throughout the West Indian Arc and along the mainland of northern South America; *O. jamaicensis*, which is endemic to Jamaica; *O. jamaicensis brunnea*, which is restricted to Puerto Rico; *O. jamaicensis zombia*, which is confined to Haiti; and *O. vermiculata*, a poorly-known and neglected little species that is endemic to Aruba and Curacao in the Netherlands Antilles.

The West African region contains only one *Strephona* species; the widespread *O. flammulata*, which is the type of the subgenus and ranges from the Cape Verde Peninsula of Senegal south to southern Angola; and its subspecies *O. flammulata verdensis*, which is restricted to the isolated, central Atlantic Cape Verde Islands. The mainland variety occurs in a number of named color forms, including purple, dark brown and golden individuals.

THE EASTERN PACIFIC STREPHONA COMPLEX

During glacial periods in the Pleistocene, when world-wide sea levels dropped as much as 200 meters below present sea level, the Gulf of California was virtually closed off and became an inland sea. During this period of isolation (which may have, in fact, happened several times), olives living in the Sea of Cortez area were cut off from the main gene pools that were located farther south along mainland Central America. This resulted in the formation of many endemic species within the Gulf of California region.

Since the Pleistocene, the Gulf of California has reconnected to the Pacific and species from the south have invaded and recolonized the area. Since the Gulf of California olives evolved in, and prefer cooler waters, they have not invaded the more tropical areas to the south of Mazatlan, Mexico. This produces an entire, distinctive faunal subregion in the Gulf of California.

The most abundant and important Panamic *Strephona* species complex is the *spicata* group, which is comprised of seven species, five subspecies and several named color forms. These include the widespread *O. spicata*, which ranges from Mazatlan, Mexico south to Ecuador; and its two subspecies, *O. spicata melchersi*, which is endemic to the Gulf of California; and *O. spicata deynzeriae*, which is endemic to remote Cocos Island off Costa Rica. The rest of the

species in this group evolved during the Pleistocene and are confined to the Gulf of California. Included in this radiation of species that are endemic to the Cortezian Subprovince are the widespread and common shallow water species *O. venulata*; its two subspecies *O. venulata cumingii* and *O. venulata pindarina* (These two subspecies may turn out to be full sibling species upon closer examination of the living animals and their ecologies.); *O. obesina* and *O. rejecta*, which are common throughout the Gulf of California; *O. subangulata* from the southern Gulf of California; *O. subangulata corteziana*, which is a deeper water subspecies that is isolated in the northern end of the Gulf of California (Sea of Cortez); *O. violacea*, which ranges from shallow to deep water; and *O. ionopsis*, which is found only in deep water. Altogether, these *Strephona* species form one of the most interesting localized species radiations of olivids found anywhere in the world.

The second largest *Strephona* species group in the Panamic Province centers around *Oliva polpasta* and contains six species; the widespread *O. polpasta*; two deep water species that are endemic to the Gulf of California, *O. kerstitchi* and *O. davisae*; and three species that are confined to the southern end of the Panamic province, *O. truncata*, which ranges from Nicaragua to Ecuador; *O. olssoni*, which is restricted to deep water in the Gulf of Panama; and the obese *O. radix*, from Ecuador. All of these closely related species differ from members of the *spicata* group by being smaller shells with drab, less complex color patterns, which are composed of small triangles, and by having larger and more conspicuous subsutural flammules.

The most beautiful group of Panamic *Strephona* species is the *splendidula* complex. This group includes only two species, *O. splendidula*, which ranges from off Mazatlan, Mexico south to Ecuador and *O. foxi*, which is endemic to the deeper water areas around Cocos Island off Costa Rica. Both species exhibit a very high gloss and color patterns that include bright pinks and purples and wide bands of dark brown. Both species also have yellow or orange apertures. Together, these two species represent a separate offshoot from the main *spicata-polpasta* lineages.

2*spicata-polpasta* lineages.

Like the *splendidula* group, the *kaleontina* group contains only

two species, but there are many named color forms of one of these (*O. peruviana*). *Oliva kaleontina* is a rare little species that occurs offshore along most of the Panamic Province; and *O. peruviana*, is an extremely variable species that is found of the coast of Peru and Chile. *Oliva peruviana* lives in the coldest water of any known olive, its shell having the characteristic dullness of cold water species. *O. peruviana* is also the most variable *Strephona* species, coming in coniform varieties and almost every color pattern from melanistic to striped, spotted and mottled.

Closely related to the Caribbean *tisiphona* group are the large, inflated, rounded shells of the *incrassata* complex. Only two species are included; the common, very large and heavy *O. incrassata*, which ranges from the Gulf of California to Ecuador; and the rare *O. julieta*, which is restricted to the southern Panamic Province, from Nicaragua south to Panama and possibly Colombia and Ecuador. Both species, and the members of the *tisiphona* group, differ from the other *Strephona* species in being heavily spotted. After *O. (Porphyria) porphyria*, *O. incrassata* is the largest Panamic olive.

SPECIES IN STREPHONA

Oliva (Strephona) antillensis Petuch and Sargent, new species (Plate 20, Figures 11, 12)

Description: Shell of medium size for subgenus, narrow and elongated, with slightly-rounded sides; spire elevated; protoconch very large in proportion to shell size; color yellow-cream, overlaid with netted pattern of reddish-brown triangles; two bands of darker brown triangles encircle the body whorl, one on the anterior third of the shell, the other on the posterior third; spire whorls with small amount of brown callus along suture; edge of suture with brown and white scalloping; interior of aperture white; columellar area very narrow, white, with 10 to 15 thin plicae; fasciole marked with row of large brown spots.

Holotype: Length 28 mm, width 12 mm, collected on sand flats at night, south coast of Gonave Island, Haiti. USNM 841425.

Etymology: Named for the Antilles Islands of the Caribbean Sea, the range of this new species.

Discussion: *Oliva antillensis* somewhat resembles a small *O. reticularis*, but differs from that sympatric species in having the spotted fasciole, a much larger protoconch in proportion to shell size, and in being far more elongated and attenuated.

Oliva antillensis has been primarily collected near Gonave Island, Haiti, but some specimens have been reported to have been taken on St. John Island, Virgin Islands. To date, this species has not been collected anywhere between these two localities.

Size: Average adult length 25 mm.

Oliva (Strephona) bahamasensis Petuch and Sargent, new species (Plate 20, Figures 15, 16, 17, 18)

Description: Shell of medium size for subgenus, thick and heavy, inflated and fusiform in shape; spire elevated; protoconch large; color bright yellow to pale canary yellow, overlaid with numerous red-brown zig-zags that run the entire length of the shell; some specimens with zig-zags coalescing into triangles; edge of suture with large purple-red flammules that run onto the shoulder; interior of aperture pale yellow-orange; columellar area yellow with 13-15 thin, weak plicae.

Holotype: length 45 mm, width 21 mm, brought up in lobster pot from 200 meter depth off the north coast of Grand Bahama Island, Bahamas. USNM 841426.

Etymology: Named for the Bahamas, the type locality.

Discussion: *Oliva bahamasensis* is similar to the other deep water olives from the eastern Caribbean, *O. drangai* and *O. barbadensis*, but differs from those species in being a more inflated, stockier shell, in having very weak columellar plications, and by characteristically having a bright yellow color.

O. bahamasensis is only known from deep water off Grand Bahama Island, but may be present, at the proper depth, throughout the entire Bahamas area. The holotype was collected from a baited deep water lobster trap, and was found along with a *Volutifusus piraticus* Clench and Aguayo. This is one of the deepest dwelling olives in the western Atlantic.

Size: Approximately 35 to 40 mm in length.

Oliva (Strephona) barbadensis Petuch and Sargent, new species (Plate 20, Figures 19, 20, 21, 22)

Description: Shell of medium size for subgenus, heavy, thickened, fusiform in shape; body somewhat inflated, wider at mid-section than at shoulder; spire elevated, protracted; color yellow to yellow-tan, overlaid with variable amounts of fine brown triangles in a netted pattern; some specimens with large zig-zag areas of bright yellow; body whorl with two bands of darker brown zig-zags; spire whorls with tan-colored callus; shoulder and edge of suture with pale blue patches, corresponding to sutural scalloping pattern; protoconch large; interior of aperture white; columellar area white with 18 to 25 thin pliae.

Holotype: Length 50 mm, width 21 mm, trawled from 200 meters depth off St. James, Barbados Island, by research vessel. USNM 841427.

Etymology: Named for Barbados Island, West Indies, the type locality.

Discussion: *Oliva barbadensis* is closest to *O. drangai* from Tobago, but differs in being a larger, more inflated species, and by having a much darker and more elaborate color pattern. This new species is one of the deepest-dwelling olives in the western Atlantic and is known only from deep water surrounding the Barbados seamount.

Size: Approximately 40 to 50 mm in length.

Oliva (Strephona) bewleyi Marrat, 1870 (Plate 20, Figures 23, 24; Plate 21, Figures 5, 6)

Description: Color pale yellow-green and tan, overlaid with network of very fine brown triangles; two mid-body bands of larger, darker brown triangles and zig-zags; area between bands paler, often glazed-over with yellow; base of columella stained dark purple; aperture yellow.

Discussion: *Oliva bewleyi* is the Atlantic counterpart of *O. spicata* from the Panamic Province. The two species are very close, both in shell shape and in color pattern. It is very likely that both species share a common ancestor. *Oliva bewleyi* ranges from the Caribbean side of Panama to Santa Marta, Colombia, offshore in deeper waters.

Size: Approximately 50 to 65 mm in length.

Oliva (Strephona) bewleyi color form *formosa* Marrat, 1870 (Plate 21, Figures 1, 2, 3, 4)

Description: Solid dark brown or black color form.

Oliva (Strephona) bifasciata Küster, 1878 (Plate 21, Figures 11, 12, 13, 14, 15, 20)
(Synonym: *greenwayae* Clench, 1937)

Description: Shell white, overlaid with dense network of brown triangles; two bands of larger, darker brown triangles around midbody; interior of aperture pale lavender to white; some specimens with two dark brown or black mid body bands, some specimens entirely dark brown or black; shell size average for subgenus; shape cylindrical with slightly convex sides, specimens may range from barrel shaped to slightly elongated; spire low, with tiny protoconch; columellar area white with broad, flattened plicae.

Discussion: *Oliva bifasciata* of Küster, although named for the color form with two dark mid-body bands, is the earliest available name for this species. Even though it is not really representative of the species morphology as a whole, it must be used. *Oliva bifasciata* typically comes with a white ground color that is covered by a loose netted pattern of brown or reddish-brown triangles.

This species is widespread throughout the western Atlantic, with the typical subspecies ranging from the Greater Antilles to Venezuela. It is interesting to note that this widespread species has a tiny protoconch. This characteristic would indicate distribution of the species by long-lived planktonic larvae.

Size: Adult length approximately 40 to 50 mm.

Oliva (Strephona) bifasciata bollingi Clench, 1937 (Plate 21, Figures 7, 8)

Description: Similar to typical *bifasciata*, but more cylindrical, with straighter sides; color pattern more complex, with a paler, less distinct appearance; spire whorls covered with dark brown,

pink or reddish enamel; spire more elevated than the nominate subspecies.

Discussion: *O. bifasciata bollingi* is found from North Carolina (offshore) southward along the eastern coast of Florida, throughout the Florida Keys to the Dry Tortugas. This subspecies intergrades with typical *bifasciata* in the Gulf of Mexico.

