



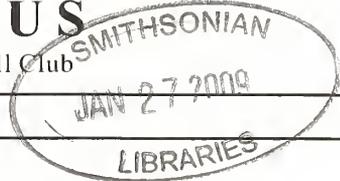
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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388



Volume: XLI

January 8, 2009

Number: 1

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 Membership (includes family). Domestic \$20.00;
 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

BIVALVES 101

Paul Valentich-Scott, of the Santa Barbara Museum of Natural History and a bivalve specialist, will present an interactive, educational, illustrated and a fun program

on bivalves. Attendees will work with bivalves and learn (or re-learn) their identifying characteristics – and much more. Don't miss this exciting program!

Meeting date: January 15, 2009

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CLUB NEWS

San Diego Shell Club Meeting Minutes 20 November 2008

The meeting was called to order at 7:45 pm by the president, Jules Hertz. The October minutes were approved by the membership and Silvana Vollero gave the treasurer's report. Carole Hertz reminded people to sign up for the Christmas dinner party. She also announced that our speaker for January will be Paul Valentich-Scott from the Santa Barbara Museum of Natural History. The January meeting will include hands-on activities in order to improve our knowledge of clams and how to identify them. Should be a great meeting so be sure to attend. Marilyn Goldammer reminded members that the book sale, which started before the meeting, would continue after the meeting.

Paul Tuskes gave a brief update on the Mission Bay Survey with 141 species of bivalves and gastropods identified in the past year. There are many minus tides in December so find a friend and do some collecting. Please be sure to complete your data sheets (on our home page) and send them in. Last month, Wes Farmer, Jules & Carole Hertz, John LaGrange, and Paul Tuskes met at Fiesta Island. Lots of interesting things including seven *Opalia funiculata* attached to an anemone.

Carole Hertz introduced the speaker, Henry Chaney from the Santa Barbara Museum of Natural History. He spoke on a topic relevant to all of us... What to do with your collection....or... what happens to your collection when you're gone?

He stated that we each need to make a decision regarding the disposition of our collections, otherwise, when we are not around, someone else will make that decision, and it may not be what we had expected. Hank reviewed the most likely options and discussed the pros and cons of each.

1. Make no plans, and you don't have to worry about it. On the other hand, if the decision is made after-the-fact some very unfortunate things may happen to your collection, including disposal.
2. Give them to family and friends, as you may inspire others, and each time your friends look at the shells, they will enjoy them and think of you.
3. Sell your collection ... this can be done a number of ways:

--Sell your collection to a dealer. The value is discounted but you part with the entire collection quickly and easily.

--Sell the valuable shells to others or on e-Bay, and donate the remainder to a society.

4. Donate the collection to a shell club. It will help the club raise money for publications, and people you know will acquire your shells.

5. Donate the collection to a community center or school as it may spark the interest of others. A donation does not mean it will be displayed or utilized.

6. Donate to a Museum. The collection must have good data and scientific value, otherwise it may not be accepted by the museum.

7. Start your own museum. Pretty costly and it would need some sort of an endowment.

Donations to museums, universities, and shell clubs with non-profit status may result in notable tax deductions, if the gift is properly assessed and documented.

It was a most worthwhile and entertaining presentation. Jim Goldammer won the shell drawing, and John LaGrange and Paul Tuskes provided the refreshments.

Paul Tuskes.

The Club's Annual Christmas Dinner Party

As always, the Club's annual Christmas Dinner party was great. The Club seems to have found a home at the Boardroom of the *Butcher Shop* in Kearny Mesa.

The room was lovely, decorated for the holidays and Don and Jeanne Pisor's donation of shells for the centerpieces was a nice touch. Members enjoyed socializing during the no-host cocktail hour.

At 7 pm, MC Carole Hertz welcomed them all and after a story or two, the dinner began. The food was delicious and the companionship at the tables was warm. Following the entree, President Jules Hertz thanked his 2008 board and introduced the members of the board for the coming year. A new program chair on the board, Benjamin Pister, was unable to attend.

After the sinful Apple Streusel Cheesecake, Carole introduced speaker Richard Herrmann – who really needed no introduction. The Club always looks forward to his presentations. His "Mish-Mash" at the party was no exception. It was terrific.

Following the program was the annual gift exchange and raffle of the centerpieces. Members stayed awhile, rather reluctant to end the very lovely evening.

THE OPISTHOBRANCH FAUNA OF ISLAS TRES MARÍAS, MEXICAN PACIFIC

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Abstract

Of the over 150 gastropods previously reported for the islands, only one was an opisthobranch, *Bulla punctulata* A. Adams in Sowerby, 1850. In this paper, 52 species of opisthobranchs are reported. All of them are known from other areas of the Mexican Pacific coast. Similar relative abundances and species most abundant are also consistent with previous reports from the main coast of México and Baja California.

Keywords – Mollusca, Opisthobranchia, México, Islas Tres Marías

Resumen

De los más de 150 gastrópodos reportados en expediciones anteriores a las Islas Tres Marías, solamente uno de ellos es opisthobranquio: *Bulla punctulata* A. Adams en Sowerby, 1850. En este artículo se reportan 52 especies observadas durante seis días de julio de 2007. Todas las especies se conocen para otras áreas del Pacífico mexicano. Se observaron abundancias relativas y que las especies más abundantes son consistentes a sitios previamente estudiados en la costa Pacífica de México y Baja California.

Palabras clave – Mollusca, Opisthobranchia, México, Islas Tres Marías

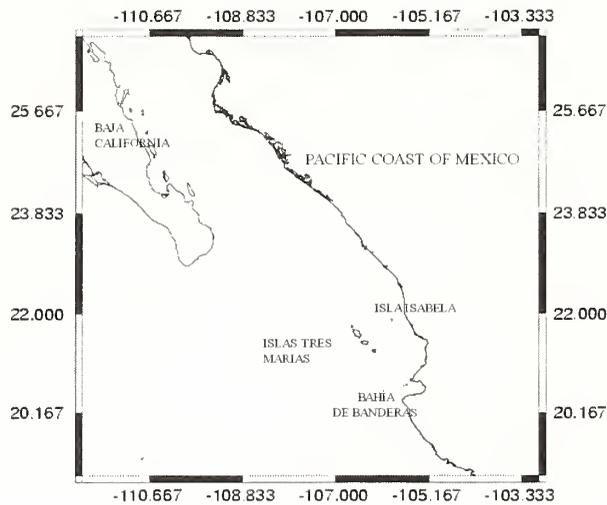
Introduction

Islas Marías (Las Tres Marías) are part of the municipality of San Blas, Nayarit, 132 km from this town. The group is 80 km in length, with a northwest to southeast orientation (Maps 1, 2). The group was discovered by Diego Hurtado de Mendoza, a cousin of Hernán Cortés in 1532 who gave them the name Islas Magdalenas. There are three larger islands (María Madre, María Magdalena and María Cleofas), one smaller island (San Juanito) as well as several smaller islets lying offshore from the larger islands (INEGI). The islands have an aggregate area of 244,970 km². The largest member of the group is the 227 km² Isla María Madre. It is located 5 km southeast from the small island of San Juanito and 4 km northwest from Isla María Magdalena.

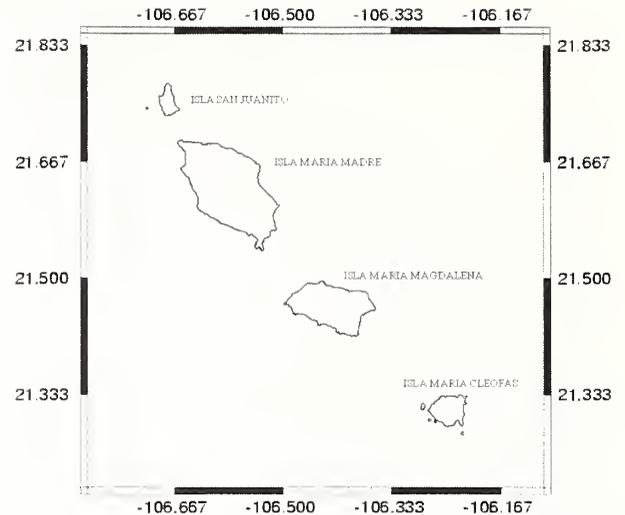
María Madre is 23 km in length (northwest to southeast) and up to 12 km across. The island consists of two low and flat plains located at either end of the island, which rise to a higher, highly divided and forested central area of ravines and ridges that rise to a height of 616 m — the highest elevation to be found within the Marías group.

As is generally the case among the islands of the Islas Marías group, the west coast of the island is marked by cliffs and rocky slopes, while that of the east is mostly low and sandy with several wide bays. At 128 km² in area, María Magdalena is the second largest of the Islas Marías, measuring 19 km in length (east to west) and up to 9 km across. From the rugged interior (457 m) its terrain descends to the sea in steep, barren slopes and cliffs on the west and to low sandy bays on the east. María Cleofas is the most southerly of the islands, being located 15 km southeast from María Magdalena. With an area of 44 km², the island is 10 km by 7 km, rising to an elevation of 402 m. Smallest and northernmost of the islands is the 8 km long, 3 km wide island of San Juanito (INEGI).

In 1905 the Islas Marías Federal Penal Colony was established under the Secretaría de Gobernación and since 2000 under the Secretaría de Seguridad Pública. According to the 2005 Mexican Census, Isla María Madre had a population of 1116, the main settlement is Puerto Balleto, with a population of 602. The other three islands are uninhabited. In addition to prisoners on Isla María Madre, there are employees of diverse institutions of the Federal Government, such as the Secretariat of Public



Map 1. México and the Islas Tres Marias



Map 2. Islas Tres Marias

Education, the Secretariat of Environment, the Secretariat of Communications and Transport, a post office and the Secretariat of the Navy. Another group of settlers is made up of religious ministers and acolytes of the Catholic Church, nuns and invited teachers, technicians and their relatives. The colony is governed by a state official who is both the governor of the islands and chief judge. The military command is independent of the government and is exercised by an officer of the Mexican Navy. On November 27, 2000 the *Diario Oficial de la Federación* published a presidential decree stating Islas Tres Marias as a natural protected area in the category of biosphere reserve. The area includes the four islands along with their marine territory. The polygon of the reserve has the following corners: 22°04'00" N, 106°40'00" W; 21°20'00" N 105°54'00" W; 20°58'00" N 106°16'00" W and 21°42'00" N, 107°03'00" W.

The molluscan fauna of Islas Tres Marias

The earlier reports of the molluscan fauna of Islas Tres Marias are from Stearns (1894) with a list of 89 species of mollusks for the islands, mainly María Madre; of which 83 were gastropods. In 1930, Strong and Hanna reported a total of 211 species, of which 152 were gastropods. The islands were visited by the *Velero III* during the Allan Hancock Pacific Expedition of 1939 and then again in 1957 by the Puritan-American Museum Expedition to Western Mexico (Emerson, 1958; Emerson & Old, 1962). More recently, Small (1998) recognized the paucity of information since 1962

due to the strict security and difficulty to do research at the archipelago. Small (1998) reported 123 species of gastropods, some of which were already listed by Strong and Hanna (1930). Only one species of opisthobranch was included in these publications, *Bulla punctulata* A. Adams in Sowerby, 1850. Only four species of mollusks (none opisthobranchs) found in Islas Tres Marias are included in the official list for Norma Oficial Mexicana NOM-059-SEMARNAT-2001, which establishes protection to the Mexican species: mother of pearl (*Pinctada mazatlanica*), ink snail (*Purpura patula pansa*), giant limpet (*Patella mexicana*) and (*Spondylus limbatus*).

Materials and Methods

The survey was conducted by SCUBA diving in the daytime, using the direct observation method. The group consisted of six researchers in total, conducting surveys for fish and other invertebrates such as corals, echinoderms and shelled mollusks. During a period of six days, from July 10 to 16, 2007, visiting, rocky shores of all four islands in sites that weather permitted, we surveyed 12 sites: one site in Isla María Magdalena, two sites in Isla San Juanito, two sites in María Cleofas and seven sites in María Madre. Voucher specimens of important species were preserved and have been deposited in the California Academy of Sciences, Invertebrate Zoology and Geology collection in San Francisco (CASIZ) and at the Natural History Museum of Los Angeles County (LACM).

Results and Discussion

A total of 52 species of opisthobranch mollusks are here documented. These are listed in Table 1. Information on biogeographical affinities, collection and islands where observed is provided.

The only opisthobranch previously reported for Islas Tres Marias was *Bulla punctulata* A. Adams in Sowerby, 1850 (Small, 1988). Given the proximity of the islands to the coast line (130 km approximately) and to Isla Isabela (this island is about 20 km in a straight line to the coast), it is not surprising that all the species found during this week of survey have already been reported for areas nearby, with no possible endemic species observed (Camacho et al., 2005; Hermosillo et al., 2006). The species more frequently observed were *Glossodoris sedna*, *Tritonia pickensi*, *Elysia diomedea*, *Phidiana lasrucensis* and *Hypselodoris agassizii*. For each island, the species count is as follows: María Magdalena, 17; María Madre, 35; María Cleofas, 24 and San Juanito 16.

Conclusions:

Given the short survey times spent at Islas Tres Marias, the number of species observed is important. This is due to the diversity of habitats and large area. Isla Isabela is a small island (1.5 km in length) situated 56 km from Isla María Madre. Extensive surveys have been conducted in Isla Isabela for many years during different seasons, finding only 78 different species, whereas collecting in Islas Marias for only one week in the summer has rendered 52 species. Of these, 38 species are common between the islands.

The most common species found in the Islas Tres Marias are also the most common species observed in other surveyed areas, to mention a few examples: Islas Revillagigedo (Hermosillo & Gosliner, 2008); Bahía de Banderas (Hermosillo-González, 2006); Bahía de La Paz (Angulo-Campillo, 2004) and Isla Isabela (pers. obs.). Further surveys are needed to render a complete list of species and more in-depth observations of population ecology patterns. Nonetheless, the difficulty in obtaining permits and the fact that the prison administration changes frequently, makes it nearly impossible to plan

ahead for long-term studies.