Size: Adult length approximately 40 to 60 mm.

Oliva (Strephona) bifasciata bollingi color form *pattersoni* Clench, 1945 (Plate 21, Figure 20)

Description: Solid dark brown color form. Dead specimens are occasionally found in dredgings along the east coast of Florida and these may appear to be an orange-brown color. This is typical of dead specimens that have faded. *Oliva bifasciata bifasciata* is also rarely found in a solid dark brown or black form. A specimen from St. Vincent, Lesser Antilles is pictured on Plate 21, in Figures 9 and 10.

Oliva (Strephona) bifasciata jenseni Petuch and Sargent, new subspecies (Plate 21, Figures 16, 17)

Description: Shell large for subgenus, thickened, ovate in outline, with rounded sides; spire low; color pale bluish-white with network of large, pale tan triangles; two bands of larger tan triangles around mid-body; spire whorls partially covered by a pale purple enamel; interior of aperture purple; columellar area white with 12 to 15 large, rounded plicae.

Holotype: Length 51 mm, width 25 mm, collected at 0.5 meter depth on sand bottom off Blue Horizons Beach, Bermuda. USNM 841453.

Etymology: Named for Mr. Russell Jensen, of the Delaware Museum of Natural History, who collected the type lot and kindly donated the specimens for study.

Discussion: *Oliva bifasciata jenseni* differs from typical *bifasciata* in being a much larger shell, with a pale or whitish color pattern. The protoconch of *O. bifasciata jenseni* is also consistently larger than that of the nominate subspecies. This new subspecies is also close to *O. olivacea*, but differs in having a stockier, more inflated shell with a much lower spire, by having a bluish-white

ground color instead of the light salmon-pink color of *olivacea* and by having a purple aperture instead of the salmon-pink aperture of *Oliva olivacea*. Both *Oliva bifasciata jenseni* and *Oliva olivacea* are endemic to Bermuda. The Bermudan population of *O. bifasciata* may represent a near-recent, Pleistocene invasion from the south that has since become isolated from the main population. *Oliva olivacea* may represent an older species that was already present on Bermuda when the *bifasciata* stock arrived. The two co-exist today in the same habitat.

Oliva (Strephona) davisae Durham, 1950 (Plate 22, Figures 1, 2)

Description: Shell with a well-developed shoulder; yellow-brown with yellow patches, overlaid with zig-zag pattern of dark brown flammules; two wide, diffuse, mid-body bands of dark brown spots and blotches.

Discussion: Restricted to deep water in the Gulf of California.

Size: Approximately 35 mm in length.

Oliva (Strephona) drangai Schwengel, 1951 (Plate 22, Figures 3, 4)

Description: Color pale pink, overlaid with fine network of pale brown triangles; subsutural flammules large, prominent, dark purple.

Discussion: Endemic to deep water off Tobago Island, West Indies.

Size: Approximately 35 to 40 mm in length.

Oliva (Strephona) finlayi Petuch and Sargent, new species (Plate 22, Figures 5, 6, 7)

Description: Shell squat, ovate in outline, with rounded sides and rounded shoulder half-way down length of shell; spire very elevated; protracted, with large protoconch; color cream-white, overlaid with dense, "smeared," and clouded pattern of tan triangles and zig-zags; mid-body with two bands of darker brown zig-zags; spire whorls partially covered with yellow or yellow-orange enamel; aperture pale lavender-white; columella white with 10 to 12 long, low, but well-developed plicae.

Holotype: Length 42 mm, width 19 mm, brought up in fish traps from 200 meter depth in Matanzas Bay, Cuba. USNM 841432.

Etymology: Named for Mr. C. John Finlay, of Palm Bay, Florida, who collected the species in Cuba in 1956, recognized it as new and kindly donated the type material. Paratype in the Finlay collection.

Discussion: *Oliva finlayi* is closest to the other deep water Caribbean endemics, *bahamasensis* and *barbadensis*, but differs from both in being a fatter, stumpier shell with a shorter body in proportion to the spire. It also differs from *bahamasensis* in having a tan colored shell, and in lacking the bright yellow-gold color of the Bahamas endemic. *O. barbadensis* differs from *finlayi* in having a finer textured triangle network, larger, darker, and more distinct subsutural flammules, a paler color pattern, and a wider shoulder.

This interesting new species is endemic to deep water off northern Cuba. Judging from its high spire and short, stocky body, *finlayi* may be a deep water offshoot of *reticularis*.

Size: Approximately 35 mm in length.

Oliva (Strephona) flammulata Lamarck, 1811 (Plate 22, Figures 8, 9, 21)

(Synonyms: *marmorea* Marrat, 1871; *marmorea* Mörch, 1852; *marmorea* Chemnitz, 1788)

Description: Shell pale tan or pinkish-tan, overlaid with darker tan and brown triangles and white spots; anterior half of shell darker in color; shell small for subgenus, cylindrical, slightly coniform, with rounded shoulder and spire of moderate height.

Discussion: This species is commonly found in shallow water along the West African coast from Senegal to Angola.

Size: Approximately 25 to 30 mm in length.

Oliva (Strephona) flammulata color form *castanea* Dautzenberg, 1910 (Plate 22, Figures 10, 11)

Description: Solid dark brown or reddish-brown color variety.

Oliva (Strephona) flammulata color form *isabellina*

Dautzenberg, 1910 (Plate 22, Figures 12, 13)

Description: Bright lavender-purple color variety with large purple triangles.

Oliva (Strephona) flammulata color form *pallida* Dautzenberg, 1910 (Plate 22, Figures 14, 15)

Description: Solid pale tan or golden-tan color variety, without triangle markings.

Oliva (Strephona) flammulata verdensis Petuch and Sargent, new subspecies (Plate 22, Figures 16, 17, 20, 21)

Description: Shell elliptical and elongated, fusiform in shape; spire high, protracted; color white to dark pink or rose, overlaid with network of various sized white triangles, that are outlined with dark, reddish-brown; subsutural flammules appear as short wavy lines of dark, reddish-brown; aperture white; columellar fasciole white; area posterior to fasciole with dark red evenly-spaced lines.

Holotype: Length 32.5 mm, width 13 mm, exposed in sand at low tide, Port Grande Harbour, Cape Verde Islands. USNM 841429.

Etymology: Named for the Cape Verde Islands, the type locality.

Discussion: *O. flammulata verdensis* differs from typical *flammulata* by having an elongated, fusiform shape as compared to the cylindrical shape of the nominate subspecies. This new subspecies also has a higher, protracted spire and lacks the definite, rounded shoulder of typical *flammulata*.

Oliva flammulata verdensis is endemic to the isolated Cape Verde Islands, where it is found in habitats ranging from intertidal to moderate depths.

Size: Approximately 30 mm in length.

Oliva (Strephona) foxi Stingley, 1984 (Plate 22, Figures 24, 25, 26)

Description: Bright rose-pink with variable amounts of dark brown and yellow triangle markings and dark brown zig-zag flammules; two wide, chocolate-brown bands around mid-body;

bands with small yellow triangles; interior of aperture bright yellow-orange.

Discussion: *Oliva foxi* is closest to *O. splendidula*, however, its distinctive smaller size, elongated, shoulderless shape and pointed spire all but eliminate any chance of possible misidentification.

O. foxi is endemic to the deeper waters surrounding Cocos Island, which is an isolated seamount, approximately 400 miles off the coast of Costa Rica.

Size: Approximately 30 to 35 mm in length.

Oliva (Strephona) fulgurator Röding, 1798 (Plate 22, Figures 18, 19, 22, 23)

(Synonym: *fusiformis* Lamarck, 1811)

Description: Shell very inflated, rotund; color pinkish-white overlaid with variable amounts of reddish-brown triangle markings and large reddish-brown cloudings and patches; protoconch very large, spire high and protracted.

Discussion: This species is endemic to the Netherlands Antilles islands of Aruba, Curacao and Bonaire. This species inhabits shallow water.

Size: Average adult size 35 to 55 mm in length.

Oliva (Strephona) fulgurator color form *aldinia* Duclos, 1844 (Plate 23, Figures 1, 2)

Description: Pale pink or pure white color variety from Curacao Island. Protoconch slightly smaller than specimens from Aruba.

Oliva (Strephona) fulgurator bullata Marrat, 1871 (Plate 23, Figures 5, 6)

Description: More slender and smaller than the typical *fulgurator*; color white with network of large, pale tan triangle markings and zig zags.

Discussion: This little-known and rarely-collected subspecies may, with further study, prove to be a full species. *O. fulgurator bullata* is endemic to the Los Roques Atoll off Venezuela, where it inhabits shallow water.

Size: Approximately 45 mm in length.

Oliva (Strephona) fulgurator form *mercatoria* Marrat, 1871 (Plate 23, Figures 3, 4)

Description: Shell squat, bulbous, smaller than typical *fulgurator*; spire higher, projected, almost scalariform; color pale pink with darker pink zig-zags in clouded pattern; large, dark sub-sutural flammules.

Discussion: This form has been found on Curacao and it may possibly inhabit some of the smaller islands off the northern Venezuela coast.

Size: Adult length approximately 40 mm.

Oliva (Strephona) goajira Petuch and Sargent, new species (Plate 23, Figures 12, 13)

Description: Shell of medium size for subgenus, very slender, with straight sides; spire low; aperture narrow; color rich chestnut orange-brown, overlaid with an extremely dense netting of minute triangles; anterior half of body whorl colored darker brown with numerous fine brown vertical lines; posterior half of body whorl with single thin brown band, composed of fine vertical lines, around middle; edge of suture and shoulder colored bluish-brown with yellow scalloping along suture edge; spire whorls with dark brown callus; interior of aperture pale violet; columellar area white with 13 to 15 raised plicae.

Holotype: Length 38 mm, width 15 mm, from 60 meter depth off Cabo La Vela, Goajira Peninsula, Colombia; taken by commercial scallop boats. USNM 841433.

Etymology: Named for the Goajira Indians of the Goajira Peninsula of Colombia and Venezuela.

Discussion: *Oliva goajira* is closest to *O. bewleyi*, but differs in being a much smaller and more slender species. The dark colored anterior half of the shell of *O. goajira* is very distinctive, and, along with its extremely fine netted pattern, can be used to separate this deeper water species from the coarser patterned *O. bewleyi*. *Oliva goajira* is known only from the deeper waters off the Goajira Peninsula of Colombia.

Size: Average adult length approximately 40 mm.

Oliva (Strephona) graphica Marrat, 1870 (Plate 23, Figures 7, 8)

Description: Bluish gray and blue green, overlaid with dense network of dark brown triangles and two darker bands of brown triangles; inner edge of lip with dark purple-brown blotches.

Discussion: *Oliva graphica* is more slender, straight-sided, and cylindrical than *O. bifasciata*, its closest relative. *O. graphica* is restricted to the coast of Brazil, from Bahia State to Santa Catarina State, in shallow water.

Size: Approximately 50 mm in length.

Oliva (Strephona) graphica color form *circinata* Marrat, 1871 (Plate 23, Figures 9, 10, 11)

Description: Blue gray color form with lower spire. This form is found off the coast of Bahia State, Brazil

Oliva (Strephona) incrassata Lightfoot, 1786 (Plate 23, Figures 14, 15, 16)

Description: Shell inflated, very thickened and heavy; some specimens with acutely angled shoulder on body whorl; color yellowish-tan or gray, overlaid with dark brown and black spots and mottlings, some specimens with a creamy-yellow ground color.

Discussion: This species is found in shallow water, and ranges from Baja California and the Gulf of California south to Ecuador.

Size: This is one of the largest olive species. Adults average from 50 to 70mm. in length, but may reach a maximum of about 95 mm.

Oliva (Strephona) incrassata color form *burchorum* Zeigler, 1969 (Plate 24, Figures 1, 2)

Description: Pure yellow-orange color form; some specimens with anterior half of shell darker orange.

Discussion: This color variety is only found at the northern end of the Gulf of California.

Oliva (Strephona) incrassata color form *nivea* Pilsbry, 1910 (Plate 24, Figures 3, 4)

Description: Pure white, albinistic color form.

Discussion: Only found in a small area near San Felipe, Mexico in the northern Gulf of California.

Oliva (Strephona) ionopsis Berry, 1969 (Plate 24, Figures 5, 6)

Description: Shell with well-developed shoulder; color cream-yellow and lavender-purple, overlaid with dense pattern of light brown zig-zags; interior of aperture and columellar area bright purple.

Discussion: Restricted to the deeper waters of the Gulf of California.

Size: Approximately 45 to 55 mm in length.

Oliva (Strephona) jamaicensis Marrat, 1870 (Plate 24, Figures 7, 8)

Description: Purple-gray color, overlaid with very dense network of sharply-defined, dark brown triangles; two mid-body bands of darker brown triangles; aperture and columellar area purple.

Discussion: This species is endemic to Jamaica and it inhabits shallow water.

Size: Approximately 25 mm in length.

Oliva (Strephona) jamaicensis brunnea Marrat, 1870 (Plate 24, Figures 9, 10, 11, 12, 13, 14)

Description: Color white, overlaid with dense network of brown triangles; two mid-body bands of vertical brown lines and flammules; aperture and columellar area white. This subspecies is also commonly found in solid dark-brown or yellow-gold color forms.

Discussion: Marrat's type of *O. jamaicensis brunnea* was an all brown specimen (hence the name *brunnea*), but this variety is only a color morph of the common, typical form. Since this was the first name applied to this subspecies, it must be used. *Oliva jamaicensis brunnea* is endemic to Puerto Rico, where it inhabits shallow water.

Size: Adults average approximately 25 mm in length, however,

a giant population up to 40 mm and larger, occurs off the southern coast of Puerto Rico.

Oliva (Strephona) jamaicensis brunnea form *figura* Marrat, 1870 (Plate 24, Figures 15, 16)

Description: Greenish in color, overlaid with a uniform netted pattern of dark edged, small triangles.

Discussion: This form is restricted to Mona Island.

Size: 25 to 35 mm in length.

Oliva (Strephona) jamaicensis zombia Petuch and Sargent, new subspecies (Plate 24, Figures 17, 18)

Description: Shell small for subgenus, ovate in outline, sides slightly convex; spire low; color cream-yellow, overlaid with dense, cloudy net of brown triangles; spire whorls partially covered with tan callus; aperture white; columellar area white with 10 to 13 large white plicae.

Holotype: Length 24 mm, width 13 mm, collected on beach after storm, Gonave Island, Haiti. USNM 841454.

Etymology: Named for the mythological zombies of Haiti, who, like the new subspecies, are endemic to that part of the island of Hispaniola.

Discussion: *O. j. zombia* differs from *O. j. jamaicensis* from Jamaica, in having a fatter shell with a more ovate shape, by having a more diffuse, blurred color pattern, and by having a white aperture and columella, instead of purple. This new subspecies is confined to shallow water areas around Gonave Island and the western coast of Haiti.

Size: Approximately 20 mm in length.

Oliva (Strephona) julieta Duclos, 1833 (Plate 24, Figures 21, 22)

(Synonyms: *mariae* Ducros de St. Germain, 1857; *pantherina* Philippi, 1848; *timorensis* Duclos, 1835)

Description: Shell squat, ovate in outline; spire low with projected center and almost needle pointed protoconch; color pale yellow or white, overlaid with dense pattern of dark green, yellow, and dark brown spots.

Discussion: *Oliva julieta* inhabits shallow water from Costa Rica southward to northern Peru.

Size: Adults average 40 to 50 mm in length, but may reach 60 mm.

Oliva (Strephona) kaleontina Duclos, 1835 (Plate 24, Figures 23, 24)

Description: Shell small, squat, somewhat fusiform in shape; spire high and conical; color yellow-cream, overlaid with large reddish-brown zig-zag flammules.

Discussion: *O. kaleontina* is found offshore in deeper water from the southern end of the Gulf of California to northern Peru and the Galapagos Islands.

Size: Approximately 15 to 25 mm in length.

Oliva (Strephona) kaleontina deep water form (Plate 24, Figures 25, 26)

Description: Shell thinner, darker-colored than the typical form, with large brown longitudinal lines and close-packed vertical flammules; subsutural flammules fused into large, dark blotches; protoconch larger, purple in color; columellar plications reduced, poorly-developed; spire more elevated.

Discussion: Trawled by commercial shrimpers from 70 meter depth, off the coast of Costa Rica.

Size: Approximately 25 mm in length.

Oliva (Strephona) kerstitchi Da Motta, 1985 (Plate 24, Figures 19, 20, 27)

Description: Shell of medium size for subgenus, slightly inflated in shape, with rounded sides; shell widest below shoulder; spire low, with protracted early whorls and protoconch; protoconch large; color brown, overlaid with darker brown zig-zags; brown areas with occasional white triangles; shell encircled with two prominent, sharply defined and conspicuous white bands, one at shoulder and one around mid-body; white bands may contain faint, pale tan triangles; spire whorls partially covered with white callus; interior of aperture white, columellar area very narrow, white, with 10 to 13 very weakly-developed plicae.

Discussion: *Oliva kerstitchi* appears, at first, to be a smaller, banded version of *O. polpasta*, but it differs in having a more slender shell without a swollen shoulder, a poorly-developed columellar region without strong plicae, and a larger and more exerted protoconch. The striking, sharply-defined, white bands of *Oliva kerstitchi* readily distinguish it from any other Pamamic *Strephona* species. Some specimens of *polpasta* may exhibit faint banding on the body whorl, but they still have the inflated shoulder, the small protoconch, and the large columellar plications of the typical *polpasta*. *Oliva kerstitchi* is known only from the Gulf of California region.

Size: Approximately 25 to 30 mm in length.

Oliva (Strephona) magdae Petuch and Sargent, new species
(Plate 25, Figures 1, 2, 3)

Description: Shell inflated, obese, ovate in outline, with rounded sides and rounded shoulder just below the suture; spire low, short in proportion to body length; color pale yellow-cream, overlaid with very pale, tan triangles and zig-zags; mid-body and anterior tip of body whorl with bands of brown zig-zags and dots; low spire whorls partially covered with yellowish-tan enamel; subsutural flammules very large, bluish-tan, and prominent, on white background; aperture white; columella white, with 13 to 15 large, separate, well-developed plicae.

Holotype: Length 40 mm, width 19 mm, brought up in fish trap from 300 meter depth off Matanzas Bay, Cuba. USNM 841441.

Etymology: Named for Mrs. Magda Finlay, who helped her husband, Mr. C. John Finlay, collect mollusks in Cuba in 1956.

Discussion: *Oliva magdae* is closest to *O. finlayi*, but differs in being a much squatter, more rotund species with the shoulder high up on the shell, just below the suture. From there, *magdae* tapers toward the anterior tip. The most prominent difference is seen in the spire, which is much lower, almost flattened on *magdae*, but is high and elevated on *finlayi* and the similar *bahamasensis* and *barbadensis*. The color pattern of *magdae* is also cloudier, paler and more diffuse than the patterns of *finlayi*, *bahamasensis* and *barbadensis*. *Oliva magdae* occurs along with *O. finlayi* in Matanzas Bay, Cuba, but at much deeper depths

(300 meters or more as compared to 200 meters for *finlayi*).

Size: Approximately 40 mm in length.

Oliva (Strephona) maya Petuch and Sargent, new species (Plate 25, Figures 4,5,8,9)

Description: Shell large for subgenus, elongated, with straight sides; spire low; aperture narrow; color bright canary yellow or yellowish-orange, overlaid with brown netted pattern of small triangles; two bands of darker brown triangles and zig-zags around middle; spire whorls with thin orange or brownish callus; protoconch small, protracted; interior of aperture yellow often with deep yellow inner area; columellar area yellow.

Holotype: Length 60 mm, width 26 mm, from 35 meters depth off Contoy Island, Yucatan Peninsula, Mexico; taken by commercial shrimp trawlers. USNM 841443.

Etymology: Named for the Mayan Indians that once inhabited the Yucatan region.

Discussion: This new species, after *O. sayana*, is the second largest olive in the Atlantic. *Oliva maya* differs from the Carolinian *O. sayana* in having a more slender shell with a lower spire. The most obvious difference is the bright yellow color of *O. maya*, a character not seen in the related *O. sayana* and *O. olivacea*. *Oliva maya* is confined to the offshore waters around the northern and eastern coasts of the Yucatan Peninsula.

Size: Approximately 50 to 65 mm in length.

Oliva (Strephona) nivosa Marrat, 1870 (Plate 25, Figures 10,11,12)

Description: Shell cylindrical, elongated; spire flattened; color yellow, overlaid with very dense and obscured pattern of dark brown triangles; triangles "smeared," giving cloudy appearance to color pattern; two faint mid-body bands of darker brown triangles; aperture and columellar area purple.

Discussion: This species is easily distinguished by its purple aperture, slender and elongated shape and its extremely small protoconch. *O. nivosa* ranges from the Lesser Antilles south to Venezuela, in shallow water.

Size: Approximately 45 to 50 mm in length.

Oliva (Strephona) nivosa deep water form (Plate 25, Figures 6, 7)

Description: Shell stockier and more rotund than typical *O. nivosa*; color golden brown with darker triangle markings; aperture purple.

Discussion: Trawled by commercial shrimpers from 50 meter depth off the Goajira Peninsula of Colombia.

Oliva (Strephona) obesina Duclos, 1835 (Plate 25, Figures 13, 14)

Description: Shell with well-developed shoulder, pyriform in outline; color pale yellow, overlaid with dense network of brown triangles and zig-zags; aperture and columellar area white.

Discussion: *Oliva obesina* is a shallow water species that is restricted in range to the Gulf of California.

Size: Approximately 40 mm in length.

Oliva (Strephona) olivacea Marrat, 1870 (Plate 25, Figures 15, 16)

Description: Shell stocky and ovate in outline; spire very elevated, protracted; color pale salmon-pink, overlaid with network of large, pale reddish-tan triangles around mid-body; interior of aperture and columellar area salmon-pink.

Discussion: Endemic to Bermuda, where it occurs with *O. bifasciata jenseni*.

Size: Approximately 50 mm in length.

Oliva (Strephona) olssoni Petuch and Sargent, new species (Plate 25, Figures 17, 18)

Description: Shell of medium size for subgenus, heavy, inflated; spire low; shoulder rounded, well-developed; body whorl coniform from shoulder to anterior tip; overall outline appears to be a round topped cone; color reddish-tan to light brown, overlaid with network of fine triangles and numerous vertical zig-zags and fine lines; center of body whorl with single band of larger triangles; spire whorls partially covered with yellow callus; aperture white with pale lavender interior in fresh specimens; columellar area white, thick, with 16 to 20 well-developed, sharply-

defined plicae.