Acknowledgments

The work herein reported would have not been possible without the invaluable support of Lic. Víctor Valencia Gutiérrez, Subdirector Técnico Penal Islas Marias and Biól. Jorge Castrejón Pineda Director Reserva de la Biósfera Islas Marias. Also the enthusiastic help of Dr. Amilcar Levi Cupul Magaña, Roberto Chavez, Dinorah Herrero, Héctor Reyes and Pedro Medina. Special thanks to Carole and Jules Hertz for critically reading this manuscript.

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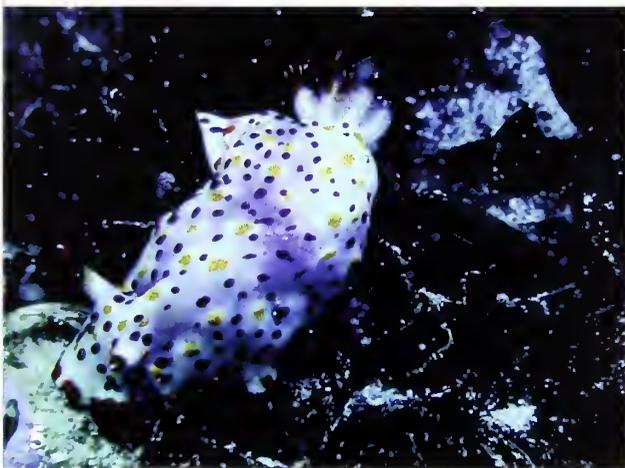
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Table 1. Taxonomic Composition of the Opisthobranchs of Islas Tres Marias.

Species	Islands where observed	Biogeographic affinities
CEPHALASPIDEA		
AGLAJIDAE		
<i>Bulla punctulata</i> A. Adams in Sowerby, 1850	All four	Tropical-Panamic. Bahía Magdalena, Golfo de California to Perú.
<i>Navanax aenigmaticus</i> (Bergh, 1894)	María Madre, María Cleofas, San Juanito	Temperate-Panamic. San Diego, California to Panamá.
<i>Navanax inermis</i> (Cooper, 1863)	María Madre	Temperate-Panamic. Sur de California; Golfo de California to Bahía de Banderas.
Anaspidea		
APLYSIIDAE		
<i>Stylocheilus striatus</i> (Quoy & Gaimard, 1894)	María Madre	Circumtropical-Panamic.
<i>Dolabella auricularia</i> Lightfoot, 1786	María Madre, San Juanito	Panamic and Indo-Pacific.
PLEUROBRANCHIA		
TYLODINIDAE		
<i>Tyrodina fungina</i> (Gabb, 1865)	María Cleofas	Temperate-Panamic.
PLEUROBRANCHIDAE		
<i>Berthella agassizii</i> (MacFarland, 1909)	María Madre, María Cleofas	Temperate-Panamic and western Atlantic.
<i>Berthellina ilisima</i> Marcus & Marcus, 1967	María Madre, María Cleofas, San Juanito	Panamic and Indo-Pacific.
<i>Pleurobranchus areolatus</i> (Mörch, 1863)	María Madre, María Magdalena, San Juanito	Panamic and western Atlantic.
SACOGLOSSA		
OXYNOIDAE		
<i>Oxynoe panamensis</i> Pilsbry & Olsson, 1943	María Madre, María Cleofas	Tropical-Panamic.
POLYBRANCHIIDAE		
<i>Polybranchia viridis</i> (Deshayes, 1857)	María Madre	Temperate-Panamic and Eastern Atlantic.
<i>Aplysiopsis</i> sp.	María Madre	Tropical-Panamic, listed in Hermosillo-González, 2006.
PLACOBRANCHIDAE		
<i>Elysia diomedea</i> (Bergh, 1894)	María Madre, San Juanito	Tropical-Panamic.
<i>Elysia pusilla</i> Bergh, 1872	María Cleofas	Tropical-Panamic, as <i>Elysia</i> sp. 2 in Camacho-García et al. (2005).
Nudibranchia		
POLYCERIDAE		
<i>Polycera alabe</i> Collier & Farmer, 1964	María Magdalena	Temperate-tropical.
<i>Polycera kaiserae</i> Hermosillo & Valdés, 2007 (Figure 4)	María Magdalena	Tropical-Panamic, as <i>Polycera</i> sp. 1 Hermosillo et al., 2006.
<i>Polycera</i> sp. 1	María Madre	Tropical-Panamic, as <i>Polycera</i> sp. in Camacho-García et al., 2005.

<i>Polycerella glandulosa</i> Behrens & Gosliner, 1988	María Magdalena	Temperate-tropical Panamic.
<i>Tambja abdere</i> Farmer, 1978	María Magdalena	Tropical-Panamic.
DORIDIDAE		
<i>Discodoris ketos</i> (Er. & Ev. Marcus, 1967)	María Madre, María Cleofas	Tropical-Panamic.
<i>Geitodoris mavis</i> (Er. & Ev. Marcus, 1967)	María Madre, María Cleofas	Tropical-Panamic.
<i>Doris immonda</i> (Risbec, 1928)	María Madre, María Cleofas	Tropical-Panamic.
CHROMODORIDAE		
<i>Cadlina</i> sp.	María Magdalena	Tropical-Panamic, as <i>Cadlina</i> sp. in Camacho-García et al., 2005, LACM 173798, 173796.
<i>Chromodoris marislae</i> Bertsch, 1973	María Madre	Tropical-Panamic.
<i>Chromodoris norrisi</i> Farmer, 1973 (Figure 6)	San Juanito	Temperate-tropical Panamic.
<i>Chromodoris sphoni</i> (Marcus, 1971) (Figure 2)	María Madre, María Magdalena, María Cleofas	Tropical-Panamic.
<i>Glossodoris baumanni</i> (Bertsch, 1970)	María Magdalena, María Cleofas	Tropical-Panamic.
<i>Glossodoris dalli</i> (Bergh, 1879) (Figure 3)	María Madre, María Magdalena, María Cleofas	Tropical-Panamic.
<i>Glossodoris sedna</i> (Er. & Ev. Marcus, 1967)	All four	Tropical-Panamic also western Atlantic.
<i>Hypselodoris agassizii</i> (Bergh, 1894)	María Madre, María Magdalena, María Cleofas	Tropical-Panamic.
<i>Mexichromis tura</i> (Marcus & Marcus, 1967)	María Madre	Tropical-Panamic.
DENDRODORIDIDAE		
<i>Dendrodoris fumata</i> (Rüppell & Leuckart, 1830)	María Madre, María Cleofas, San Juanito	Tropical-Panamic and Indo-Pacific LACM 173795.
<i>Doriopsilla janaina</i> Marcus & Marcus, 1967	María Madre, María Cleofas	Tropical-Panamic.
DENDRONOTINA		
<i>Tritonia pickensi</i> Marcus & Marcus, 1967	María Madre, María Magdalena, María Cleofas	Tropical-Panamic.
<i>Doto</i> sp. 1	María Cleofas	Tropical-Panamic, as <i>Doto</i> sp. 1 Hermosillo et al., 2006.
<i>Doto</i> sp. 2	María Madre	Tropical-Panamic, as <i>Doto</i> sp. 2 Hermosillo et al., 2006.
<i>Doto</i> sp. 3	María Cleofas	Tropical-Panamic, as <i>Doto</i> sp. 3 Hermosillo et al., 2006.
<i>Lomanotus vermiformis</i> Eliot, 1908 (Figure 5)	María Madre	Circumtropical-Panamic.
<i>Lomanotus</i> sp.	María Magdalena, María Cleofas, San Juanito	Tropical-Panamic, as <i>Lomanotus</i> sp. 2 Hermosillo et al., 2006.
AEOLIDINA		

FLABELLINIDAE		
<i>Flabellina bertsi</i> Gosliner & Kuzirian, 1990	María Madre	Tropical-Panamic.
<i>Flabellina cynara</i> Marcus & Marcus, 1967	María Magdalena	Tropical-Panamic.
<i>Flabellina marcesorum</i> Gosliner & Kuzirian, 1985	All four	Tropical-Panamic.
<i>Flabellina telja</i> Marcus & Marcus, 1967	María Magdalena, María Cleofas	Tropical-Panamic.
<i>Flabellina vansyoci</i> Gosliner, 1994	All four	Temperate-Panamic
AEOLIDIIDAE		
<i>Aeolidiella chromosoma</i> (Cockereil & Eliot, 1905)	María Madre	Tropical-Panamic.
<i>Antaeolidiella indica</i> (Bergh, 1888) (Figure 1)	María Madre, San Juanito	Circumtropical.
EUBRANCHIDAE		
<i>Eubranchus yolandae</i> Hermosillo & Valdés, 2007	San Juanito	Tropical-Panamic.
FACELINIDAE		
<i>Favorinus elenalexiae</i> García & Troncoso, 2001	María Madre	Tropical-Panamic.
<i>Hermosita hakunamatata</i> (Ortea, Caballer y Espinosa, 2003)	All four	Tropical-Panamic.
<i>Noumeaella rubrofasciata</i> Gosliner, 1991	San Juanito	Temperate-Panamic.
<i>Phidiana lasrucencis</i> Bertsch & Ferreira, 1974	María Madre, María Magdalena, San Juanito	Tropical-Panamic.
TERGIPEDIDAE		
<i>Phestilla lugubris</i> (Bergh, 1870)	San Juanito	Tropical-Panamic and Indo-Pacific LACM 173797.



Figures 1-6. (1) *Antaeolidiella indica* (San Juanito) (2) *Chromodoris sphoni* (Maria Cleofas) (3) *Glossodoris dalli* (Maria Madre) (4) *Polycera kaiserae* (Maria Magdalena) (5) *Chromodoris norrisi* (San Juanito) (6) *Lomanotus vermiformis* (Maria Madre).

LOW TIDES FOR 2009 AT SAN FELIPE, BAJA CALIFORNIA, MÉXICO

The entries below show periods of low tides of -3.90 feet and below. The times of low tides are given in Pacific Standard Time, except those dates marked with an asterisk which are in Pacific Daylight Time. To cor-

rect for Puerto Peñasco add one hour to listed times when they are in Pacific Standard Time. Tides below the midriff of the Gulf cannot be estimated using these entries. All entries are approximate times and tides.

Jan. 9	7:16 p.m.	-4.70 ft	May 24	8:49 a.m.*	-4.57 ft	Sep. 17	8:13 a.m.*	-4.33 ft
Jan. 10	8:01 p.m.	-5.49 ft	May 25	9:31 a.m.*	-4.57 ft	Sep. 18	8:50 a.m.*	-4.41 ft
Jan. 11	8:43 p.m.	-5.51 ft	May 26	10:16 a.m.*	-3.95 ft	Sep. 18	9:10 p.m.*	-4.08 ft
Jan. 12	9:25 p.m.	-4.73 ft	Jun. 22	8:42 a.m.*	-4.74 ft	Sep. 19	9:40 p.m.*	-3.99 ft
Feb. 7	7:13 p.m.	-4.46 ft	Jun. 23	9:28 a.m.*	-4.62 ft	Oct. 17	8:42 p.m.*	-4.18 ft
Feb. 8	7:54 p.m.	-5.35 ft	Jul. 22	9:22 a.m.*	-5.04 ft	Oct. 18	9:11 p.m.*	-3.98 ft
Feb. 9	8:32 p.m.	-5.40 ft	Jul. 23	10:05 a.m.*	-5.14 ft	Nov. 2	7:42 p.m.	-4.02 ft
Feb. 10	9:08 p.m.	-4.62 ft	Jul 24	10:46 a.m.*	-3.96 ft	Nov. 3	8:15 p.m.	-4.11 ft
Mar. 9	7:40 p.m.	-4.43 ft	Aug. 18	7:45 a.m.*	-3.90 ft	Dec. 1	7:29 p.m.	-4.26 ft
Mar. 10	8:14 p.m.	-4.31 ft	Aug. 19	8:28 a.m.*	-5.09 ft	Dec. 2	8:09 p.m.	-4.58 ft
Apr. 25	7:05 a.m.*	-4.34 ft	Aug. 20	9:08 a.m.*	-5.45 ft	Dec. 3	8:51 p.m.	-4.31 ft
May 23	8:09 a.m.*	-3.97 ft	Aug. 21	9:47 a.m.*	-4.91 ft	Dec. 30	7:24 p.m.	-4.46 ft
						Dec. 31	8:08 p.m.	-5.38 ft

Compiled by Jules Hertz

Dues are Due

Dues for 2009 are due and payable now. The domestic rate will remain the same at \$20 but, as reported earlier, non-domestic rates will be raised as a result of the several increases in postage. Rates for Mexico and Canada will be \$30 and subscriptions for all

other countries will be \$40. Please return the enclosed colored dues slip with your check even if your address, e-mail or phone numbers haven't changed.

If you haven't paid your dues by the end of this month, this will be your last issue.

MISSION BAY SURVEY NOVEMBER 2007-2008 – A PROGRESS REPORT AND MISSION BAY TIDES FOR 2009

During the first year of our survey 51 species of bivalves, 69 species of gastropods, 15 species of opisthobranchs, and 4 species of chitons were identified from Mission Bay. Several species of octopus were also found but not identified. The current total is 139 species, but that number will increase with more collecting and the identification of material in question. Members who have participated in the survey include Julie, Chris and Jeannie Hume; Carlie and Taylor Lepore; Lexi, Bill and Nancy Schneider; Jules and Carole Hertz; Clint Crowe and children; Wes Farmer, John Bishop, John LaGrange and Paul Tuskes. If I missed your name it's because I don't have a data sheet from you.

Bivalvia

Amiantis callosa
Amadara multicosata
Argopecten ventricosus
Barbatia reeveana
Chama arcana
Chione californiensis
Chione fluctifraga
Chione undatella
Crassostrea gigas
Cryptomya californica
Cumingia californica
Diplodonta orbellus
Donax californicus
Donax gouldii
Epilucina californica
Florimetis obesa
Gari californica
Heterodonax pacificus
Hinnites giganteus
Laevicardium substriatum
Leptopecten latauratus
Lyonsia californica
Macoma indentata
Macoma nasuta
Macoma secta
Mactra californica
Mactromeris hemphilli
Modiolus capax
Modiolus rectus
Musculista senhousia
Mytilus californianus
Mytilus galloprovincialis
Nuttallia nuttalli
Ostrea lurida
Periploma planiusculum
Pododemsus cepio
Protothaca laciniata

Protothaca staminea
Pseudochama exogyra
Pteria sterna
Saxidomus nuttalli
Semele decisa
Semele rupicola
Solen rosaceus
Tagelus californianus
Tagelus subteres
Tellina idae
Tellina modesta
Trachycardium quadragenarium
Tresus nuttalli
Venerupis philippinarum

Gastropoda

Acanthina lugubris
Acanthina spirata
Amphissa versicolor
Astraea undosa
Bitium purpureum
Bitium quadrifilatum
Caecum californicum
Certaostoma nuttalli
Cerithidea californica
Collisella limatula
Collisella scabra
Conus californicus
Crepidula coei
Crepidula norrisiarum
Crepidula onyx
Crucibulum spinosum
Cypraea spadicea
Epitonium tinctum
Erato columbella
Erato vitellina
Fissurella volcano
Forreria belcheri
Granulina subtrigona

Haliois corrugata
Haliois fulgens
Kelletia kelletii
Lacuna unifasciata
Lamellaria diegoensis
Lamellaria sharonae
Lirularia acuticostata
Littorina planaxis
Littorina scutulata
Lottia gigantea
Lucapinella callomarginata
Maxwellia gemma
Megatebennus bimaculatus
Megathura crenulata
Melampus olivaceus
Mitra idae
Mitrella carinata
Nassarius fossatus
Nassarius mendicus
Nassarius perpinguis
Nassarius tegula
Neosimnia barbarensis
Norrisia norrisi
Notoacmaea depicta
Notoacmaea insessa
Olivella baetica
Oliella biplicata
Opalia funiculata
Ophiidermella ophioderma
Petalocochus montereyensis
Polinices altus
Polinices lewisii
Polinices reclusianus
Pseudomelatoma penicillata
Pteropurpura festiva
Pteropurpura trialata
Roperia poulsoni
Serpulorbis squamigerus

Sinum scopulosum
Tegula aureotincta
Tegula eiseni
Tegula funebris
Tegula regina
Trivia californiana
Trivia solandri
Volvarina taeniolata

Cephalopoda

Octopus spp.

Opisthobranchia

Acteocina culcitella
Aplysia californica
Aplysia vaccaria
Armina californica
Bulla gouldiana
Chromodoris macfarlandi
Corambe pacifica
Diaulanla sandiegensis
Doriopsilla albopunctata
Doriopsilla gemela

Flabellina bertschi
Haminoea virescens
Hermisenda crassicornis
Limacia cockerella
Navanax inermis

Polyplacophora

Lepidozona pectinulata
Mopalia muscosa
Stenoplax conspicua
Cyanoplax hartwegi

2009 LOW TIDES AND LOCALITIES FOR MISSION BAY SURVEY

When sampling, please use the online data sheet for recording your information. List all collectors so that they can be acknowledged. It is up to you to call some friends to get together for a field trip. Most locations have restrooms nearby and some have tables, fire rings and BBQ facilities for a picnic before or after the tide. It is probably best to be at your site 45 minutes before the low tide. Please send completed data sheets to Paul Tuskes by e-mail, post, or bring them to a meeting. Remember, a fishing license is needed if picking up live critters. Have fun.

Date	Time	Tide	Location	Date	Time	Tide	Location
Jan 9 Fri	2:20p	-1.9	Ski Beach	Apr 5 Sun	1:29p	-0.5	Ventura Cove
Jan 10 Sat	3:02p	-2.1	Santa Clara Pt	May 2 Sat	11:09a	-0.1	Mariner's Pt
Jan 11 Sun	3:38p	-1.7	Mariner's Pt	May 3 Sun	12:01p	0.1	Santa Clara Pt
Jan 25 Sun	3:12p	-0.9	South Cove	May 30 Sat	9:19a	-0.1	Your Favorite
Jan 26 Mon	3:38p	-0.9	Fiesta Island	June 27 Sat	7:42a	-0.3	Fiesta Island
Feb 6 Fri	1:25p	-1.4	Your Favorite	Sept 19 Sat	4:20p	-0.1	Anza Cove
Feb 7 Sat	2:05p	-1.8	Ventura Cove	Oct 17 Sat	3:28p	-0.5	West Crown Pt
Feb 8 Sun	2:42p	-1.9	Santa Clara Pt	Oct 18 Sun	4:09p	-0.6	South Cove
Feb 9 Mon	3:18p	-1.7	Mariner's Pt	Oct 31 Sat	2:34p	0.2	Your Favorite
Mar 7 Sat	1:03p	-1.2	Ski Beach	Nov 2 Sun	2:10p	-0.3	Ventura Cove
Mar 8 Sun	2:40p	-1.3	West Crown Pt	Nov 14 Sat	1:43p	-0.5	Anza Cove
Mar 21 Sat	1:40p	0.0	South Cove	Nov 15 Sun	2:23	-0.8	West Crown Pt
Mar 22 Sun	2:06p	-0.2	Fiesta Islan	Nov 16 Mon	3:02p	-0.9	Your Favorite
Apr 3 Fri	11:56a	-0.3	Your Favorite	Dec 29 Tues	1:21p	-0.2	Fiesta Island
Apr 4 Sat	12:48p	-0.5	Anza Cove	Dec 30 Wed	2:00p	-0.8	Your Favorite

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

February 12, 2009

Number: 2

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 Membership (includes family). Domestic \$20.00;
 Overseas (air mail);\$40.00; Mexico/Canada (air mail);\$30.00.

Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM.
 Room 104, Casa Del Prado, Balboa Park, San Diego

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PROGRAM

THE CALIFORNIA RED ABALONE (*HALIOTIS RUFESCENS*) AND ITS POPULATION DYNAMICS

Speaker Cynthia Button earned her Ph.D. in 2008 at Scripps Institution of Oceanography Her research included hundreds of dives in the kelp forests of the coast of California studying the life history characteristics of abalone and wavy turban snails. She is currently a post-doc at Scripps.

Meeting date: February 19, 2009

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CLUB NEWS

San Diego Shell Club Meeting Minutes January 15, 2009

The meeting was called to order by President Carole Hertz at 7:30 pm. The previous meeting's minutes were approved as published in *The Festivus*. Silvana Vollero gave the treasurer's report, and Wes Farmer gave the Botanical Garden Foundation information. Ben Pister, our new Vice President, reported that our February speaker will be Cynthia Button, and the topic will be on the red abalone.

The Club's shell auction/potluck will be on 4 April 2009. Save this date. You can review the auction shells from 5-6 pm while socializing and having punch. Dinner is from 6-7 pm and the voice auction starts at 7 pm. More details later.

Carole Hertz introduced our speaker Paul Valentich-Scott from the Santa Barbara Museum of Natural History. Paul started his presentation, *Bivalves 101*, with some slides that oriented us to general clam morphology and terminology. After that, we each opened our bag of clams, and with the aid of the key to the superfamilies we keyed-out our clams with Paul's help. It reinforced the slide presentation and gave everyone good practice which was both interesting and fun.

Paul Valentich-Scott is one of the co-authors of *Bivalve Seashells of Western North America*, which is the publication with the most extensive information on our bivalves and which was used at the meeting to confirm our identifications with the key.

Members and guests were so involved in following the key to the bivalves and enjoying the learning process that President Carole Hertz had to remind people that there were cookies and beverages – offering to let attendees enjoy the refreshments as they worked and continue even after the meeting was adjourned.

Paul Tuskes

Save the Dates

The date for the Club's annual auction/potluck has been secured. It will be on Saturday April 4th and once again it will be at Wes Farmer's Clubhouse.

The date for the annual Christmas Party will be held on Saturday evening December 5th and will again be

held at the *Butcher Shop* in Kearny Mesa.

Further information will be published in the Club News page as the dates get closer.

Committee Offices for 2009

Without the dedication of the following committee members, the Club could not function. Our thanks for their continued support.

Botanical Foundation Rep: Wesley Farmer
Club Website Manager: Robert Dees
Historian: Silvana Vollero
Librarian: Marilyn Goldammer
Mentor Parliamentarian: Jules Hertz

42nd Western Society of Malacologists (WSM) Annual Meeting June 23-27, 2009

The 2009 Annual Meeting of the WSM will be held at California State University, Fullerton (CSUF) from Tuesday June 23rd to Saturday the 27th.

For a preliminary announcement of some of the events – there will be a micromollusks workshop led by Daniel Geiger, a bivalve workshop led by Paul Valentich-Scott, a molluscan conservation symposium convened by Hans Bertsch, presentations, poster session, an auction and reprint sale, and an all-day field trip to Santa Catalina Island complete with snorkeling and exploration of the ecology and geology of the island.

Registration forms must be received with payment by April 30, 2009. For those wishing to submit abstracts, the deadline is April 30th.

More information on the WSM 2009 meeting, is at <http://sites.google.com/site/wsm2009meeting/> and updates at www.diversiforma.com.

For additional information about the annual meeting contact WSM President Michael Vendrasco at mvendrasco@fullerton.edu, or for those not using a computer and who require a registration form, or have additional questions, write to President Michael Vendrasco, Department of Biological Science (MH-282), California State University, Fullerton, PO Box 6850, Fullerton, CA 92834-6850, USA.

THE SHALLOW-WATER PATELLOGASTROPODA
(TRUE LIMPETS)
OF THE ISLAND OF NEVIS, LEEWARD ISLANDS, WEST INDIES

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Introduction

During eleven brief annual visits to the Caribbean island of Nevis, St. Kitts and Nevis, Leeward Islands, West Indies, (17°10'N, 62°35' W) (Map 1), the shallow-water marine mollusk fauna of the island was surveyed, primarily as shells from beach drift. For more background on this project, see the introduction section in Hewitt (2005).

On Nevis the shallow-water true limpets, Patellogastropoda, are only a minor part of the fauna and yet there appear to be as many as seven or more different species and morphotypes on the island. (This paper does not include Nevis limpets from other gastropod taxa, such as the Phenacolepadidae Pilsbry, 1895 and Siphonariidae J. E. Gray, 1840.)

The taxonomy of the gastropods is currently very much in flux, but the most recent taxonomy (Bouchet & Rocroi, 2005) appears to place all of the Nevis patellogastropods within the family Lottiidae J. E. Gray, 1840. Two of the species of Caribbean true limpets are readily identifiable: *Patelloida pustulata* (Helbling, 1779) shown here in Figure 1, and *Tectura antillarum* (Sowerby 1, 1843) shown here in Figure 2. However, the Caribbean species within the genus *Lottia* have not been thoroughly studied by experts. Currently it is not clear how many *Lottia* species there are in the Caribbean, or what the correct names for them might be.



Map. 1. The Caribbean area showing the location of Nevis with magnified insert showing both St. Kitts and Nevis.

On Nevis, in addition to what are probably three recognizable *Lottia* species, there are another two morphotypes present. The first, called here ?*Lottia* morphotype A, is very uncommon and very small (Figure 6), and is apparently not shown in the literature. The second, *Lottia* morphotype B, is fairly common on Nevis, is reasonably large (Figure 7) and is apparently almost unknown in the literature, except for a possible illustration in Díaz and Puyana (1984, pl. 35, sp. 341).

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Background

The clade (or order) Patellogastropoda Lindberg, 1986 has historically been given short shrift by shell collectors and by professional taxonomists. In many major museum collections true limpets are under-represented. Confusion and misunderstanding within the taxonomy at the species level has often stood uncorrected for long periods of time.

Limpets are known to be difficult to identify using only shell characters, and this is partly because the simple form of a limpet shell permits only a limited range of possible diagnostic characters. Even so, some limpet species are relatively easy to differentiate, whereas others are not possible to tell apart using shell characters. To make matters worse, in the literature there are often too few views of a shell, with too brief a description. And in some species of limpets there is a high degree of variability in shell appearance, often including distinctive-looking forms known as ecomorphs, which are simply responses to ecological factors. However, when large samples of shells are in hand from one area, as was sometimes the case in the current study, it is somewhat easier to recognize diagnostic characters.

Thirty years ago, the shallow-water true limpet fauna of the Caribbean Sea was often viewed as being extremely limited. The species were placed in the family Acmaeidae Carpenter, 1857, and they were all grouped under the genus *Acmaea* Eschscholtz in Rathke, 1833. As for what we would now consider *Lottia* species, Abbott (1974) held the view that in the Caribbean Sea there was only one species which he referred to as *Acmaea leucopleura* (Gmelin, 1791). This was also the only species now understood to be *Lottia* that was listed in Warmke & Abbott (1961), in Vokes & Vokes (1983), and in De Jong & Coomans (1988). However, Humfrey (1975) listed what he believed were three separate species: *L. jamaicensis* (Gmelin, 1791), *leucopleura*, and *cubensis* (Reeve, 1855). In more recent times, Redfern (2001) working in the Bahamas, listed three separate species of *Lottia* from Abaco: *jamaicensis*, *albicosta* (C. B. Adams, 1845) and *leucopleura* (Gmelin, 1791). Morris (1951) listed *A. jamaicensis* and *A. leucopleura* as Caribbean species, but in the 1995 fourth edition, Abbott and Morris considered there to be one species, *A. leucopleura*.