Holotype: Length 36 mm, width 20 mm, trawled from 60 meter depth at outer edge of the Gulf of Panama (8°7'N, 78°40'W), by fisheries research vessel. USNM 841444.

Etymology: Named for the late Dr. Axel Olsson, in memory of his work on the Panamic Olividae.

Discussion: *Oliva olssoni* is closest to *O. polpasta*, but differs from that species in having a more pyriform shape, a larger protoconch, and in having a reddish color pattern composed of longitudinal zig-zag lines with a distinct central band.

Olsson (1971, *Bulletin of Marine Science* 21(1): 55-56, Figure 25) discussed and illustrated this new species, but did not describe it. Like ourselves, he compared it to *O. polpasta* and mentioned the consistent differences in color pattern. *Oliva olssoni* appears to be restricted to very muddy bottoms in deeper waters at the edge of the continental shelf at the edge of the Gulf of Panama.

Size: Approximately 35 mm in length.

***Oliva (Strephona) peruviana* Lamarck, 1811 (Plate 26, Figures 1, 2)**

(Synonyms: *senegalensis* Lamarck, 1811; *vadi* Vanatta, 1915)

Description: Shell stocky, variable in shape from ovate, to pyriform and coniform; spire low to moderate in height; color extremely variable, typical form lavender or pinkish-white, overlaid with evenly-spaced reddish brown dots.

Discussion: This is the most variable of all olive species. Generally, all color and shape variations can be found in every population. All of the specimens pictured in this book were collected on Cavanha Beach near Iquique, Chile. Gigoux, 1937 described sixty forms of *O. peruviana*, none of which were taxonomically valid.

Oliva peruviana ranges from southern Peru to Chile and it inhabits shallow water. This species lives in the coldest waters of any known *Oliva* species.

Size: Approximately 35 to 50 mm in length.

***Oliva (Strephona) peruviana* color form *castanea* Johnson,**

1911 (Plate 26, Figures 3, 4)

Description: Solid dark brown color form.

Oliva (Strephona) peruviana form *coniformis* Philippi, 1848
(Plate 26, Figures 7,8,9,10)

Description: Cone-shaped variety with greatly-produced, angular shoulder. This form can be found in all color varieties.

Oliva (Strephona) peruviana color form *fulgurata* Martens, 1869 (Plate 26, Figures 5, 6)

Description: Color lavender-purple, pinkish-white or yellowish with wide, dark reddish-brown, undulating longitudinal lines, producing a zebra pattern.

Oliva (Strephona) peruviana color form *livida* Johnson, 1911
(Plate 26, Figures 11, 12)

Description: Solid bright (livid) lavender, purple, or bluish-gray color form.

Oliva (Strephona) peruviana color form *subcastanea* Vanatta, 1915 (Plate 26, Figures 13, 14)

Description: Solid pale brown or golden-tan color form.

Oliva (Strephona) polpasta Duclos, 1835 (Plate 26, Figures 15, 16, 19)

Description: Shell inflated, pyriform, with low spire and rounded shoulder; color dark khaki-green, overlaid with dark brown triangles, dots and zig-zags; light, creamy-yellow, small, sub-sutural triangle markings.

Discussion: *O. polpasta* is closest to *O. kerstitchi* and *O. truncata*. See the discussion sections listed under those species for detailed identification. *Oliva polpasta* ranges from the Gulf of California and Baja California south to northern Peru. This species is found both offshore and in shallow water.

Size: Average adult length approximately 40 mm.

Oliva (Strephona) polpasta color form *callosa* Li, 1930 (Plate 26, Figures 17, 18)

Description: Shell more inflated, thicker, color khaki-green with large bright yellow patches and large yellow triangles.

Discussion: This form is found in the Gulf of Panama region.

Oliva (Strephona) radix Petuch and Sargent, new species (Plate 26, Figures 20,21,22,23)

Description: Shell of medium size for subgenus, short and stocky, very inflated and heavy, coniform in outline; spire flattened, shoulder very well developed and pronounced; color pale tan to flesh overlaid with network of fine, reddish-colored triangles; interior of aperture white; columellar area narrow, white, with 10 to 15 weak plications.

Holotype: Length 38 mm, width 23 mm, trawled by commercial shrimpers from 75 meter depth, on mud bottom, off Isla La Plata, Ecuador. USNM 841446.

Etymology: *radix*, root or radish, in reference to the unusual shape of this new species.

Discussion: *Oliva radix* resembles a greatly inflated and truncated *O. polpasta*, but differs from that species by having a larger protoconch, a more diffuse color pattern, and by lacking well-developed columellar plications. *Oliva davisae* from the Gulf of California appears to be the closest relative of *O. radix*, but differs from the new species in being a smaller shell, in having fewer and larger subsutural flammules, and by being much less inflated.

Oliva radix is the most obese member of the subgenus *Strephona*, with some specimens being almost globular in form. At present, it is known only from deep water off Ecuador and represents the southernmost member of the *spicata* and *polpasta* species complexes.

Size: Approximately 35 mm in length.

Oliva (Strephona) reclusa Marrat, 1871 (Plate 27, Figures 1,2,3,4)

Description: Color pale blue-green, overlaid with network of large, pale tan triangle markings; two mid-body bands of dark brown dots; protoconch larger than that of *reticularis*.

Discussion: *Oliva reclusa* is endemic to the Netherlands

Antilles islands of Aruba, Bonaire and Curacao, and it inhabits shallow water. This species can be distinguished from *reticularis*, by its larger protoconch, more cylindrical shape and straighter sides and by its geographical range.

Size: Approximately 30 mm in length.

Oliva (Strephona) rejecta Burch and Burch, 1962 (Plate 27, Figures 5, 6, 7)

(Synonym: *punctata* Marrat, 1870 not *punctata* Röding, 1798)

Description: Shell slender, fragile and thin, with high spire; color purple or white, overlaid with a dense network of dark brown triangles and large, dark brown spots; aperture and columellar area deep purple.

Discussion: This species is easily distinguished from the other species in its range by its slender, elongated shape, its high spire, the deep purple aperture and columella and by being very thin and light in weight. Adults of this species appear to have a thin, almost juvenile lip.

Oliva rejecta is endemic to the Gulf of California, where it is found in shallow water.

Size: Average adult length approximately 40 to 50 mm.

Oliva (Strephona) reticularis Lamarck, 1811 (Plate 27, Figures 8, 9, 12, 15, 16, 17, 18)

(Synonyms: *diaphana* Duclos, 1835; *pallida* Marrat, 1871; *quersolina* Duclos, 1835)

Description: Shell ovate in outline with rounded sides; spire varies from moderate height to high and conical; color white, overlaid with a pattern of large pink, red, or reddish-brown triangles, which may form a loose, netted pattern.

Discussion: *Oliva reticularis* is a variable species with many color forms, but it always has rounded sides and an inflated ovate body. Although *O. reticularis* is often confused with the straight-sided, more elongate *bifasciata*, *reticularis* always has a much larger, globose protoconch (over twice as large as *bifasciata*) and a coarser color pattern.

O. reticularis ranges from the Bahamas and the West Indies westward to the Caribbean coast of Central America. This

species is not found in Florida or anywhere else along the coast of the United States. *Oliva reticularis*, being an inhabitant of shallow water and having a larger protoconch which signifies a larger embryonic shell, is effectively cut off from the mainland of Florida by the Gulf Stream. This current flows between that state and the closest occurrence of this species on the Island of Bimini, only 40 miles away.

Size: Approximately 30 to 40 mm in length.

Oliva (Strephona) reticularis color form *olorinella* Duclos, 1835 (Plate 27, Figures 13, 14)

Description: Pure white, pale yellow or golden color form.

Discussion: Although this form is found throughout the range of *reticularis*, it is particularly common in the Bahamas. On South Bimini Island, *O. reticularis olorinella* outnumbers the typical color form.

Oliva (Strephona) reticularis color form *sowerbyi* Marrat, 1870 (Plate 27, Figures 10, 11)

Description: Grayish-green to greenish-yellow, overlaid with pattern of brown triangles; two mid-body bands of large, dark brown dots.

Discussion: This color form is restricted to the Greater Antilles, particularly eastern Hispaniola Island (Haiti), where it is relatively abundant.

Oliva (Strephona) sayana Ravenel, 1834 (Plate 27, Figures 21, 22)

(Synonym: *litterata* Lamarck, 1811 not *litterata* Röding, 1798)

Description: Shell large, cylindrical, with relatively straight sides; spire raised, conical; color pale greenish yellow to cream-yellow, overlaid with a dense network of very fine brown triangles; two mid-body bands of larger, darker brown triangles and dark brown zig-zags; aperture white, pale lavender or purple; columella white.

Discussion: This species has a split range, with the eastern portion extending from Cape Hatteras, North Carolina south to Palm Beach, Florida; and the western portion extending from

Sanibel Island, Florida northward and westward to Padre Island, Texas. This is the abundant shallow water species that is commonly referred to as the "lettered olive."

Size: This is the largest olive species in the Atlantic, with some specimens exceeding 80 mm in length. The average adult size is approximately 50 to 60 mm.

Oliva (Strephona) sayana color form *citrina* Johnson, 1911 (Plate 27, Figures 19, 20)

Description: Solid bright yellow-orange color form; anterior half of shell often darker orange; some specimens may have faint triangle markings.

Discussion: This is the "rare golden olive" of many contemporary authors. In actuality, this color form is not uncommon and it is not unusual to see as many as a half dozen or more specimens displayed in a single shell show. Unfortunately, however, the works of these authors have a tendency to manufacture "glamour shells" with artificially high prices, out of relatively common species or forms. This form is most commonly collected along the beaches of Florida's west coast.

Oliva (Strephona) sayana albinistic color form (Plate 28, Figures 1, 2)

Description: Pure white, unmarked color form. Many of these are actual albinos with white animals, as was the specimen figured in this book.

Oliva (Strephona) sayana lavender or purple color form (Plate 28, Figure 3)

Description: Bright lavender purple with brown triangle markings. This form often fades to pale gray within months of the date collected.

Oliva (Strephona) sayana sarasotensis Petuch and Sargent, new subspecies, (Plate 28, Figures 4, 5)

Description: Shell of medium size for subgenus; fusiform in shape, somewhat inflated, with rounded sides; spire high, protracted; color yellow-tan, bright-yellow or white, with greenish

patches, overlaid with a network of fine, brown triangles; body whorl encircled with two bands of darker brown triangles, one above mid-body, one below; some specimens with large areas devoid of pattern and having the yellow or white ground color showing through; spire whorls partially covered by tan callus; aperture pale lavender to bright purple within; columellar area white, with 15 to 20 thick white plications.

Holotype: Length 40 mm, width 18 mm, collected on sand bottom at 15 meter depth, approximately 15 km due west of Lido Beach, Sarasota, Florida in a large barren sandy area, which is referred to by local SCUBA divers as "the desert." This specimen is part of a lot of approximately 20, that was taken by the junior author while SCUBA diving. USNM 841450.

Etymology: Named for Sarasota, Florida, the type locality.

Discussion: This new subspecies of the widespread *O. sayana* differs from the typical species in being smaller, shorter and much stockier. In some specimens, the spire is almost one-third the body height. In the typical *sayana* the spire is generally one-fifth the body height or less. There is some intergradation at depths of approximately 5 to 8 meters. However, at depths that are less than 5 meters, the typical form is found alone and at depths of over 8 meters *O. sayana sarasotensis* is found exclusive of its larger relative. We have studied this species in its natural habitat for years, and we are extremely confident in the validity of our new subspecies. Zeigler and Porreca (*Olive Shells of the World*, Plate 1, Figure 3) illustrates a specimen of this well-known offshore subspecies, that was generally referred to as the "deep water form."

Oliva sayana sarasotensis has been found only from Tampa south to Sanibel Island, Florida, in depths ranging from 8 to 100 meters. This new subspecies represents the southernmost tip of the Gulf of Mexico component of the Carolinian Province.

Oliva (Strephona) sayana texana Petuch and Sargent, new subspecies, (Plate 38, Figures 3, 4)

Description: Shell of medium size for subgenus; fusiform in shape, elongated with rounded sides; spire extremely high and exerted; color yellow-tan, bright yellow or white, with a tight

pattern of fine brown triangles; body whorl encircled with two bands of darker brown zig-zag flammules, one about mid-body, one below; spire whorls angularly concave with tan callus on anterior "stepped" portion of each spire whorl; aperture purple; columella and fasciole buff to creamy-white; posterior portion of columella concave and eroded, devoid of plications.

Holotype: Length 45 mm, width 16 mm, collected in shallow water, Padre Island, off the coast of southern Texas. USNM 841465.

Etymology: Named for Texas, the type locality.

Discussion: This new subspecies differs from all other races of *O. sayana* by having an eroded, concave columella that is devoid of plications. The stepped protracted spire is much more exaggerated in this subspecies than in any other population of *O. sayana*. *O. sayana texana* has an overall appearance that is somewhat twisted or distorted, which in some specimens may be almost peanut like.

Size: Average adult length about 45 mm.

Oliva (Strephona) spicata Röding 1798 (Plate 28, Figures 7, 8, Plate 39, Figures 5, 6, 9, 10)

(Synonyms: *litterata* Röding, 1798 not *litterata* Lamarck, 1811; *arachnoidea* Röding, 1798; *oblongata* Marrat, 1870)

Description: Shell large, sides rounded, elongated; spire moderate to high and pointed; color pale tan, overlaid with dense network of very fine, brown triangles; triangle pattern "smeared," producing an obscure, cloudy appearance; two mid-body bands of larger, darker brown triangles and zig-zags; area between bands paler than rest of shell; bands may be obscured in some specimens; aperture white.

Discussion: This species ranges from Sinaloa, Mexico south to northernmost Peru. *O. spicata* is an inhabitant of shallow water.

Size: Adults average from 45 to 60 mm in length.

Oliva (Strephona) spicata color form *araneosa* Lamarck, 1811 (Plate 28, Figure 11)

Description: Tan, covered with dense pattern of dark brown speckles.

Oliva (Strephona) spicata color form *fuscata* Marrat, 1871 (Plate 28, Figures 9, 10)

Description: Solid dark brown or almost black, color form. The triangle net pattern is usually very slightly discernable in this color variety.

Oliva (Strephona) spicata color form *intertincta* Carpenter, 1857 (Plate 28, Figure 6)

Description: Pinkish or pinkish-gold, overlaid with bright pink or reddish triangle pattern.

Oliva (Strephona) spicata deynzeræ Petuch and Sargent, new subspecies, (Plate 28, Figures 12, 13).

Description: Shell large for subgenus, heavy, elongated, with slightly convex sides; spire elevated, protracted; color cream-yellow, overlaid with an occluding pattern of light brown triangles of varying sizes; body whorl with two bands of dark brown spots and flammules; adult specimens with a pale blue glaze over the anterior half of the body whorl; interior of aperture yellow; columellar area purple, with 23 to 30 thin, well-developed plications; anterior tip of columella brownish-purple with one large, deep purple plication anterior to the fasciole; spire whorls partially covered with a dark purple callus.

Holotype: Length 55 mm, width 22 mm, collected at 20 meter-depth off Cocos Island, Costa Rica, by Hookah diver. USNM 841452.

Etymology: Named for Mrs. Beverly Deynzer of Sanibel, Island, Florida, who kindly donated the type lot.

Discussion: This new subspecies differs from *O. spicata spicata* in being a more slender shell with a higher spire, in having a more vivid color pattern including a blue overglaze, by having a bright purple columella below the fasciole, and by having a dark purple glaze on the spire whorls.

Oliva spicata deynzeræ represents an isolated population of *O. spicata* that has settled on the remote Pacific island of Cocos, approximately 400 miles off the Costa Rican coast. This new subspecies occurs with *Oliva foxi*, which is also endemic to the insular Cocos Island Subprovince of the Panamic Province. *O.*

spicata deynzeræ also comes in a dark brown or black color form (Plate 28, Figures 14, 15)

Oliva (Strephona) spicata melchersi Menke, 1851 (Plate 28, Figures 16, 17)

Description: Spire very elevated, protracted; color yellow, overlaid with tan and cream patches and a network of fine, dark brown triangles; aperture white.

Discussion: This high-spired, dark-colored subspecies represents the Gulf of California population of the species. Here it is found living with *venulata*, *subangulata*, *rejecta* and the others of this group. *O. spicata melchersi* is restricted to the Gulf of California, where it is found in shallow water.

Size: Average adult length approximately 55 mm.

Oliva (Strephona) splendidula Sowerby, 1825 (Plate 29, Figures 1, 2, 3, 4)

Description: Shell cylindrical, slightly inflated, with rounded sides; spire low with early whorls protracted; color pink, purple and yellow, overlaid with a pattern of pink and white triangles; two wide, dark brown bands around shell, one at mid-body, one at anterior end; brown bands with small yellow triangles.

Discussion: Ranges from Tres Marias Islands, Mexico, to Ecuador and the Galapagos Islands. This species is found both offshore and in shallow water.

Size: Average adult length 40 to 50 mm.

Oliva (Strephona) subangulata Philippi, 1848 (Plate 29, Figures 5, 6)

Description: Shell very broad with well-developed shoulder, coniform in outline; color khaki-green and yellow, overlaid with dense, diffuse pattern of brown triangles and cloudings; body whorl sprinkled with large, dark brown spots; columella purple.

Discussion: Restricted to the southern half of the Gulf of California, in shallow water.

Size: Approximately 35 mm in length.

Oliva (Strephona) subangulata corteziana Petuch and

Sargent, new subspecies, (Plate 29, Figures 7, 8, 9, 10)

Description: Shell of medium size for subgenus, heavy, coniform in shape, with angled shoulder; spire high, elevated; color pale yellowish-tan overlaid with netted pattern of fine reddish-tan triangles; body whorl with two wide bands of darker tan triangles and reddish spots; spire whorls with yellow callus; interior of aperture white; columellar area white with 15 to 20 thin, long plications.

Holotype: Length 32 mm, width 16 mm, found on sand bottom, 20 meter depth, off Isla Angel de la Guarda, Sea of Cortez, Gulf of California, Mexico, by SCUBA diver. USNM 841457.

Etymology: Named for the Sea of Cortez in the Gulf of California, the type locality.

Discussion: *Oliva subangulata corteziana* differs from *O. subangulata subangulata* by being a much paler-colored shell, totally lacking the khaki-green and dark brown color of the typical species. The netted pattern of *O. s. corteziana* is also much finer than that of *O. s. subangulata*, and lacks the large, dark brown spots that appear on the body of the typical subspecies. The nominate subspecies often has a purple or lavender columellar area and fasciole, *O. subangulata corteziana* always has a white columella. The new subspecies is also much squatter and more obese than *O. s. subangulata*.

Oliva subangulata corteziana represents a northern, deeper water, isolated population of the southern Gulf of California shallow water *O. subangulata*. It is known only from the northern end of the Gulf of California (Sea of Cortez).

Size: Approximately 35 mm in length.

Oliva (Strephona) tisiphona Duclos, 1844 (Plate 29, Figures 11, 12)

Description: Shell very inflated and ovate in outline; color yellow or gray, overlaid with very dense and diffuse pattern of fine dark brown or gray triangles; triangle pattern often "smeared," producing a cloudy appearance; two wide mid-body bands of dark brown flammules and zig-zags; aperture white; columella with purple blotch.

Discussion: *O. tisiphona* ranges from Santa Marta, Colombia

to Cumana, Venezuela and is confined to the mainland of these two countries. This shallow water species is most common in the Gulf of Venezuela.

Size: Approximately 40 mm in length.

Oliva (Strephona) tisiphona color form *hepatica* Marrat, 1871 (Plate 29, Figures 16, 17)

Description: Solid brown or black color form.

Oliva (Strephona) tisiphona color form *oblonga* Marrat, 1870 (Plate 29, Figures 13, 14, 15)

Description: Large, ovate shell; color bright canary yellow, overlaid with scattered, diffuse pattern of green triangles. Columella yellow without purple blotch.

Discussion: This form is found in deeper water, along the Goajira Peninsula of Colombia.

Size: *oblonga* is larger than the typical *tisiphona* and may reach up to 60 mm in length.

Oliva (Strephona) tisiphona oniska Duclos, 1844 (Plate 29, Figures 18, 19)

Description: Shell large, inflated, fusiform in shape with a high, protracted spire; color bright yellow, overlaid with a pattern of green triangles and dots; columella bright yellow.

Discussion: This deeper water subspecies is occasionally trawled by shrimpers from depths of 35 to 100 meters off the mouth of the Magdalena River, Colombia.

Size: Approximately 60 mm in length.

Oliva (Strephona) tisiphona schepmani Weisbord, 1962 (Plate 30, Figures 1, 2)

Description: Bright sky-blue and lavender purple, overlaid with a network of purple triangles and dots.

Discussion: This subspecies was originally named as a Pleistocene fossil from the Cabo Blanco Formation of Venezuela, but has been recently found living, offshore at depths of from 30 to 100 meters. This subspecies ranges from the Golfo de Triste, Venezuela to Isla Margarita, Venezuela. This is the only bright

blue olive in the western Atlantic.

Size: Approximately 40 to 50 mm in length.

Oliva (Strephona) truncata Marrat, 1867 (Plate 30, Figures 3,4,5,6)

Description: Shell cylindrical with straight sides; protoconch large, protracted; color reddish-brown, overlaid with dense pattern of dark brown, close-packed, longitudinal zig-zag lines.

Discussion: *O. truncata* differs from *O. polpasta* by being a more slender, cylindrical shell with a reddish-brown zig-zag color pattern, by having smaller, less prominent subsutural flammules, and by having a higher spire with a larger, protracted, needle-like protoconch. *O. truncata* ranges from Costa Rica to Ecuador and it is found both offshore and in shallow water.

Size: Approximately 35 mm in length.

Oliva (Strephona) venulata Lamarck, 1811 (Plate 30, Figures 7,8,9,10)

(Synonyms: *perfecta* Johnson, 1911; *venulata* Steinbeck and Ricketts, 1941 not Lamarck, 1811)

Description: Color bright yellow, overlaid with pattern of large, dark green triangles and dots; columella with purplish-brown blotch.

Discussion: Restricted to the outer coast of Baja California and the Gulf of California, in shallow water.

Size: Approximately 40 mm in length.

Oliva (Strephona) venulata color form *harpularia* Lamarck, 1811 (Plate 30, Figure 26)

Description: Pale yellow with zebra pattern of pale blue, undulating longitudinal lines.

Oliva (Strephona) venulata color form *hemphilli* Johnson, 1915 (Plate 30, Figures 24, 25)

Description: Pale salmon-pink to white, without triangles or other markings; generally slightly stockier than the typical form.