The online database Malacolog (Rosenberg, 2006) attempts to list and synonymize every name that has ever been used for Western Atlantic mollusks. Malacolog 4.1.0 acknowledges the existence of six species of *Lottia* from the Caribbean Sea: *albicosta*, *balanooides* (Reeve, 1855), *gadelupa* (Christiaens, 1976) considered a dubious name by Rosenberg, and *jamaicensis*, *leucopleura*, and *tranquebarica* (Gmelin, 1791). Some species have a number of synonyms: in the case of *leucopleura*, Rosenberg lists eight, including *cubensis*.

In a DNA study, Simison (2000) collected live *Lottia* material in the Caribbean Sea, on the mainland coasts of Costa Rica, Panama, Venezuela, and the West Indian islands of Jamaica, St. Thomas and St. John. He then "morpho-sorted" the material, and DNA analysis confirmed 13 of these groups as Molecular Operational Taxonomic Units (MOTUs), which may or may not prove to be distinct species. Simison also coined some new names in his thesis, for one genus and several species, but these names are invalid by the rules of the International Code of Zoological Nomenclature. He provided a diagram of the hypothetical relationships of the MOTUs, shown geographically (Simison, 2000: 197). Unfortunately there are no photographs or descriptions of the material, and I do not know whether the shells were retained or discarded. In 2004, Simison told me he would share what data he has with any researcher if requested (personal e-mail communication, 10/2004) but more recently I have not been able to contact him.

Discussion

The great majority of the limpet shells from Nevis were obtained from intensive searches of beach drift. Therefore, many of the shells illustrated are worn, chipped and faded compared with shells of live specimens. For the two more common limpets, live colonies were observed, and the living animals were examined with a hand lens. Because the material from Nevis did not always appear to correspond well with the species shown in the literature, the shell material was morpho-sorted to separate into groups. Wherever it was possible, species identifications were tentatively made from comparisons with the more accessible literature. The Nevis species or morphotypes are listed below, in

decreasing order of the certainty of their identifications. Less information is given in cases where the identity is considered to be straightforward and in cases where the number of shells found were less than four.

Genus: *PATELLOIDA*

Patelloida pustulata (Helbling, 1779). Figure 1.

Shells of this species are not uncommon in the beach drift on Nevis, where the maximum size is about 18 mm. The shell is creamy white in color. The exterior is often (especially in juveniles) adorned with radiating rows of red spots. For another exterior view of a shell, see DeJong & Coomans (pl. 30, fig. 28). The shell varies in height, and is irregularly ribbed. The apex is approximately $\frac{1}{3}$ of the shell height back from the anterior end. To the right in Figure 1 is a beach drift shell that appears to represent the smaller ecomorph of this species, which according to Redfern (2001) lives on the blades of turtle grass *Thalassia* sp.

Genus: *TECTURA*

Tectura antillarum (Sowerby I, 1834). Figure 2.

Shells of this species are fairly common in the beach drift on Nevis. This is a relatively large limpet; the maximum dimension observed on Nevis is 24 mm. The exterior is usually pale in color with delicate, sometimes spotted rays in a range of muted colors, including dark pink and greenish or purplish-brown. The number of colored rays is variable. When the colored raying is crowded, the shell can appear quite dark, but the dark layer is only superficial. The shell is often somewhat translucent, and the external raying is almost always clearly visible on the interior. For a good interior view see DeJong & Coomans (1988: 226, pl. 30, fig 27). For a good exterior view see Humfrey (1975: 65, pl. 2, fig. 15).

The shell is extremely flat and regular in shape with an egg-shaped outline. The surface has fine radiating sculpture. The shell is thin and light even when it is large. The apex of the shell is a little less than $\frac{1}{3}$ back from the anterior end. The central callus on the interior of the shell is ringed with discontinuous muscle attachment scars, which sometimes show clearly as white chalky blotches.

The visible soft parts of *T. antillarum* on Nevis are creamy white with a slightly yellowish-orange head

area. This species lives in the upper intertidal zone on the sides of rocks.

Genus: *LOTTIA*

Lottia albicosta (C.B. Adams, 1845). Figure 3.

These shells are somewhat uncommon in beach drift on Nevis, where the maximum size is 15 mm. The shell often has spots or rays of dark brown between white ribs. Occasionally shells have an all-white background as shown here and in Redfern (2001, pl. 1 fig. 2A). When there is dark raying, this usually shows through to the interior, except in what are assumed to be very mature shells. The central callus area is often white in the center with brown at the edge. These shells appear to be similar to the photograph of C. B. Adams' holotype, as shown in Clench & Turner (1950), where Adams' original description is given as: "*P. t. crassa, atro-fusca, costulis 12 elevatis, totidem brevioribus, omnibus albis -- instructa; margine pectinato, juniorum fusco -- et albo-maculato, seniorum albo.*" Translated for this paper, it reads: "Patella with shell thick, dark brown, furnished with 12 elevated riblets, just as many shorter ones, all white; margin pectinate, that of younger ones brown- and white-spotted, that of older ones white." Some of the Nevis shells resemble the various shells from Abaco, Bahamas, illustrated in Redfern (2001, pl. 1 fig. 2B, C), confirmed by Redfern, personal e-mail communication, 2007. The Nevis shells are depressed and strong, but unlike the type description they are usually not thick. The exterior of the shell has 12 to 20 low white ribs. The apex is a little less than $\frac{1}{3}$ back from the anterior end. The outline of the base of the shell is ovate with almost parallel sides such that the anterior end is almost as wide as the posterior end.

The two views of the shell on the lower right of the group in Figure 3 are what may possibly be just a form or variety of *albicosta*. This kind of shell is found somewhat rarely in the beach drift at several different localities but it is fairly consistent in appearance. It is slightly smaller than regular *albicosta*, with a maximum size of 13 mm; the ribbing is much more subdued and the shell is more elevated. On the exterior, the juvenile part of the shell has darker markings, but the later growth is all white. It is possible that this change in color might simply be a result of a change in diet. In the interior, the central callus is usually whitish.

Lottia cf. *leucopleura* (Gmelin, 1791). Figure 4.

The shell has been found rarely in beach drift on Nevis. The shell illustrated in Figure 4 is 13 mm in maximum dimension. This may possibly be the “dwarf suck-on limpet” *Lottia leucopleura*. The ribbing however, is not black on a white background as is usually described for *L. leucopleura*; instead the shell exterior is dark greenish-gray with raised whitish ribs. The interior is whitish with a brownish callus area. The apex is almost central. The shells are elevated and conical, with subdued but noticeable ribbing.

The limpet *L. leucopleura* has been described as living on the columellar area of the large West Indian top snail, *Cittarium pica* (Linnaeus, 1758). It has not been possible for the author to check to see if *C. pica* on Nevis has an associated limpet because the top snail has been over-collected as a food item.

Lottia cf. *jamaicensis* (Gmelin, 1791). Figure 5.

One shell of this species was found in the beach drift on Nevis in 2008. The shell is 11 mm in length. The external coloration consists of white blotches on a black background. The apex of the shell is worn to white. The interior of the shell is whitish, and the central muscle scar is pale with some brown around the edge. The apex is less than $\frac{1}{3}$ of the shell length back from the anterior end. The shell is quite elevated with sculpture consisting of many small ribs which are crossed with growth lines.

?*Lottia* morphotype A. Figure 6.

This shell is rare in the beach drift on Nevis. During the April 2005 visit to Nevis, nine shells of this morphotype were found over four days in searches of the beach drift in a sheltered lagoon area rich in sea grasses, on Newcastle Beach just west of the Nisbet Plantation hotel grounds. That group of shells is illustrated here. One other shell of the same kind was found in the drift at the north end of the Four Seasons property in 2008.

The shells are about 3-5 mm in length. (If this is indeed a *Lottia*, it is very small indeed for that genus.) The shell is all white with very subdued white riblets. The shells are well elevated. The apex is $\frac{1}{4}$ of the way back from the anterior end. On the interior there is no brown stain on the central callus; instead there is a distinctive marking of a brown smear outlining the head

part of the callus area and fading off into the surrounding white towards the periphery of the shell.

Two shells of the group of nine have striking morphology. They are both elevated, narrow-based, very parallel-sided, and are triangular in profile (one view of each of these two shells is shown to the lower right in Figure 6). The form of these two shells appears similar to that of the eastern Pacific species *Acmaea triangularis* (Carpenter, 1864) as shown in Abbott (1974) where it is stated that *A. triangularis* lives among coralline red algae.

None of the Nevis shells resembles juveniles of *L. albicosta*; they are elevated and distinctly conical instead of depressed (as is the case in typical *albicosta*). It could, perhaps, be argued that the shells represent an ecomorph of *L. albicosta*, but it seems possible that they may be another taxon altogether.

The extreme form of the two triangular Nevis shells and their presence on a lagoon beach could suggest that at least some (possibly all?) individuals of this morphotype might live on a substrate such as narrow-bladed tropical sea grasses in the genus *Halodule*, which have flat blades with a maximum width of about 3 mm, or perhaps on branching green calcareous algae such as *Halimeda*.

Lottia morphotype B. Figure 7.

Empty shells of this morphotype are found fairly often in beach drift all around Nevis. Live colonies of specimens seem to be relatively common intertidally in both sheltered and exposed areas, on smooth rock or concrete surfaces. The complete tidal range on Nevis is only about 25 cm and intertidal zonation is not easy to see in most places. However, this morphotype occupies the upper intertidal zone immediately above where *Tectura antillarum* lives.

Because this limpet is relatively common on Nevis, it is possible to give a detailed description of the shell. An exceptionally large shell was 24.7 mm in length, however usually the shell is 15 to 20 mm. It is always moderately elevated, the height being almost $\frac{1}{3}$ of the length and is somewhat inflated, more so on mature shells. When the shell is mature, it is often thick and solid. When adult it is never translucent. The outline of the base of the shell is distinctly egg-shaped with the anterior being the narrower end. (The base is never circular and never has parallel sides.) The apex is

situated well forward, $\frac{3}{4}$ of the way to the anterior end of the shell. The apex is hooked forward and, thus, the anterior slope of younger shells can sometimes be concave; the posterior slope is always convex.

The surface of the shell, when not eroded, appears smooth but is actually finely textured (a sample area is shown to the right in Figure 6). Under magnification there are numerous, minute, closely-spaced, radial riblets, alternating in size: one broad riblet, one very narrow riblet. Growth lines intersecting these riblets can sometimes result in a finely reticulated appearance. This fine sculpture is often easier to see on younger shells.

The external background color of the shell is dark brown, but it appears dark greenish when live or fresh-dead, due to epiphytic algae. The apex of the shell, when eroded or beach worn is whitish or beige; when intact it is brown. Over the majority of the shell surface there is always a rather coarse and somewhat blurred color pattern of off-white or beige patches or stripes which contrast with the brown background. The patches are often arranged in a characteristic, expanding checker-board pattern caused by abrupt reversals of pigmentation at growth stages. On many shells these reversals in color patterns are not consistent and the pattern coalesces into stripes for part of the shell surface. Rarely the stripes bifurcate closer to the margin of the shell. On one Nevis shell, the stripes are narrow and appear as light lines on a dark background. A few small shells have less pigment, so that they appear to be pale shells with darker external markings, and a very pale internal callus. There is never any red or purple in the shell color pattern of this morphotype and the shell color is never broken into very fine lines or rows of dots as in *Tectura antillarum*.

Most of the interior surface of mature shells is bluish-white and the muscle-attachment scar appears as a continuous band rather than blotches. The central callus area is often a whitish-brown but can be mid-brown. As is the case in the majority of *Lottia* species, the shell has a thin marginal strip which is translucent, and in this species the external pattern (of about 50 alternating narrow bars of brown and cream) shows through to the inside of the marginal strip.

In living animals, the observable soft parts are a creamy, grayish-white. The soft parts are partially translucent, including the ventral surface of the foot which has a longitudinal, medial, grayish area. The head of the animal is pinkish.

This morphotype does not seem to be *Lottia jamaicensis* (Gmelin, 1791), which is usually quite strongly ribbed, and usually appears as a white shell with black markings. This limpet also differs from *Lottia subrugosa* (d'Orbigny, 1741) from Brazil, despite the apparent similarity to the illustration in Rios, (1994, pl. 8, sp. 74). The shell of *L. subrugosa* has no fine sculpture but sometimes has very rugged ribbing. It tends to be black and white and is usually much thicker than this morphotype.

As far as this author has been able to determine, the shell of this morphotype has not been illustrated in the more accessible literature, with one exception: two images of a shell from the Caribbean coast of Colombia in Díaz & Puyana (1984, pl. 35, sp. 341). The authors show a dorsal and ventral view (no lateral view) of a shell which appears to be similar to this morphotype. However, Díaz and Puyana's description (on p. 113) is that of typical *Tectura antillarum*. In a personal e-mail communication with Juan Manuel Díaz (6/2007), he told me that in the early 1980s when he was working on the book, he observed that this kind of limpet was more abundant than *T. antillarum* at Santa Marta on the Caribbean coast of Colombia and at that time he had speculated that this limpet was simply an ecomorph of *T. antillarum*. Díaz also told me that in 2006 he visited one locality on the northern coast of Margarita Island, in Venezuela and saw and collected both this limpet morphotype and *T. antillarum*. He noted that at that locality this limpet was less common than *T. antillarum*, and from my observations, that is also the case on Nevis.

On Nevis, specimens of this limpet and *T. antillarum* are found in close proximity, sometimes on the same rock, and there are no intermediate forms whatsoever. I feel this is a distinct morphotype, a *Lottia* species.