Oliva (Strephona) venulata color form *ustulata* Lamarck, 1811

(Plate 30, Figures 13, 14)

Description: Solid dark brown or black color form; triangle markings usually barely discernable on dark ground color. This form parallels the *fuscata* form of *O. spicata*.

Oliva (Strephona) venulata cumingii Reeve, 1830 (Plate 30, Figures 11, 12)

Description: Tan and yellow, overlaid with network of fine, light brown triangles; triangles "smeared," often coalescing into wide bands of darker brown color; some specimens uniformly tan or brown with markings almost absent.

Discussion: This subspecies is restricted to the southern part of the Gulf of California on the Baja California side. Further study may prove this subspecies and its close relative *O. venulata pindarina* to be a separate full species.

Size: Approximately 35 to 40 mm in length.

Oliva (Strephona) venulata pindarina Duclos, 1835 (Plate 30, Figures 15, 16, 17)

Description: White or pale yellow with scattered, dark reddish-brown dots; inner edge of lip with large, dark brown blotches; base of columella with large, dark reddish-brown patch, from which lines of the same color radiate across the fasciole.

Discussion: The dark red patch and radiating lines on the columellar fasciole are distinctive of this subspecies. *O. venulata pindarina* is also found in *hemphilli* (white or albinistic) and golden color forms. This subspecies is restricted to the Gulf of California.

Size: Approximately 25 to 35 mm in length.

Oliva (Strephona) venulata golden color form (Plate 30, Figures 18, 19)

Description: Solid golden-yellow color form, which may or may not have the reddish patch and lines of *pindarina* on the columellar fasciole. This appears to be a color form of *O. venulata cumingii*.

***Oliva (Strephona) vermiculata* Gray, 1858 (Plate 30, Figures 22, 23)**

Description: Shell slightly fusiform with large protoconch; color white with zebra pattern of thin, brown undulating longitudinal lines and scattered brown triangles; two mid-body bands of large, dark brown dots.

Discussion: *Oliva vermiculata* is a shallow water species that is endemic to the Netherlands Antilles islands of Aruba and Curacao. This species occurs with *O. fulgurator*, *O. reclusa* and *O. reticularis*.

Size: Approximately 25 mm in length.

***Oliva (Strephona) violacea* Marrat, 1867 (Plate 30, Figures 20, 21)**

Description: Shell with large, dome-like protoconch and high, elevated spire; color lavender purple and yellow, overlaid with diffuse, cloudy pattern of brown zig-zags and dots; aperture and columella bright purple.

Discussion: *O. violacea* is often confused with the common shallow water *rejecta*, which also has a deep purple columella. *Oliva violacea* is, however, a thicker, sturdier shell, with a more inflated shoulder and an overall shape that resembles a sharp cone (the spire) and a truncated cone (the body whorl) with their bases coming together in the middle (at the shoulder). *O. violacea* also lacks the well-defined triangle markings of *rejecta*. This species inhabits depths that range from intertidal to approximately 35 meters and it is found only in the Gulf of California.

Size: Approximately 45 mm in length.

Subgenus *Strephonella* Dall, 1909

TYPE SPECIES: *Oliva undatella* Lamarck, 1811. Recent, eastern Pacific.

SPECIES IN STREPHONELLA

***Oliva (Strephonella) undatella* Lamarck, 1811 (Plate 31,**

Figures 1, 2)

Description: Shell small, stocky, ovate in outline; spire pointed with exserted protoconch; shell with two areas of colored enamel, one at anterior one-third, and other at posterior two-thirds and spire; color of posterior enamel brown or gray with undulating longitudinal lines; color of anterior enamel yellowish, often with thin, reddish-brown longitudinal lines.

Discussion: This small species comes in a large variety of color variations, many of which have been named. These are listed below. *Oliva undatella* is a shallow water species that ranges from Baja California and the Gulf of California south to Panama.

Size: Average adult size approximately 10 to 12 mm.

Oliva (Strephonella) undatella color form *nedulina* Duclos, 1835 (Plate 31, Figures 3, 4)

Description: White with scattered, large, dark brown flammules.

Oliva (Strephonella) undatella color form *tenebrosa* Wood, 1828 (Plate 31, Figures 5, 6)

Description: Yellow with white and brown patches.

Oliva (Strephonella) undatella albinistic form.

Description: Pure white, albino form, commonly found in average populations.

Oliva (Strephonella) undatella ecuadoriana Petuch and Sargent, new subspecies (Plate 31, Figures 7,8,9,10,11,12)

Description: Shell large for subgenus, inflated, thickened; color slate-gray to lime-green on posterior enamel, overlaid with undulating longitudinal flammules of white or gray; anterior enamel bright yellow, often marked with reddish-brown longitudinal lines; columellar area dark purple-brown, with 15 to 20 fine, poorly-developed plicae; interior of aperture dark brown.

Holotype: Length 22 mm, width 10 mm, trawled by commercial shrimpers from 20 meter depth off Isla La Plata, Ecuador. USNM 841459.

Etymology: Named for Ecuador, the type locality.

Discussion: *Oliva undatella ecuadoriana* differs from typical *undatella* in being a much larger shell (over twice as large) with a more inflated outline, by having a dark purple-brown columella, and by having more numerous, finer and less-developed columellar plications. This new subspecies ranges from the western coast of Colombia south to northern Peru, but it is most common off the coast of Ecuador. *O. undatella ecuadoriana* also occurs in the albino color form.

Size: Average adult size 18 to 24 mm in length.

Subgenus *Viduoliva* Petuch and Sargent, new subgenus

DIAGNOSIS: Shells large for genus, thin for their size, inflated, with rounded sides and shoulders; spires low, depressed; characteristically, mature specimens have raised portion on posterior end of lip that projects beyond the spire; corresponding thickened callus on the body wall opposite raised portion of lip; body wall callus and lip projection together producing constricted, posterior canal next to spire; colors generally in shades of green, green-gray, khaki, or blue, overlaid with dark brown or black flammules of various sizes; triangle net patterns present in only few species; aperture wide and flaring.

TYPE SPECIES: *Oliva vidua* Röding, 1798. Recent, Indian Ocean and southwestern Pacific.

SPECIES IN VIDUOLIVA

Oliva (Viduoliva) angustata Marrat, 1868 (Plate 31, Figures 13, 14)

Description: Yellow and olive-green, overlaid with minute,

brown zig-zag flammules and two wide bands of black or dark brown blotches; subsutural area above shoulder usually without pattern; columella and columellar plications characteristically white with large wine-red blotch that outlines plicae.

Discussion: *Oliva angustata* is a shallow water species that ranges from the Philippines and Indonesia eastward to Papua New Guinea.

Size: Average adult length 40 mm.

***Oliva (Viduoliva) clara* Marrat, 1871 (Plate 31, Figures 17, 18)**

Description: Shell squat and stubby; color gray-green, overlaid with darker gray spots and triangle markings; two wide bands of darker gray blotches; some specimens with dark brown spots; entire pattern appears clouded-over; columella white.

Discussion: *Oliva clara* ranges from the Philippines and Indonesia to New Guinea and the Solomon Sea Islands, in shallow water. This species is also found in a solid dark brown or black form.

Size: Approximately 30 mm in length.

***Oliva (Viduoliva) elegans* Lamarck, 1811 (Plate 31, Figures 15,16,19,20)**

Description: Shell shape varies from semi-cylindrical with rounded sides to inflated and ovate (sometimes almost rounded); color cream-white, salmon-orange, bright-blue or gray, overlaid with dense pattern of dark green and khaki zig-zag longitudinal lines; some specimens with shoulder band of black flammules; some specimens with two bands, one at shoulder, one at mid-body; columellar fasciole with bright salmon-orange blotch; aperture white.

Discussion: *Oliva elegans* is a common shallow water species that ranges from the Indian Ocean, through the Philippines and Indonesia, southward to northern Australia and eastward to Melanesia.

Size: Average adult length 35 to 40 mm, however; some

specimens may exceed 50 mm.

Oliva (Viduoliva) elegans color form *othonia* Duclos, 1835 (Plate 33, Figures 12, 13)

Description: Color white or salmon-pink covered with numerous blue dots; spire partially callused-over with white enamel; aperture purple.

Discussion: Form *othonia* differs from the typical *elegans* by having a light color to the body whorl and a purple aperture. The purple aperture also helps to distinguish it from *Oliva octavia*, which has a white aperture. Form *othonia* appears to be restricted to Palawan Island in the southwestern Philippines, where it inhabits shallow water.

Size: 35 to 40 mm in length.

Oliva (Viduoliva) elegans color form *pintamella* Duclos, 1835 (Plate 31, Figures 21, 22)

Description: Shell smaller than the typical *elegans*, squat, ovate in shape; color salmon-orange with dark gray or brown reticulated pattern; columella with dark orange blotch.

Discussion: Many recent authors have placed *pintamella* as a form of *O. reticulata*. Upon close examination, it is very obvious that the *pintamella* of Duclos is simply a small adult *elegans* with a dark orange fasciole. This form is restricted to the Philippines and Indonesia, in shallow water.

Size: Approximately 25 to 30 mm in length.

Oliva (Viduoliva) elegans color form *tenebrosa* Marrat, 1871 (Plate 31, Figures 27, 28)

Description: Solid dark brown or black, melanistic, color form.

Oliva (Viduoliva) elegans color form *zigzag* Perry, 1811 (Plate 31, Figures 25, 26)

Description: White, cream or light salmon, with prominent black zig-zags that run the entire length of shell.

Discussion: This is another taxon that has been incorrectly linked with *O. reticulata* by some contemporary authors. Again, our study shows this to be a form of *O. elegans*. This form is most

common in New Guinea, but some specimens with this color and pattern have been taken in the south central Philippines.

Oliva (Viduoliva) elegans unnamed form (Plate 31, Figures 23, 24)

Description: Pale salmon-orange, cream or white with pale gray spots and loose zigzags.

Discussion: This form of *Oliva elegans* has been incorrectly pictured in many contemporary shell books as *Oliva vidua macleaya*. Upon close comparison it is very obvious that this form is *Oliva elegans* (NOTE: *vidua* and *macleaya* are in themselves full and separate species). This form is restricted to northern Australia and New Guinea.

Oliva (Viduoliva) hemiltona Duclos, 1835 (Plate 32, Figures 1, 2)

Description: Size and shape similar to a slender *elegans*; color bright sky-blue, overlaid with darker blue spots and zig-zags; columella and fasciole, pure white.

Discussion: *Oliva hemiltona* is generally smaller and more slender than *elegans* or *vidua*. Its most distinctive characteristics are its bright blue color and the pure white columella and fasciole. Both *elegans* and *vidua* have an orange or orange-stained fasciole. This species is restricted to the Ryukyu Islands, southern Japan and the Volcano Islands. *O. hemiltona* is a shallow water species.

Size: Average adult length 40 mm.

Oliva (Viduoliva) indomalaysica Petuch and Sargent, new species (Plate 32, Figures 7,8,11,12)

Description: Shell average size for subgenus, slender, elongated, with fairly straight sides; color pale yellow-green, overlaid with dense pattern of brown zig-zags and dots; two bands, one at shoulder, one at mid-body, composed of larger zig-zag flammules; aperture white; columella white with pale salmon blotch at anterior end; columellar plications number 10 to 15, rounded, poorly-developed.

Holotype: Length 33 mm, width 16 mm, trawled by commer-

cial fishermen from 35 meter depth off the north coast of Flores Island, Sunda Sea, Indonesia. USNM 841436.

Etymology: Named for the Indo-Malaysian region where this new species lives.

Discussion: *Oliva indomalaysica* is closest to *pacifica*, but differs in being a smaller, more slender species with a much darker, more complex color pattern. *O. indomalaysica* also lacks the clear, patternless subsutural area seen in *Oliva pacifica*. This species ranges throughout the Indonesian and Malaysian regions, where it inhabits shallow to moderate depths.

Size: Average adult length approximately 30 to 35 mm.

***Oliva (Viduoliva) infrenata* Marrat, 1871 (Plate 32, Figures 3, 4)**

Description: Color bright lime-green with blue-green overtones; entire shell covered with zig-zag longitudinal lines of blue and purple-blue color; some specimens with two bands of widely-spaced black blotches; enamel on exterior of shell unusually thick and glossy.

Discussion: This species is one of the glossiest and most beautifully colored olives. It is restricted to the Bay of Bengal, in particular the Mergui Archipelago of Burma. *Oliva infrenata* is generally found in deeper water offshore.

Size: Average adult length 35 to 45 mm.

***Oliva (Viduoliva) leucostoma* Duclos, 1835 (Plate 32, Figures 9, 10, 15)**

Description: Shell very elongated and cylindrical, with straight sides; color yellow, yellow-green or yellow-orange, overlaid with a close packed pattern of triangles and undulating, zig-zag, longitudinal flammules of dark green or brown; aperture white; anterior end of columella with orange or brownish-orange patch.

Discussion: This species has often been confused with *elegans*, however, *leucostoma* is a much longer, more cylindrical species with a very different, finer textured color pattern. Some authors have synonymized *leucostoma* with *Oliva (Carmione) funebris*, however, *leucostoma* has a spire with well defined sutures. That of *funebris* is covered with a callus, and *leucostoma* averages

almost twice as large in size.

Oliva leucostoma is found in shallow water from the Philippines and Indonesia southward to northern Australia, where it is particularly abundant along the coast of Queensland, and eastward to the Fiji Islands.

Size: Adult length 45 to 55 mm.

Oliva (Viduoliva) leucostoma color form *flava* Marrat, 1871 (Plate 33, Figures 1, 2)

Description: Bright yellow color form with pattern much reduced or absent.

Discussion: Specimens exhibiting this color form are found only occasionally along the northern coast of Queensland, Australia.

Size: Average length approximately 40 to 45 mm.

Oliva (Viduoliva) leucostoma color form *fulva* Marrat, 1871 (Plate 33, Figures 3, 4)

Description: Solid dark brown or black, melanistic color form.

Discussion: This color form is found occasionally in the Philippine Islands.

Oliva (Viduoliva) macleaya Duclos, 1835 (Plate 33, Figures 5, 6, 7)

Description: Pale tan and gray, overlaid with light brown network of closely-packed triangles; two bands of widely-spaced large black patches, one around shoulder, other around mid-body; aperture and columella white.

Discussion: Ranges from East Africa and Madagascar, to India and the Bay of Bengal, to Indonesia and the Philippine Islands. *O. macleaya* is a shallow water species.

Size: Average adult length 50 to 55 mm.

Oliva (Viduoliva) mindanaoensis Petuch and Sargent new species (Plate 38, Figures 11, 12, 13, 14)

Description: Size medium for subgenus, cylindrical in shape; spire flat with low conical center; sutures deeply chiseled; color yellowish to orange-tan, overlaid with numerous, small brown

triangles; triangles form two faint bands in some specimens, one at shoulder, one at mid body; area directly below suture unmarked or with limited dark markings; columella straight with 23 to 28 fine well developed plications; columella and aperture white; fasciole light orange with brown or dark-orange stains on plications.

Holotype: Length 49 mm, width 20 mm, commercially collected in shallow water in the vicinity of Zamboanga, Mindanao Island, Philippines. USNM 841466.

Etymology: Named for Mindanao Island, Philippines, the type locality.

Discussion: *O. mindanaoensis* differs from *O. leucostoma* by having a flatter spire, a more cylindrical shape and fine plications on the columella. This new species differs from *O. vidua* by its cylindrical shape and columellar plications. *O. mindanaoensis* is somewhat variable in color and pattern with some specimens being almost uniformly dark brown or banded. The dense network of fine triangles is generally visible even in melanistic specimens. This species is restricted to the southeastern Philippines.

Size: 55 to 55 mm in length.

Oliva (Viduoliva) neostina Duclos, 1835 (Plate 33, Figures 8, 9)

Description: Shell stubby with slightly rounded sides; color gray or yellowish, overlaid with a zebra pattern of wide, dark gray zig-zags; shoulder and mid-body each with band of black chevron-shaped flammules; aperture and columella white.

Discussion: *Oliva neostina* ranges from the Bay of Bengal to southern Japan, southward through the Philippines, Indonesia and New Guinea and eastward to the Fijis. This species inhabits shallow water.

Size: Approximately 35 mm in length.

Oliva (viduoliva) neostina color form *laevis* Marrat, 1871 (Plate 32, Figures 5, 6, 13, 14)

Description: Uniform medium to dark brown; some specimens overlaid with indistinct pattern of darker spots.

Discussion: *Oliva laeve* Marrat, 1871 is a misspelling. This form ranges from the Philippines and Indonesia to Papua New Guinea.

Size: This form ranks among the smallest of the *Viduoliva* with an average adult length of only 25 to 30 mm.

Oliva (Viduoliva) octavia Duclos, 1844 (Plate 33, Figures 10,11,14,15)

Description: Shell elongated, slender with rounded sides; color white, cream or pinkish-cream, profusely covered with red and blue-green spots; spots sometimes fuse to form zig-zags; aperture white; columella with large pale-salmon blotch.

Discussion: *Oliva octavia* is closest to *elegans*, but differs by having a much more slender, elongated shell. *O. octavia* differs from *O. tricolor philantha* in lacking black flammules on the spire, and by having a much lower spire. *O. tricolor philantha* is a bluish or purplish-white as compared to the pinkish-cream color of *octavia*. *Oliva octavia* is restricted to the southern Philippines, in shallow water.

Size: Approximately 40 mm in length.

Oliva (Viduoliva) pacifica Marrat, 1871 (Plate 33, Figures 16, 17)

Description: Color pale green or greenish-yellow, overlaid with close-packed network of darker brown triangles, dots and zig-zag markings; two wide bands of large, dark brown flammules, one at shoulder, one at mid-body, encircle shell; subsutural area pale greenish, without color pattern; aperture pale purple or gray; columella white with pale salmon spot on anterior end; shell narrow, cylindrical and elongated.

Discussion: Some contemporary authors have referred to this species as *scripta* Lamarck. This is incorrect as the true *scripta* is a species from the Caribbean. The patternless, cloudy-appearing subsutural area is distinctive in this species.

Oliva pacifica ranges from the Bay of Bengal, to Indonesia and the southern Philippines and south to the western coast of Australia. *Oliva pacifica* inhabits shallow water.

Size: Average adult length 45 to 50 mm.

Oliva (Viduoliva) pacifica form *cana* Marrat, 1871 (Plate 38, Figures 5, 6)

Description: Smaller, stockier, more obese than the typical form; body whorl with wide dark longitudinal bars partially connected by dark zig-zag flammules.

Discussion: This rare color form of *O. pacifica* is restricted to the Bay of Bengal.

Size: Length 30 mm.

Oliva (Viduoliva) pacifica unnamed form (Plate 33, Figures 18)

Description: Large, pale tan color form with two wide, dark brown bands.

Discussion: Restricted to northwestern Australia.

Size: Some specimens may exceed 60 mm in length.

Oliva (Viduoliva) raderi Petuch and Sargent, new species (Plate 34, Figures 1, 2, 3, 4)

Description: Shell average size for subgenus, elongated, with straight sides, cylindrical in shape; spire low; color pale green-gray or gray covered with abundant dark gray spots and yellow patches; spots sometimes fuse into elongated zig-zag flammules, creating an intricate zebra pattern on some specimens; aperture white with large purple or lavender blotch at anterior end; columellar plications 20 to 30, low, small and poorly-developed; some specimens with purple lines on the ridges of the fasciole.

Holotype: Length 44 mm, width 22 mm, from 10 meter depth off Zamboanga City, Mindanao Island, Philippines. USNM 841445.

Etymology: Named in memory of the late Mr. Jack Rader of Bradenton Florida, who also loved the *Olividae* and who kindly donated olives from his collection for use in our study.

Discussion: *Oliva raderi* is closest to the sympatric *vidua*, but differs in being a smaller, more cylindrical and elongated shell with straight sides and a narrower aperture that does not flare toward the shoulder. The grayish, yellow-blotched ground color and the abundant gray spots of *raderi* are not seen in any of the many color forms of *vidua*. *Oliva raderi* is endemic to the south-

ern Philippines and the Sulu Sea.

Size: Approximately 35 to 45 mm in length.

Oliva (Viduoliva) reticulata Röding, 1798 (Plate 34, Figures 5, 6)

(Synonyms: *sanguinolenta* Lamarck, 1811; *variabilis* Röding, 1798; *variegata* Röding, 1798)

Description: Shell cylindrical with slightly rounded sides; spire low; color white, cream or salmon-pink, overlaid with a very dense netted pattern of dark greenish-brown or grayish-black; the overall appearance of the typical form is a dark colored shell; two dark bands, one just below suture, the other at mid-body; columella and fasciole bright orange-red.

Discussion: *Oliva reticulata* is a common shallow water species, that has an extremely variable pattern, however; its red-orange columella and fasciole provide easy identification. This species ranges across the Indian Ocean to the entire tropical western Pacific.

Size: Average adult length 40 mm but this species commonly reaches 50 mm or more.

Oliva (Viduoliva) reticulata color form *azona* Dautzenberg, 1927 (Plate 34, Figures 7, 8)

Description: Dark color form, similar to the typical variety, but without bands.

Oliva (Viduoliva) reticulata color form *evania* Duclos, 1835 (Plate 34, Figures 9, 10)

Description: Cream colored with loose zig-zags and large triangles; two prominent dark bands, one below suture, other around mid-body; overall appearance is of a light cream colored shell with loose marks and bands.

Oliva (Viduoliva) reticulata color form *pallida* Dautzenberg, 1927 (Plate 34, Figures 11, 12)

Description: White or pale cream, with faint tan netted pattern; pattern often absent on large portions of body whorl; columella and fasciole lighter orange than the typical form.

Oliva (Viduoliva) reticulata color form *viridescens* Marrat, 1870 (Plate 34, Figures 13, 14)

Description: Bright khaki-green or yellow-green with triangle pattern "smeared" into amorphous greenish cloudings.

Discussion: We have received this form only from Vanuatu (the New Hebrides). It appears to be a localized form and bears further study to determine its appropriate relationship to the typical *reticulata*. All of the other named color forms are found routinely in most populations of the species.

Oliva (Viduoliva) reticulata color form *zebra* Weinkauff, 1878 (Plate 34, Figures 15, 16)

Description: White or cream with large, separated zig-zag lines in zebra pattern.

Discussion: This form is incorrectly referred to by many as *zigzag* Perry, which is a color form of *Oliva elegans*.

Oliva (Viduoliva) rubrolabiata Fischer, 1902 (Plate 35, Figures 1, 2, 3, 4)

Description: Dark gray with reddish overtones and numerous fine, black spiral bands; inner and outer edge of lip and all of columellar area bright orange-red; interior of aperture paler orange.