After a search of the relevant cabinets in the AMNH collection in September of 2008, I was able to find six lots of shells that appeared to be the same morphotype. One of the six lots, AMNH 136267, consisting of four shells, was collected on Nevis in 1966. A lot comprising five shells was from Guadeloupe in 1969: AMNH 173743. Three lots from Martinique in 1968 are as follows: 145708 (4 specimens with dried soft parts), 145718 (2 shells), and 145721 (one shell). The sixth lot, 153833 (one shell), was taken from the island of Bequia, the Grenadines in 1969.

The localities for these limpets other than Nevis are islands in the Lesser Antilles lying south-southeast of Nevis: Guadeloupe by approximately 120 km, Martinique by 350 km, and Bequia by 500 km. As for the two localities mentioned by Díaz, Margarita Island, Venezuela lies south-southwest of Nevis by approximately 700 km, and Santa Marta, Colombia is almost 1,300 km southwest of Nevis. These localities might indicate a southern Caribbean distribution for this morphotype.

Conclusion

In addition to the one *Tectura* and one *Patelloida* species, it seems there may be five or more *Lottia* morphotypes on Nevis. This author hopes to alert people to the fact that there appear to be a number of obscure, poorly known or unknown lottiid species in the Caribbean Sea. Hopefully more professional attention can be drawn to this; a great deal more work needs to be done in order to understand Caribbean *Lottia*.

The mollusk section of Invertebrate Zoology at the American Museum of Natural History has been inactive since 2006, but when it becomes active again, I hope to be able to donate voucher material for this paper.

Acknowledgments

I wish to thank the Nevis Island Administration, Division of Fisheries, including the new Director, Mr. Audra Barrett, and secretary Inga Lawrence, for collecting permits, and the AMNH for Field Associate status. Many thanks to Gary Rosenberg for very helpful discussions at ANSP, and to Brian Simison for answering my e-mail inquiry. Thanks to Colin Redfern for pointing out the Díaz and Puyana illustration, and to

Harry G. Lee for helpful correspondence. Sincere thanks to Juan Manuel Díaz for e-mail correspondence and information. Thanks to Ilya Tëmkin for critically reading part of a draft of the paper. Thanks to Charles Whitman for finding the largest shell of *Lottia* morphotype 2 on Nevis, and to Jim Johnson and Nikki Johnson of Nevis for help in getting to localities and collecting material. The research and writing would not be possible without the support and help of Ed Subitzky. Translation of the original description of *L. albicosta* is by Mark Garland of Scientific Latin Translations. The plate was assembled with expert help from Roberta Jaret and Ron Hartley. The information from Gary Rosenberg's database Malacolog 4.1.0 is provided with the permission of the Academy of Natural Sciences, Philadelphia, PA.

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Figures 1 – 7: Lottiidae from the island of Nevis, West Indies. The anterior ends of the limpets are towards the top of the page. The images are not to the same scale. Photographs by Susan J. Hewitt.

(1) *Patelloida pustulata*, three shells 15 mm to 18 mm, and at far right the form “pulcherrima” 7.5 mm. (2) *Tectura antillarum*, seven shells, 13 mm to 21.5 mm, including a side view. (3) *Lottia albicosta*, seven shells, 9.5 mm to 19.5 mm, and at lower right two views of one shell of the bicolor, more elevated form. (4) *Lottia* cf. *leucopleura*, one shell, 14 mm, three views. (5) *Lottia* cf. *jamaicensis*, one shell, 11 mm, three views. (6) ?*Lottia* morphotype A, nine shells, 3 mm to 5 mm. The two triangular shells are shown at lower right, one shell viewed from below and the other shell viewed from the side. (7) *Lottia* morphotype B, six shells, 18 mm to 24.7 mm, including a close up of shell sculpture.



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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLI

March 12, 2009

Number:3

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Annual dues are payable to San Diego Shell Club.
 Membership (includes family). Domestic \$20.00;
 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc., c/o
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The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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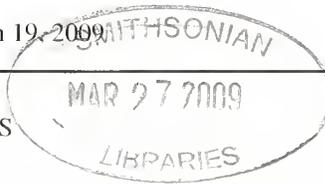
PROGRAM

DIVING & COLLECTING IN MARLBOROUGH SOUND ON THE SOUTH ISLAND OF NEW ZEALAND

Kathy & Joe Kalohi of The Pacific Conchological Club
 will be showing pictures and displaying specimens col-

lected from five days of scuba diving off of Arapawa Is.
 on the N/E corner of the South Island of New Zealand.

Meeting date: March 19, 2009



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CLUB NEWS

San Diego Shell Club Meeting, Minutes February 19, 2009

Carole Hertz called the meeting to order at 7:45 pm, with 29 members and guests present. The minutes from the previous meeting were accepted. The treasurer was not present. Jules Hertz reminded us that the shell club auction is Saturday April 4th (see col. 2).

Benjamin Pister introduced speaker Cynthia Button, who is finishing up her Ph.D at SIO. She presented some of her research on red abalone populations and touched on the pinks off Point Loma. In general, abalones are broadcast spawners and, as such, there is a density dependent relationship with success. Based on the number of individuals in an aggregation you can estimate the probability of both sexes being present, and when linked with estimated distances between individuals and fertilization success, it may be possible to estimate the potential success of successful breeding. For red abalone, it is estimated that populations below 2000 per hectare are at risk and requires management. At 6000 per hectare, the population is thought to be strong enough to support collecting. Red abalones in northern California have the highest density. Central California, in the range of the sea otter, has very low densities and in southern California they bounce up to 1-2000 per hectare.

Steven Mallet won the door prize and the refreshments were provided by John Jackson. Bruce Kemp and the Hertzses.

Paul Tuskes

Too Late for the Roster

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The San Diego Shell Club's Annual Auction/Potluck

The Club's annual auction/potluck on Saturday evening April 4th will be held, once again, at the Community Room of Wes Farmer's condo. Browsing the auction tables with wine, punch and soft drinks will begin at 5 pm. There will be fantastic bargains in the silent auction so attendees will be signing on as they drink their wine and socialize with friends. Dinner is at 6 pm and the voice auction starts promptly at 7 pm.

Attendees are asked to bring a potluck dish to serve 12 hungry people – either a salad, main dish or dessert. If you haven't signed up for a potluck contribution, contact Carole Hertz (858) 277-6259 to see what is needed. Our dinners are always fantastic.

At 7 pm the fun really begins when auctioneer Carole Hertz gets the action going on the voice auction. There are some incredible offerings such as *Cypraea leucodon*, *C. rashleighana*, *Cerastostoma burnetti*, a 115 mm *Conus textile* var. *scriptus*, *Lophocardium cumingii*, *Trophon catalinensis*, a D'Attilio original shell drawing beautifully framed, many fine books such as Keen's (1971) *Sea Shells of Tropical West America*, the two-volume set of *Australian Marine Shells* and *Australia's Spectacular Cowries* both by Barry Wilson, along with MacFarland's color nudibranch plates from vol. 6 of his book and much, much more.

At the mid-evening break there will be the usual huge Dollar Sale table as you have a second dessert or something to drink as you guard your silent auction choices.

The auction is so much fun and the proceeds go to worthy causes – *The Festivus*, Club library purchases, Greater San Diego Science Fair, and donations to worthwhile student grants as well as keeping Club costs low.

If you have any questions or would like a copy of the voice auction list, call or e-mail Carole or Jules Hertz at (858) 277-6259 or e-mail at <jhertz@san.rr.com> And if you can't attend but wish to bid, we can arrange to have a bidder for you.

But we hope to see you all there!

INFLUENCE OF HABITAT ON GROWTH AND PREY SELECTION OF *PTEROPURPURA FESTIVA* THE FESTIVE MUREX

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Abstract: The Festive Murex *Pteropurpura festiva* (Hinds, 1844) occurs in a wide range of habitats. The size, distribution and occurrence of animals is closely related to different habitats studied in Mission Bay, San Diego, California. As the snails grow larger their prey species change with a progression from barnacles and limpets and other gastropods, to primarily bivalves. Successful attack patterns on two of the most common bivalve prey differ.

Introduction: *Pteropurpura festiva* occurs primarily south of Point Conception with most records from Santa Barbara, Los Angeles and San Diego. The collection of the California Academy of Science contains two specimens from Morro Bay in central California. Three other species of murex in the genus *Pteropurpura* occur in San Diego: *P. trialata* (Sowerby, 1841), *P. macroptera* (Deshayes, 1839), and *P. vokesae* Emerson, 1964. *Pteropurpura festiva* is easily separated from these by its small, re-curved, somewhat flattened varices and thin, evenly spaced spiral dark brown lines (Figure 1). The ground color of the shell may vary from white to light brown. In some specimens, the ground color is brown with white streaks, a characteristic also seen in both species of *Ceratostoma* on the west coast of the United States. The shell surface of larger specimens can become soft and slightly chalky, such that only the newest growth exhibits the attractive color and brown lines. The author of one book from Europe described this species as fossil-like (Wye, 2000), but we have found some specimens to 60+ mm with both excellent color and pattern.

The general literature regarding this species is sparse. It is mentioned in passing in various faunal surveys (Turner et. al, 1969; McLean, 1969) and has received some attention as a predator of the introduced mussel *Musculista senhousia* (Benson, 1842) in Thorsten & Reusch, 1998; Ray, 2004; Kushner & Hovel, 2006. Negus (1991) published color photos documenting some of the shell patterns and colors. A detailed study involving survival, growth rates, longevity, and both recruitment and mortality, north of La Jolla, California, was published (Fotheringham 1971) and provides the most comprehensive information.

Methods: Observations were made while skin diving along the entire inside length of the south Mission Bay jetty and into Quivira Basin. Live snails were collected and returned to shore where they were measured with micrometer calipers, the data was recorded, and the snails released back to the habitat. Every live *P. festiva* was collected regardless of its size, but small specimens (< 15 mm) were separated so larger individuals would not damage them.

Prey species. All intact dead clams found on the sand at the west end of Quivira Basin were collected, cleaned, and then bleached. Cleaning was necessary to ensure that all points of attack could be identified. The clams were separated by species and each point of attack was plotted. Successful attacks were defined as events where the shell of the clam was completely drilled. Unsuccessful attacks were locations that were partially drilled, and for unknown reasons, the shell was not penetrated. The surface of the shell was divided into three concentric zones, the margin, submargin, and medial area. The thickness of the clam shell was determined after lamellae on the shells were removed by sanding. Measurements were made with a micrometer, and the average of five measurements in each zone was used to estimate shell thickness. Based on similarity in thickness, the submarginal and medial areas were combined. Clams that had been drilled by moon snails were easily distinguished by their counter-sunk drill holes and were removed from the sample lot. Successful attack patterns on *Chione undatella* (Sowerby, 1835) appeared related to clam length, and the sample was divided into two groups; 20-29 mm and 33 to 49 mm. No clams larger than 49 mm and no clams between 30 and 32 mm were found in the study area.

Results:

Habitat and Its Influence. *Pteropurpura festiva* is present, but not common, on exposed rocky beaches and those individuals that are found are often less than 25 mm in length. On the protected sides of the jetty entrance, the species can be very common from mid intertidal to the base of the structure. Of 236 specimens measured in this habitat, the size ranged from 11 to 42 mm in length and the median size was 25 mm in length. The highest frequency of juvenile shells under 15 mm in length were from 5 to 15 feet in depth, while the largest shells were low intertidal and subtidal.

Further into the bay, at Quivira Basin and on the same rocky structure, there is little wave force and individuals ranged from 24 to 47 mm, with a median length of 38 mm (N=80). In the sand area away from the rocks, individuals ranged from 33 to 55 mm and the median length was 42 mm (N=80). We have found specimens to 63 mm in the same habitat, but outside of our study area. Size appears to be inversely related to increased wave force. Large specimens, 50+ mm in length are uncommon, except in protected areas or deeper water. The percent distribution by size (in 5 mm increments) for each location is shown in Table 1.

Table 1. Percentage of individuals in various size categories from three locations in Mission Bay

Size Location	Sample Size	11-15 mm	16-20 mm	21-25 mm	26-30 mm	31-35 mm	36-40 mm	41-45 mm	46-50 mm	51-55 mm
QB Sand	80	0	0	0	0	7	36	37	16	4
QB Riff-Raff	80	0	0	0	3	27	50	15	5	0
Jetty Entry	236	5	7	36	27	14	10	1	0	0
North reef **	425	3	15	21	26	20	12	3	0	0

**Data adapted from Fotheringham, North Reef, La Jolla, 1971.

Individuals on the sand flats may be covered with various species of red and brown algae and are a sharp contrast to the relatively clean shells found on the jetty. The lack of juveniles in this habitat suggests they are more successful in complex multi-dimensional rocky habitat with an abundance of small prey. As they mature, larger individuals can move to the exposed flats and feed on larger prey. The largest specimens (55 to 60+ mm) are from rocky off-shore habitat and on sand substrates in protected bays. In both of these habitats small snails (< 35 mm) were not commonly observed when compared to their frequency on the rocky breakwater or open rocky coast.

Ideal locations to observe breeding in Mission Bay are isolated low rocks in sand patches at depths of 1 to 7 meters. It is not uncommon to observe over 30 mature snails in a reproductive cluster. The minimum size of the individuals observed in breeding clusters was approximately 40 mm in length (Figure 2). Size and age at maturity is probably influenced by the habitat and prey availability. The eggs are attached to rocks and other firm substrate that occasionally includes tunicates, the large top shell *Astraea undosa* (Wood, 1828), and the whelk *Kelletia kelletii* (Forbes, 1852). The yellow egg case is on a short pedicel and approximately 6-8 mm in length and relatively flat. Fotheringham (1971)

found that larvae emerge from the eggs in 4 to 6 weeks and are planktonic. In Mission Bay, mating clusters and fresh egg were observed every month of the year, with a peak in activity between March and August and a low from December to February.

Contrast Between Populations in Mission Bay and the Exposed Coast

Fotheringham (1971) published the results of his 3-year study of *P. festiva* at North Reef, an exposed rocky reef approximately 6 air miles north of our study location. His study placed an emphasis on growth rates, mortality and recruitment. Differences in observations are to be expected and some are clearly related to the suitability of the habitat. Note the similarity in size distribution between the exposed Mission Bay Jetty and North Reef (Table 1). At North Reef reproduction occurred between March and July, whereas in the more protected areas of Quivira Basin mating clusters and eggs were found every month of the year, with a peak between March and August. At North Reef, shells larger than 35 mm actually decreased in size over the study period due to lack of new growth and erosion of the apex or siphon area. Shells in Quivira Basin showed little or no erosion. At North Reef approximately 15% of those sampled exceeded 35 mm in length. On the



Figure 1. Mature *Pteropurpura festiva* on rock.

Mission Bay Jetty 11% exceeded 35 mm, while at Quivira Basin on the sand 93% were 35 mm or greater in length. Neither study found the smallest juveniles. Fotheringham found only one shell less than 10 mm in length. He also collected hundreds of hermit crabs carrying various shells as small as 4 mm, but none carried *P. festiva* less than 10 mm. Fotheringham estimated the median size at death of the North Reef population to be 32-33 mm and estimated longevity of mature snails to be 10 years. He found that larger snails did not continue to grow, and in fact decreased in length, and concluded that the size of individuals could not be used as a predictor of age. Our study did not attempt to estimate longevity, but based on the difference in the size distribution, either *P. festiva* in the bay grow faster, live longer, or a combination of both, when compared to those studied on the open coast.



Figure 2. *P. festiva* with egg masses.

Prey Species and feeding patterns. We have not observed *P. festiva* feeding in the mussel beds that occur on the high surf areas of the exposed jetties. In rocky habitat *P. festiva* drills *Balanus* sp. barnacles in the upper intertidal zone, especially during high tide (Figure 3). Limpets such as *Collisella limatula* (Carpenter, 1864),



Figure 3. *P. festiva* drilling *Balanus* sp. barnacles

Collisella scabra (Gould, 1846) and *Lottia gigantea* Sowerby, 1834, are drilled as are small *Crassostrea gigas* (Thunberg, 1793). Subtidally, we have found numerous specimens of *Maxwellia gemma* (Sowerby, 1879), *Pteropurpura tratalata*, and *Tegula eiseni* Jordan 1936, which have been drilled by *P. festiva*. On one occasion we observed a mature *P. festiva* feeding on a mature freshly dead crab, *Pachygrapsus crassipes*, which it had drilled and this is the only occasion we have observed them scavenging.

In the sandy habitat, *P. festiva* commonly drills the following prey: *Chione californiensis* (Broderip, 1835), *C. undatella*, *Protothaca staminea* (Conrad, 1837), *Sanguinolaria nuttalli* (Conrad, 1837), *Laevicardium substriatum* (Conrad, 1837), *Musculista senhousia* and to a lesser extent on snails such as: *Astraea undosa*, *Forreria belcheri* (Hinds, 1844), *Bulla gouldiana* Pilsbry 1893, and in one instance, *Conus californicus* Hinds, 1844. We suspect they are feeding on other bivalves and gastropods. Large prey species, such as *Bulla* and *Astraea* are not commonly drilled, but rather *festiva* feeds on the exposed foot. We have observed on numerous occasions, both *P. festiva* and *Conus californicus* feeding simultaneously on large bubble snails. We suspect that the cones initiate the attack, as we find cones feeding singly or in groups on *Bulla*, and cones and *P. festiva*

feeding, but have not seen *P. festiva* feeding by itself on *Bulla gouldiana*.

In Quivira Basin, large numbers of dead, intact clams of both *Chione undatella* and *Protothaca staminea* (Conrad, 1837) were collected from the sand. The behavior of these two species of clams is quite different. The *C. undatella* can be found commonly on the surface of the sand, and at times crossing the sand with the use of its foot, but few *P. staminea* were observed on the surface of the sand.

Twenty-six small *Chione undatella* 20-29 mm in length were examined. Nineteen (73%) had been successfully drilled on the first attack, while seven had been incompletely drilled, and succumbed to the second attack. Fifty percent of all successful attacks occurred in the medial area of the shell and 50% along the margins (Figure 4). On the margin 19% of the attacks were unsuccessful while in the medial area that number was 23%.

Among 28 *C. undatella* 33-43 mm in length, 35% had been successfully drilled on the first attack, the majority were attacked in multiple locations before being successfully drilled. Unlike the smaller clams, 83% of all successful attacks were at or near margins. Of the 49 attacks in the margins, 41% were unsuccessful. Only 17% of the successful attacks occurred in the thicker medial area and 66% of those were unsuccessful. Measurements of shell thickness indicated the margin to be the thinnest; often less than 1.5 mm in thickness whereas the medial area was 2.4 to 3.5 mm in thickness. By plotting the position of successful and unsuccessful attacks on these clams, it appears that *P. festiva* alters its attack on larger *C. undatella* to take advantage of the more vulnerable margin (Figure 5). Of the 67 attacks (successful and unsuccessful), 73% were in the marginal area, with the remainder in the medial area.

The shells of *Protothaca staminea* are more uniformly thin, and approximately one-half as thick as a *Chione californiensis* of similar length. The distribution of successful attacks on *P. staminea*, (N=38) are more broadly spread over the shell and there was no discernable difference in attack pattern with size. The medial portion of the shell received 52% of all successful attacks with a successful attack ratio of 50%. The margin, which is slightly thinner received 48% of the successful attacks but the success rate was higher at 70% (Figure 6).

Adult *P. festiva* have at least two approaches for finding clams in the sand. Individuals travel across the surface of the sand and come upon *C. undatella*, or plow through the sand and leave a deep trail; these

individuals come upon both *C. undatella* and *P. staminea*. This is easily confirmed by scooping under snails that are partially buried. Perhaps 15 to 20% of these individuals have come to rest on a live clam, and when the snail is removed, the drill marks on the clam are obvious. On occasion, numerous *P. festiva* feed on the same *P. staminea* and as many as four individuals have been found to have successfully drilled the same clam.

The shells of some large sand dwelling *P. festiva* are blackened, presumably from being buried in the sand. An effort to determine if *P. festiva* were buried from sight under the sand was unsuccessful. On two occasions, all *P. festiva* and clams were removed from the surface in a 200-foot square area, at a depth of 6 feet. The area was then raked to a depth of three inches below the surface of the sand, and although both species of clams were found, no additional *P. festiva* were located. This suggests that in our area of study, only clams at or just below the surface of the sand are susceptible to predation from *P. festiva*.

The occurrence of *P. festiva* in diverse habitats is perhaps the result of its ability to feed on a wide range of prey. There is little doubt that additional observations in other environments would identify even more variation regarding the biology of this species, and expand our knowledge of the resources it utilizes.

Acknowledgments

We wish to thank Carole Hertz for assistance with tracking down literature and Paul Valentich-Scott for confirmation of the *Chione* species.

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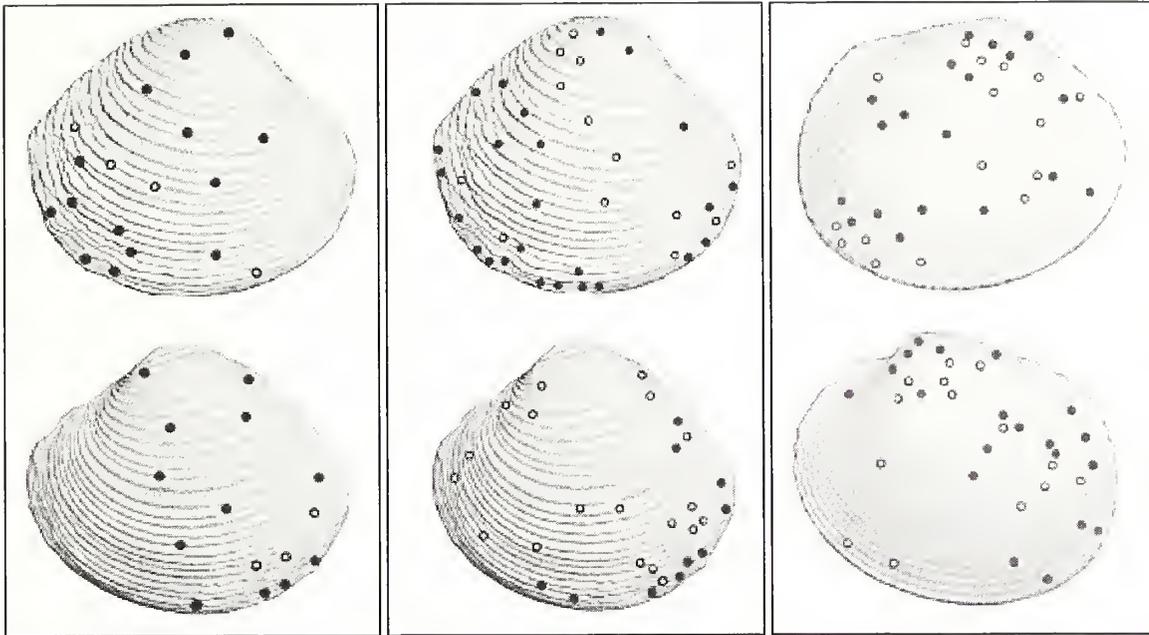


Figure 4 (left) *Chione undatella*, 25-29 mm in length, **Figure 5 (center)**: *C. undatella* 33-43 mm in length **Figure 6 (right)**: *Protothaca staminea* 21-44 mm in length.

● Closed dark circles are successful attacks. ○ Open circles are unsuccessful attacks.

THE THIRTEENTH ANNUAL SCUM MEETING

The thirteenth annual meeting of the Southern California Unified Malacologists (SCUM) was held on 24 January 2009 at the campus of California State Polytechnic University in Pomona, California. The meeting was in the Centaurus Room in the Bronco Student Union. Refreshments were available at 8:00 a.m. and the meeting was officially convened at 9:00 a.m. by our host, Ángel Valdés. There were 35 attendees.

The meeting began with the traditional self-introductions by the attendees, with each person giving a brief statement of his/her particular interest in malacology and what they had been working on in the past year. This was followed by short prepared presentations. The first presenter was Carla Stout from Cal. State Poly and her presentation was on the *Morphological and Molecular Phylogenies for Dendronotus Nudibranchs*. She started her presentation with slides showing what a typical *Dendronotus* looks like and some actual species. She also showed a figure of the only sea slug found on a hydrothermal vent, of course a *Dendronotus*. This was followed with a map of the world showing the various known species and their localities, including two new species from tropical waters. She spent most of the talk on four recently-named *Dendronotus* species, primarily based on color differences. She described her morphological and molecular studies of *D. diversicolor*, *D. albus*, *D. nanus* and *D. iris*, and based on her studies concluded that they were synonymous. She also discussed her work on a world-wide species, *D. frondosus*, and as a result of her studies concluded that the species could be divided into at least two species.

The second talk was given by Wendy Enright Storms and was on *Deep Water Mollusca from San Diego, Bight 08* and was on sampling from depths greater than 500 m. There were 14 stations sampled in July 2008 and 87 animals were found representing 27 species. Of these, there were 10 bivalve species and 4 gastropod species, mostly specimens in the 1-10 mm size range. The pictures were particularly fascinating to me as a San Diego intertidal shell collector, since they represented species I had never seen before.

Michael Vendrasco spoke next on ancient and not-so-ancient chitons. He illustrated new shell micro-

structures in Cambrian mollusks. Earliest mollusks had very diverse and multiple types of microsculptures and it looks like these could be useful for identification. Calcitic semi-nacre is common in early mollusks but not in current mollusks.

The next presentation by Elysse Gatdula was on the *Molecular Characteristics of the Genus Chelidonura*. Species in the genus *Chelidonura* lack a radula but have a small internal shell. New species have recently been described from the Caribbean based on color patterns (external morphology). The presenter used DNA to check if there were species differences. She used 16S and H3 genes to evaluate the Caribbean species and concluded that they are all color variants of *Chelidonura berolina* and that the wide color variation is not enough to describe new species.

Doug Eernisse was the next speaker and he gave short statements on all the papers that he had written and co-authored in 2008, those that were in press for 2009, and those projects currently being worked. The papers were primarily on chitons but there were some on limpets and starfish. He talked briefly of chitons found off sea mounts. That concluded the morning session.

In the afternoon there was the traditional taking of the group photograph (Figure 1) followed by presentations by the last two speakers. Hans Bertsch discussed some recent books and then presented *Long-Term Population Studies Of Opisthobranchia in Bahía de Los Angeles*. He presented regression analyses of population density of nudibranch species from 1992 to 2001. Seven of nine species showed no change while two showed significant declines. The most significant decline was observed in the population density of *Elysia diomedea*.

The final presenter was Pat LaFollette. He spoke on the *Malacological Literature on the INTERNET*. He stated that the available literature is growing at an astounding rate and exceeds the ability of an individual's ability to keep up. Retrieval tools have not kept up and it is difficult to find what is available. The contents of great libraries are becoming available and there are hundreds of individuals that have websites on various aspects of malacological interests. He gave many examples of available sources, including internet archives, libraries and museums, societies and clubs,

and individuals both professional and amateur The next SCUM meeting will be held in January 2010 and

Wendy Enright Storms volunteered to host it at the City of San Diego, EMTS Laboratory.