Discussion: This species is often referred to as the rarest of olives. In actuality it is relatively common, and anyone with the money can buy one from almost any specimen shell dealer. Fortunately, the glamour of this species has diminished somewhat during the past few years and prices, although still high, are affordable for the average collector. *Oliva rubrolabiata* is restricted to the Solomon Islands, Vanuatu and New Caledonia, in shallow water. This species is most commonly encountered in Vanuatu (the New Hebrides).

Size: Average length 40 mm.

Oliva (Viduoliva) rubrolabiata light color form (Plate 34, Figures 17, 18)

Description: Higher spired than the typical form with a lighter

color pattern. Color white or light blue gray with vertical flammules or pale spiral bands.

Oliva (Viduoliva) tricolor Lamarck, 1811 (Plate 35, Figures 5, 6)

(Synonyms: *tinga* Duclos, 1835; *guttula* Marrat, 1871)

Description: Color bright green with large salmon-orange and light blue triangles; spire enamel with prominent black flammules; some specimens with darker green band around mid-body; columella bright salmon-orange; aperture white.

Discussion: Ranges from East Africa, throughout the Indian Ocean and throughout the southwestern Pacific to Polynesia. This is probably the widest ranging olive species.

Size: Approximately 50 mm in length.

Oliva (Viduoliva) tricolor color form *palawanensis* Bartsch, 1923 (Plate 35, Figures 7, 8)

Description: Shell more slender and with a higher spire than typical *tricolor*; color white with pale blue and yellow reticulated pattern, overlaid with two, broad, solid green bands, one at shoulder, one at mid-body; aperture with pale purple interior.

Discussion: Most common in the southern Philippines.

Oliva (Viduoliva) tricolor color form *philantha* Duclos, 1835 (Plate 35, Figures 9, 10)

Description: Color white with salmon-orange and blue spots; spots sometimes fuse into loose zig-zag flammules; aperture usually white, sometimes stained with pale purple.

Oliva (Viduoliva) tricolor color form *subviridis* Perry, 1811 (Plate 35, Figures 11, 12)

Description: Color form with large patternless areas of solid dark green.

Oliva (Viduoliva) vidua Röding, 1798 (Plate 35, Figures 13, 14; Plate 36, Figures 1, 2, 9, 10, 15)

(Synonyms: *maura* Lamarck, 1810; *mauritiana* Marrat, 1871; *fusca* Link, 1807)

Description: Shell large, inflated with elongated body and very rounded sides; aperture flaring; color solid dark brown or black; columella white, with pale salmon blotch at anterior end.

Discussion: Although *Oliva vidua* is extremely consistent in shape, it comes in a variety of color forms, some of which are named. Many of the forms overlap and many specimens are found that exhibit characteristics of several forms (on one shell). The common *vidua* is generally a brown or greenish shell with somewhat obscure spots and/or reticulations. Unfortunately, Röding's type was one of the solid black specimens, which are relatively common, but still do not represent the majority of the specimens. *Oliva vidua* ranges from India and the Bay of Bengal, to northern and northeastern Australia, north to the Ryukyu Islands and eastward to the Fijis. This species is an inhabitant of shallow water.

Size: Average length 50 to 60 mm, but some specimens may exceed 70 mm.

Oliva (Viduoliva) vidua color form *aurata* Röding, 1798 (Plate 35, Figures 15, 16)

Description: Solid golden-yellow or orange color form; sometimes with darker bands of orange or brown. Found in the western portion of the range from Sri Lanka to the Philippines.

Oliva (Viduoliva) vidua color form *albofasciata* Dautzenberg, 1927 (Plate 36, Figures 3, 4)

Description: Pale gray or greenish with mid-body band composed of alternating white and dark gray checkers.

Oliva (Viduoliva) vidua color form *cinnamonea* Menke, 1830 (Plate 36, Figures 5, 6, 7, 8)

Description: Reddish or orangish-brown, overlaid with obscure reticulations of darker brown. Some specimens with dark brown bands.

Oliva (Viduoliva) vidua color form *cincta* Dautzenberg, 1927 (Plate 36, Figures 11, 12, 13, 14)

Description: Olive-gray, khaki, brownish or bluish-gray rela-

tively solid ground color, with two wide, prominent dark bands, one around shoulder, one around mid-body. Relatively common in the southern Philippines and New Guinea.

Oliva (Viduoliva) vidua color form *fenestrata* Johnson, 1915 (Plate 37, Figures 5, 6)

Description: Khaki, overlaid with dense network of black triangles and zig-zag flammules; zig-zags often interconnect.

Oliva (Viduoliva) vidua color form *fulminans* Lamarck, 1810 (Plate 37, Figures 1, 2, 3, 4)

Description: Khaki or gray-green with large, prominent, black zig-zag longitudinal flammules; some specimens with zebra pattern.

Oliva (Viduoliva) vidua color form *rumphi* Dautzenberg, 1927 (Plate 37, Figures 7, 8, 9, 10)

Description: Pale gray or bluish gray with faint, gray reticulated pattern over entire shell; row of large, black, zig-zag flammules around shoulder. Most common in the western portion of the range, from India to the Philippines.

Oliva (Viduoliva) vidua color form *sepulchralis* Lamarck, 1810 (Plate 37, Figures 11, 12)

Description: Dark gray or greenish-gray with numerous, scattered black flammules and dots and with a prominent band of large black flammules around shoulder.

Oliva (Viduoliva) westralis Petuch and Sargent, new species (Plate 37, Figures 17, 18)

Description: Shell small for subgenus, stocky, rotund, with rounded outline; color yellow-green to yellow, overlaid with greenish-brown, longitudinal zig-zag lines and triangles; two bands of dark brown, widely spaced flammules, one around shoulder and one around mid-body; some specimens with large, dark brown longitudinal zig-zag flammules; aperture white; columella white, with large pale orange patch at anterior end.

Holotype: Length 35 mm, width 17 mm, taken on muddy sand

bottom, 1 meter depth off Derby, Western Australia. Deposited in the collection of the Department of Malacology, Australian National Museum.

Etymology: Named for Western Australia, the type locality.

Discussion: This new species, which is restricted to Western Australia, is closest to *leucostoma*, but differs in having a smaller, stockier and stumpier shell with a more diffuse color pattern. The two bands of dark flammules are larger and more prominent on *westralis* than they are on *leucostoma*. *Oliva westralis* may have evolved from *leucostoma*, as an isolated population along the Western Australia coast.

Size: Approximately 35 to 40 mm in length.

Oliva (Viduoliva) zamboangensis Petuch and Sargent, new species (Plate 37, Figures 13, 14, 15, 16)

Description: Shell small for subgenus, stocky, barrel-shaped in outline; color khaki green and yellow, overlaid with dense network of dark brown and gray zig-zags and dots; aperture white; columella white with numerous fine plications; anterior tip of columella with a very faint light-orange stain.

Holotype: Length 31 mm, width 16 mm, taken at 1 meter depth on muddy sand, south of Zamboanga, Mindanao Island, Philippines. USNM 841449.

Etymology: Named for Zamboanga, Mindanao Island, Philippines, the type locality.

Discussion: This new species is closest to *leucostoma*, but differs in being a much stockier and less elongated shell. A specimen of *O. zamboangensis* with the same diameter of a specimen of *O. leucostoma* would be less than two thirds as long. *Oliva zamboangensis* is consistently smaller than *O. leucostoma*, its spire is flatter and broader, and it lacks the clear, unmarked subsutural area that is characteristic of Philippine specimens of *leucostoma*. This new species appears to be endemic to the south central Philippines. At the time of this writing, this species has only been taken from Mindanao Island.

Size: Average adult length 30 to 40 mm.

GLOSSARY

- Anterior** In olives, the end of the shell nearest to the head.
- Aperture** The opening, or mouth, of the shell into which the living animal retracts.
- Body Whorl** The last coiling of the main part of the shell which surrounds or covers the pervious coils.
- Callus** Thickened deposit of enamel.
- Columella** The central core of the shell, around which the shell coiling takes place. Usually manifested as a thickened or glazed area on the body side of the aperture.
- Columellar Plications (or Plicae)** Ribs or folds along the columellar side of the aperture. Used as a systematic character.
- Conchology** The study of shells.
- Exserted** Prominently extended or elongated.
- Fasciole (or Fascicular Band)** A wide, raised, heavily glazed band running around the anterior end of olivids, from the columella to the outer lip.
- Fusiform** Shaped like a spindle or bullet.
- Gerontic** Old, senile, thickened.
- Globose** Rounded or ball-shaped.
- Holotype** The solitary specimen of a new species or subspecies, selected by the original author to represent that species, and deposited in a museum.
- Inflated** Swollen.
- Malacology** The study of molluscan animals.
- Melanistic** A dark or black color form.
- Mucronated** Calloused with a pointed raised center.
- Paratype** One or more specimens used by the author in the naming of new species or subspecies but not necessarily from the same location as the holotype.
- Posterior** In olives, the end of shell opposite the head.
- Posterior Canal** The opening at the extreme posterior end of the aperture.
- Propodium** Plow-shaped, muscular fold along the anterior of the living *Oliva* animal; used for pushing through sand, in the same fashion as a show plow.
- Protoconch** Embryonic shell at the extreme tip of the shell spire, representing the first few whorls of shell growth.
- Province** Biogeographical unit based on the "50%" rule. Any geographical area where 50% or more of the total fauna is not found elsewhere. Can range in size from small islands to entire oceans.

- Radula** Long, tooth-covered ribbon located within the mouth region of gastropods. The teeth are arranged in rows, in a file-like fashion. When one row wears out, a new row moves forward to replace it.
- Realm** The most extensive biogeographical unit, encompassing a collection of climatically similar regions.
- Region** The biogeographical unit composed of a collection of climatically and faunistically similar provinces.
- Reticulate** Resembling a network.
- Species** A population of similar-appearing organisms that are capable of interbreeding and will produce viable offspring. The offspring, in turn, must be able to produce another generation of viable offspring.
- Spire** The elevated, earlier coils of a shell. Usually projects posteriorward, although some are flattened.
- Shoulder** The inflated area of the body whorl of a shell near the spire and posterior end.
- Stenohaline** Referring to an organism's ability to live only within a very narrow range of salinity.
- Stenothermal** Referring to an organism's ability to live only within a very narrow range of temperatures.
- Stenotopic** Referring to an organism's ability to live on only a few types of substrates.
- Subspecies** A geographically or bathymetrically isolated population of a species that, over a period of time, has developed some differences in form or color. If separated from the main gene pool for a long enough time, the subspecies will become a full, distinct species.
- Suture** The areas on the shell spire where a later whorl comes in contact with a previous whorl. This contact point or juncture is usually marked with a distinct line.
- Sutural Canal** A narrow, but deep, spiral groove that follows the line of the suture on the spire. In living olives, a thin filament of mantle tissue fills this groove.
- Veliger** The unique larval form of the phylum Mollusca, most often composed of a tiny shell (veliconch) and two large, ciliated tissue lobes (velar lobes). The velar lobes are used for locomotion, allowing the larva to swim through the water column.
- Volutaceans** In reference to any member of the gastropod superfamily Volutacea, comprising all the volute-like shells. Included are the families Volutidae, Olividae, Marginellidae, Mitridae, Volutamitridae, and Harpidae.
- Whorl** One revolution of shell growth around the shell axis (columella).

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