Jules Hertz



Photo: Lindsey Groves

Front Row (L to R): Wendy Enright-Storms, Rosa Campay, Ángel Valdés, Hans Bertsch

Middle Row (L to R): Crystal Johnson, Carla Stout, Laney Whitlow, LouElla Saul, Christine Fernandez, Elysse Gatdula, Kathy Kalohi, Carole Hertz, Jim McLean, Yuliana Bedola

Back Row (L to R): Bill Huber, Kelvin Barwick, Lindsey Groves, Bob Stanton, Doug Eernisse, Pat LaFollette, Mike Vendrasco, Chuck Powell II, George Kennedy, Jules Hertz, Rick Nye, Bob Moore, Shawn Wiedrick

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

April 9, 2009

Number:4

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The publication date appears on the masthead above.
Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

THE ANNUAL AUCTION POTLUCK

(There will be no regular meeting this month)

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CLUB NEWS

The San Diego Shell Club Minutes March 19, 2009

Vice President Benjamin Pister welcomed everyone to the meeting and new members introduced themselves. The minutes of the February meeting were approved, as published in the *Festivus*. Treasurer Silvana Vollero said the Club is financially solvent. Benjamin discussed the upcoming Auction and passed the sign-up sheet for the potluck. The cookie sign-up for the meetings was passed around too. Librarian Marilyn Goldammer said there would be a sale of reprints and books at the meeting. Benjamin talked about the programs for May and June.

Kathy and Joc Kalohi began their program on their visit to New Zealand in February 2008. They went to Arapawa Island off the South Island, for diving and shelling. Kathy mentioned that it was hard to find rubbing alcohol for chitons so she used vodka instead, which worked very well. They stayed on a self-sufficient farm. There is an abalone farm on the property and they raise *Haliotis iris*. The shells are used for jewelry and the meat is sold to the Asian markets. The owner is starting a new business raising abalone pearls which are very valuable. The farm dog, Finn, became their good buddy.

The area was famous for whaling until the 1960s. There are strong currents in the channel and the water temperature was a comfortable 57 degrees. Kathy was excited to go shipwreck diving. She found some bottles covered with chitons. The ship was a Russian "love boat" that sank in 1986.

Kathy commented that they found many species that are similar to ours, including anemones, algae, urchins, sponges, and scallops. One day they went tramping (hiking) in the old forest looking for land snails. Unfortunately, they did not find any. Finally, Kathy invited everyone to take a look at their display of shells collected on the trip.

Silvana won the drawing and the meeting was adjourned for the usual delicious treats.

Silvana Vollero

Too Late for the 2009 Roster

BEDELL, HARRY, 23852 Pacific Coast Hwy. #178, Malibu, CA 90265, (310) 456-0012. E-mail: malibuone@aol.com

COA 2009 Convention Cruising the Suncoast - July 19-23

Staterooms: You can book your stateroom at our special convention rate of \$159.00 + 12% sales tax before June 22 by going to the Hilton web site: www.clearwaterbeachresort.com and enter the Group Convention ID Code: **SHELGS**; or in the USA, you can call 1-727-461-3222 or 1-800-753-3954. Overseas: call 1-727-461-3222. You **MUST** mention Conchologists of America to get this special rate. Parking is complimentary for one car per/stateroom for guests of the Hilton, otherwise the charge will be \$5/day to park at the Hilton on a space available basis. Staterooms include: high-speed internet access, in-room safe, mini-refrigerator, coffee maker, 27" premium cable TV, desk area, hair dryer, iron and ironing board and weekday delivery of *USA Today*.

Boarding Pass: Without your Boarding Pass (Registration) you will **not** be able to board the *Silver Alatus* or participate in many convention activities, including shore excursions. Get them from the December issue of *American Conchologist*, or by logging on to www.conchologistsofamerica.org. Please note: US citizens will **not** be required to carry passports. **Do not**, we repeat, **do not** wait until the last minute to submit your boarding documents.

Shore Excursions: For those of you arriving early, there is a choice of five interesting (field trips) to choose from on Saturday, July 18th:

Fossil Trip – 8 hrs. (35 persons max.)

Dive Trip – 8 hrs. (6 persons max.)

Weeki Wachee Springs – 8 hrs.

Florida Aquarium – 7 hrs.

Tarpon Springs/Sponge-O-Rama Cruise -- 8 hrs.

Plus three more shore excursions on Tuesday afternoon and evening:

StarLite Majesty Dinner Cruise – 4 hrs.

Dolphin Excursion – 1 ¾ hrs.

Shelling Trip – 6 hrs.

These trips will be filling up fast so get your reservations in quickly – once a trip is filled it will no longer be available.

Questions? Contact us at COA2009@aol.com

MALACOLOGICAL LITERATURE ON THE INTERNET

PATRICK LAFOLLETTE¹

Malacology Section, Natural History Museum of Los Angeles County
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E-mail: pat@lafollette.com

There is an explosion of malacological literature in digital format freely available to anyone via the internet. After increasing slowly for several years, the growth has accelerated at an astounding rate in recent months. The expansion exceeds any individual's ability to keep up, due in large part to the failure of indexing and retrieval tools to keep pace. It can be annoyingly difficult to find what is available. The "Internet Library" needs a librarian!

The contents of the great libraries are rapidly becoming available to everyone everywhere in the world. This democratization is obviously a boon to students in the third world. It is equally useful to any of us who do not live within easy commuting distance of a major academic library. Where is all this digital literature coming from? The sources are diverse. Major projects such as Google Books, the Internet Archive, and the Biodiversity Heritage Library project are digitizing the classic literature. Numerous smaller efforts by libraries and museums, online journals, societies and clubs, and an army of individuals, both professional and amateur, contribute both contemporary and older titles.

Google Books has been the elephant in the room, with an estimated two to six million books. Its motivation is commercial, a vehicle for "capturing eyeballs" for advertising and book marketing. Its declared objective is to scan "everything" in a consortium of academic and public libraries. Unfortunately, quality has been sacrificed in the pursuit of raw quantity. The text is usually legible, though pages are sometimes skipped. The quality of plates vary from barely adequate to useless. Indexing metadata is inadequate. Coverage is often spotty and availability of titles is unpredictable. Other resources are now making it largely irrelevant – the source of last resort.

Internet Archive is non-profit, receiving support from foundations and contributors. Its holdings of 1.2 million volumes have benefited from numerous sources, including the fruits of an abandoned Microsoft digitization project.

It also benefits from the ambitious Biodiversity Heritage Library project, which is vastly increasing available biological literature in digital format. The quality of their PDF (Portable Document Format) files is good, with some exceptions. Original photos of the book pages are generally available in JP2 format. Their indexing of metadata is uneven, so locating a specific volume of a journal or multi-volume work can be cumbersome and time consuming.

The Biodiversity Heritage Library is a new project of ten major institutional libraries. The British Museum (Natural History), Smithsonian Institution, American Museum of Natural History, Field Museum of Natural History, Harvard, and the Woods Hole Marine Biological Laboratory, among others, are collaborating to make their combined holdings available. Their efforts are now available on the Internet Archive and the project's own site, biodiversitylibrary.org. The quality of PDF files is identical to Internet Archive. Original page images are available and the indexing is excellent. They currently report 27,500 volumes online. In time, this resource will likely surpass the others as best for malacological research.

Libraries and Institutions are frequently making selected works available online. A few examples are:

- National Library of New Zealand: Transactions and Proceedings of the Royal Society of New Zealand for the years 1868-1961. Specific papers may be downloaded individually.
- Bibliotheque nationale de France Gallica project (Gallica.bnf.fr) offers a diverse selection of works. Unfortunately the quality of many documents is poor, the result of producing digital images from microfilm. Coan, Kabat & Petit, 2008, note many titles available from Gallica.

¹ Adapted from a presentation at the SCUM Meeting (Southern California United Malacologists) at California State Polytechnic University, Pomona, 24 January 2009.

- Smithsonian Institution/NMNH has many publications online but finding them can be challenging. These will presumably find their way into the Biodiversity Heritage Library. Their author index is useful.
- American Museum of Natural History: AMNH Novitates, Bulletin and Memoirs.
- Natural History Museum of Los Angeles County: Selected LACM Contributions in Sciences.

Online Journals are burgeoning. Some are available by subscription only, while others are free. Most major journals are now available online in digital format but require access through a subscribing institution, usually restricted to on-campus use.

There are now hundreds of free online journals, some of malacological interest. A good source of information on these is "Directory of Open Access Journals" (DOAJ.org). A few examples are –

- Acta Geologica Polonica
- Aquatic Invasions
- Comunicaciones de la Sociedad Malacologica del Uruguay
- Gayana – Universidad de Concepción, Chile
- Raffles Bulletin of Zoology, Singapore

Societies and Clubs Most malacological societies now have their meeting abstracts online. Many also have other works of interest to their members –

- American Malacological Society: Coan, Kabat & Petit, 2008. 2,400 years of Malacology
- Internet Hawaiian Shell News
- Società Italiana de Malacologia: Notiziario S.I.M.; Lavori del Gruppo Malacologico Livornese; etc.
- Houston Shell Club: Texas Conchologist (forthcoming)

Individuals Hundreds of people have websites with digital reprints of their own papers or papers reflecting their malacological interests. Here are a very few examples:

- Daniel Geiger – vetigastropoda.com
- Arie Janssen – Fossil Mollusca of Western Europe; Holoplanktonic Mollusca
- Steve Long – Opisthobranch Newsletter
- Stefano Palazzi – BioSophia, an archive of separates in many fields
- Mikhail Rogov – Jurassic of Russia – This site is spectacular for the vast number of PDF papers made available on this and related areas and subjects.

Examples of the sorts of literature now available over the Internet –

- Reeve and Sowerby's *Conchologia Iconica* – 20 volumes, color, [Set lacks volumes 4 and 13].

- Tryon and Pilsbry's *Manual of Conchology* – 35 volumes, including sets with colored and uncolored plates.
- *The Nautilus*, volumes 9-117
- *Annales de la Societe (Royale) Malacologique de Belgique*
- *Occasional Papers on Mollusks*
- *Annals and Magazine of Natural History*
- *Proceedings of the Zoological Society of London*
- *Journal, Proceedings, and Transactions of the Linnean Society of London*
- *Proceedings of the Royal Society of Victoria*
- *Transactions of the Royal Society of New Zealand*

Some taxonomic and bibliographic references of use to malacologists –

- Sherborn, *Index Animalium* (PDF in 33 parts), also available as an online database.
- Ruhoff, 1980. *Index of mollusks published 1850-1870*.
- Neave, 1939-1950. *Nomenclator Zoologicus*. PDF version not found, but there is an online database, with additions to 2004.
- Earlier nomenclators available in PDF include Agassiz, 1842; Marschall, 1872; Scudder, 1882; Waterhouse, 1904.
- British Museum (Natural History) *Catalogue of Books, 1903-1940* – 8 vol.
- British Museum (Natural History) *Catalogue of Serials, 1980* – 3 vol.
- *Zoonomen* – Alan Peterson – Website with major compilation on dates of publication available at zoonomen.net/cit/joura.htm - [jourz.htm](http://zoonomen.net/cit/jourz.htm)
- Coan, Kabat, Petit, 2009. *2,400 Years of Malacology*

Summarizing the Downside These works can sometimes be hard to find, even if you know they are available on the Internet. Search engine results are frequently not complete, reliable or repeatable. As an example, Ralph Arnold's *Paleontology... of San Pedro*, *Memoirs, California Academy of Sciences* vol. 3, 1903, could not be found on the internet by author, title or journal, but the reprint was there, as volume 31 of "Contributions to Biology" from the Hopkins Seaside Laboratory of the Leland Stanford Jr. University. (This was true when the SCUM presentation was drafted. Now "Memoirs of the California Academy of Sciences" vol. 2 to 6 are available at BiodiversityLibrary.org.)

Despite the phenomenal growth of malacological literature on the Internet, the odds are that any specific title is not (yet) available. Good humor and a high tolerance for frustration are desirable qualities when

seeking literature on the web. Serendipity plays an important role - one often finds an item of interest by fortuitous accident while searching for something else entirely.

Now you see it – now you don't

In addition to the above mentioned difficulties with search engines

- Documents may be removed from websites.
- Websites may break or be restructured, leaving portions inaccessible or difficult to find.
- Websites may move or just disappear.
- Web servers may be unreliable, especially in the third world; even major western sites suffer technical difficulties and overloading that may make documents unavailable for extended periods.
- Google Books often changes a document's status, making previously available books unavailable.

Moral of the Story

- Do not count on anything you find on the Internet being available the next time you look for it.

- If you think you may need a book or paper again, SAVE A COPY.

- External computer disk storage is incredibly cheap, pennies per gigabyte. Take advantage of it.

Start your own e-Library

- Keep the files you download organized so they are easier to find on your computer than on the Internet.
- Use the original file name (except for Google) and note where the file came from to avoid duplication.
- One easy way to do this is to make a separate folder for each document, labeled with the journal title or author, date, and perhaps a short title.

Acknowledgments

I would like to thank Robert Moore for his interest and discussions on these subjects and ideas regarding creating a website where sources of malacological literature on the web might be shared. I thank Carole Hertz for turning my rough and informal SCUM Power Point presentation into the first draft of this article.

**Program and Events for the
2009 Western Society of Malacologists Annual Meeting
California State University, Fullerton (CSUF)
June 23-27, 2009**

Meeting Schedule and events

June 23	Tuesday	Day - Workshop on micro-mollusks led by Daniel Geiger. Evening - Opening Reception (with snacks and beverages).
June 24	Wednesday	Talks and poster session.
June 25	Thursday	Morning - Workshop on bivalves led by Paul Valentich-Scott. Afternoon - Talks.
June 26	Friday	Morning - Talks including Molluscan Conservation Symposium led by Hans Bertsch. Late Afternoon / Early evening - Auction and reprint sale (with snacks and beverages). Early evening: Conferencia Magistral (Keynote Speech) by Hans Bertsch.
June 27	Saturday	Field trip to Santa Catalina island (all day).

Registration and abstracts are both due on April 30, 2009. *Exact meeting place on the CSUF campus to be determined. For more details and specific directions go to: www.diversiforma.com*

AN ADVENTURE AT PLAYA MATANCHÉN, NAYARIT, MÉXICO

CAROLE M. HERTZ¹

Associate, Department of Invertebrate Zoology, Santa Barbara Museum of Natural History
2559 Puesta del Sol Road, Santa Barbara, CA 93105-2936, USA

It was February 2001, on a visit to Kirstie Kaiser in Puerto Vallarta that Kirstie, Carol Skoglund, Jules and I decided to spend a few days in the town of San Blas, Nayarit, about a five hour drive north of Vallarta.

San Blas, founded in 1537, was one of the first shipping ports on the western shore of either North or South America. It was a regular stop for treasure ships to unload their cargos for the overland trip to Veracruz where the treasures were then shipped on to Spain. Today San Blas still has the ruins of some of the early buildings and is a fishing town known for its jungle river trips, banana plantations and many estuarial areas that make it a favorite of bird watchers.

After settling ourselves in the charming *Garza Blanca* hotel in San Blas with spacious, clean rooms and a lovely restaurant, our plan was to explore surrounding areas and look for shells when the tide was low.

On the 7th of February we headed for the large, open Bahía Matanchén which is adjacent to the south side of San Blas. At low tide, a wide, hard-sand beach is uncovered at the upper end of the bay. This beach runs for more than a mile and has a rocky outcropping at the south end – a perfect place for shell hunting. Carol Skoglund told us that in 1965, before the road was cut through the jungle, this beach was the only way for vehicles to get from one town to the next and at that time the high tide line had a heavy litter of shells which was missing in 2001.

We spent much of the -1.5 ft (-.46 m) low-tide time, walking the long sand flat at Matanchén. We found live specimens of *Tivela byronensis* (Gray, 1838) (Figure 1) and *T. argentina* (Sowerby, 1835) emerging from sand in the mid to low tide zone. Then the marvelous surprise was finding live specimens of *Pitar lupanaria* (Lesson, 1830) (Figure 2).

Kirstie had noticed that a Mexican man was also looking for shells, gathering bivalves and putting them in



Figure 1. *Tivela byronensis* (Gray, 1828). 40.5 mm height x 47.8 mm maximum diameter, popping in sand at low tide at Bahía Matanchén.

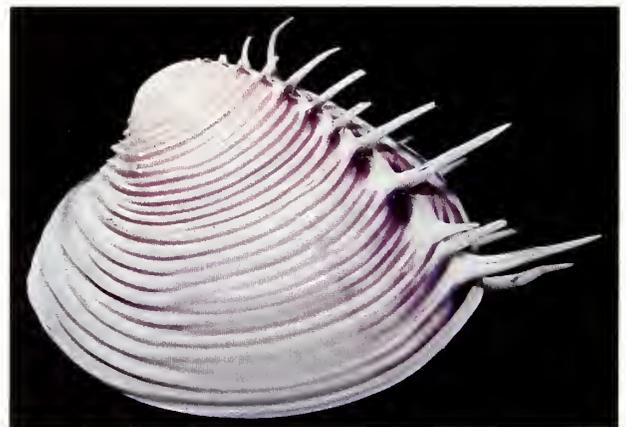


Figure 2. *Pitar lupanaria* (Lesson, 1830). 39.5 mm height x 40.0 mm maximum diameter (without spines) popping in sand at low tide at Bahía Matanchén

¹Mailing address: 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

a large sack, no doubt for food. She approached him and asked him in Spanish if, at the end of the collecting time, he would be willing to exchange his *Pitar lupanaria* for the *Tivela* species that we found. He was more than willing and we went happily on our way collecting the *P. lupanaria* and the other *Tivela* species that we could find, knowing that our largesse of *P. lupanaria* would increase when we met again with our new collecting

friend.

After an hour or so on the flat and among the rocky outcroppings, we searched for our friend, looking forward to the exchange of species. We finally found him and he was still agreeable with the swap of shells. Imagine our horror when he dumped out the shells of *P. lupanaria* and we found that he had chopped off all their beautiful, sharp spines!!

BOOK REVIEW: *OPISTOBRANQUIOS DE BRASIL*

HANS BERTSCH* reviewer

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Opistobranquios de Brasil: Descripción y distribución de opistobranquios del litoral de Brasil y del Archipiélago Fernando de Noronha

By: García García, Francisco J., Marta Domínguez Álvarez & Jesús S. Troncoso. 2008.

Feito, S.L., Vigo, Spain. 215 pp. ISBN: 978-84-614-5995-3

Price: (40 Euros, approximately \$52 US) on the Internet

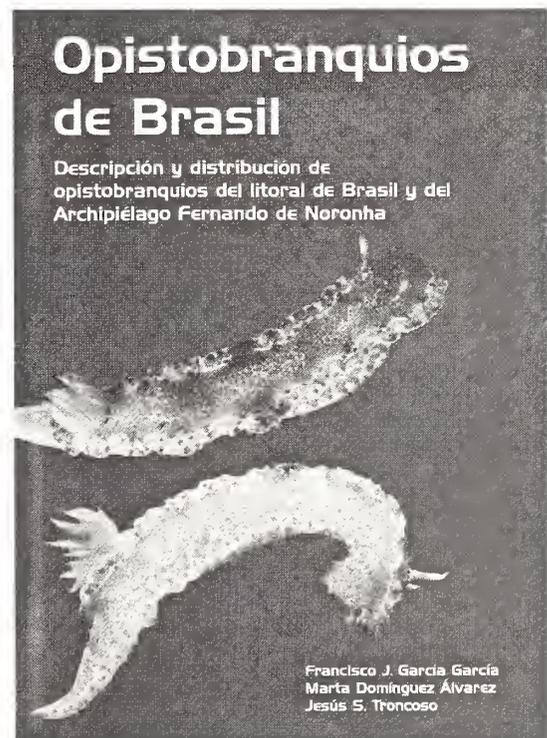
from Spain: mcodax@martincodax.e.telefonica.net

or from Brazil: (R\$112, approximately \$48 US)

www.useb.com.br

Disclosure: Before beginning this review, I must state that I was involved in the writing and editing of this book (acknowledged by the authors on p. 15) and wrote one of the Introductions (pp. 3-5). Several of my photographs also appear in it, including four SEMs of the radulae of *Discodoris evelinae* and *Bornella calcarata*. I will maintain an objective description and review of its contents, refraining from subjective evaluations.

This work by García, Domínguez & Troncoso is written in Spanish. It is significantly different in scope, size and collaborative authorship from the recently published *Indo-Pacific Nudibranchs and Sea Slugs* by Gosliner, Behrens & Valdés (2008). It does not pretend to be comprehensive. Only 65 of 205 species reported



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from Brazil are in the Species Description and almost all photographs were taken by the three authors.

It consists of three major sections: Introduction, Species Descriptions and Biogeography of Brazilian Opisthobranchs. The 41-page Introduction begins with an overview of the history of Brazilian opisthobranch research, emphasizing the contributions of Ernst Gustav Gotthelf Marcus (1893-1968) and Eveline du Bois Reymond Marcus (1901-1990). Photos of the authors working in the Marcus' Collection at the Museo de Zoología de la Universidad de São Paulo and of several type specimens of species named by them augment a biography and bibliography of this distinguished husband-and-wife team who fled the German Nazi regime to Brazil in 1936, where Ernst Marcus accepted a professorship in the Faculty of Philosophy at the Universidad de São Paulo.

An overview of the Brazilian coastline continues the Introduction, with descriptions of the four collecting sites from which the authors obtained the specimens illustrated in Species Description. These sites are in four of the six Brazilian marine faunal regions: in the states of São Paulo (Ensenada del Sur, SBB, 23° S-28.4°S), Rio de Janeiro (Región de Abrolhos-Campos, ACR, 15° S-23° S), Bahia (Plataforma Este de Brasil, EBS, 8° S-15° S) and Pernambuco (Plataforma Noreste de Brasil, NBS, 2° S-8° S). The northernmost location is the World Heritage Site of Archipiélago Fernando de Noronha, lying 345 km from the NE coast of Brazil. It had been situated on the earliest routes between Europe and South America, being one of the first areas discovered in the New World. It was described by Amerigo Vespucci in 1503.

Ending this section is an introduction to methods of research (collection, observation and dissection) which is useful to beginning students, and a brief classification

of the orders and suborders of opisthobranchs; they hint that the *s.l.* groups Cephalaspeidea, Notaspidea and Arminina are polyphyletic.

Each species description (pp. 59-194) ranges from 1 to 3 pages, and includes the binomial, with author and date; synonyms, size, coloration and external anatomy, internal anatomy (= jaw elements and radula), and distribution (with mapped Brazilian occurrence records). Almost all the animal pictures have been tightly cropped and placed on a black (rarely cream-colored) background. Of their 65 described species, the radula is illustrated with line drawings (25 spp.) or SEMs (21 spp.), and the jaw elements for, respectively, 10 and 15 species. Please note that the SEM of *Discodoris evelinae* does not show marginal teeth; it illustrates the newly forming radular teeth from the most posterior portion of the radular ribbon (Bertsch, 1976).

The authors emphasize that biogeographic analyses are based on faunistic inventories, using good taxonomy. They list 205 reported species of Brazilian opisthobranchs *s.l.* (excluding the pelagic Thecosomata and Gymnosomata), of which some 170 had been first reported by Marcus & Marcus. They use the multivariate Bray-Curtis analysis to describe similarities between the six regions of the Brazilian faunal province, concluding that "the opisthobranch fauna of Brazil is still far from completely known" (p. 203, HB translation).

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1976. Intraspecific and ontogenetic radular variation in opisthobranch systematics (Mollusca: Gastropoda). *Systematic Zoology* 25 (2): 117-122.
- GOSLINER, TERRENCE M., DAVID W. BEHRENS & ÁNGEL VALDÉS
2008. Indo-Pacific Nudibranchs and Sea Slugs. A field guide to the World's most diverse fauna. *Sea Challengers Natural History Books and California Academy of Sciences*. 426 pp.

IN MEMORIAM PAT SAGE

It is with sadness that we report the passing of Pat Sage on March 6th of this year after a long illness. Pat and her husband John were active members of the Club from 1980 to 1987. Pat was Club president in 1983. She and John both loved México and often joined Club groups in visiting San Felipe.

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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLI

May 14, 2009

Number:5

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Emily H. Vokes	<i>Emerita, Tulane University, New Orleans</i>



PROGRAM

ANTIQUÉ PRINTS, VINTAGE PRINTS AND LITHOGRAPHS ON MARINE LIFE, SHELLS, FISH AND BIRDS

Ben Wollman, of Wollman's Classic Prints, featuring steel and copper engravings and chromo and stone lithographs, will give a presentation on prints, the different kinds and how they differ from reproductions.

After, members will view selections of his prints which will be laid out on tables. There will be no sales at the meeting; those interested will take Ben Wollman's card and arrangements for purchases can be made later.

Meeting date: May 21, 2009

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CLUB NEWS

The Annual San Diego Shell Club Auction-Potluck, 2009

The shell club auction was held Saturday evening the 4th of April. Many people came early to set things up prior to the viewing period. Lots of great food and beautiful weather as many of us ate outside. After dinner the auction got underway and I would estimate at least 45 people were present. Our auctioneer, Carole Hertz held up for the entire evening and did a great job.

The auction is 100% fun. Even if you missed out on something, it was nice to see the smiles of those who out-bid you. I had my eyes on some old Hawaiian land snails, but it was not meant to be. The books in the auction were outstanding as were items on the silent auction table. Also as always, the dollar shell table during the break drew a lot of attention. Like everyone, Ann and I walked away with a number of treasures and look forward to the next auction, which is only a year away. I enjoyed curating the new material over the next couple of evenings and thought about the people whose names I read on the data tags.

The auction is a critical fund raising activity, and we want to thank all those who helped set up and then clean up afterwards, those who donated shells and books, and those who attended. This event funds the monthly publication of *The Festivus*. Lastly, thanks to Wes Farmer, for making arrangements for the auction to be held again at his location.

Paul Tuskes

Donors to the Club's 2009 Auction-Potluck

Many people contributed to make the auction the fun event and financial success that it was. The board members, as always, worked heroically to put this all together. John LaGrange prepared the refreshments – Dave's Punch; soft drinks and bottled water were all set up by Larry Catarius and wine was brought by Jules Hertz. Bill Schneider's lights for the several auction events were set up by Jim Goldammer who also managed the distribution of all the silent auction materials near the end of the auction. And a special "thank you" to Christian and Daniel Petroski for delivering the auction purchases to the winning bidders.

Many members stayed and helped with the cleanup, for which we owe them a big thank you. And as always, Wes Farmer is our hero for again hosting this favorite event.

The following people donated shells and shell related items to the auction for which we express our appreciation. Tom & Elysa Agnew, Twila Critchlow Estate, Billee Gerrodette Estate, Carole & Jules Hertz, John Jackson, Scott Jordan, Rosemary Pierce, Don & Jeanne Pisor, Charles Powell, Carol Skoglund and Dee Vawter.

We thank everyone who contributed with their donations and help and also to all of those who attended, and while having a good time, helped to fill the coffers of the Club.

the auctioneer

ROSEMARY PIERCE 1921-2009

Rosemary was a longtime member of The San Diego Shell Club. She was a feisty lady who loved her shells and greatly enjoyed mingling with other collectors and friends. Even though she lived some distance from our meetings, she attended most of the Club's special events. As her devoted daughter Kathy noted, "she was a unique and loving person who enjoyed an eventful, adventurous life." We will all miss her.

SORTING OUT THE GENERIC PLACEMENT OF THE THREE PANAMIC SPECIES ASSIGNED TO *EUMETULA* THIELE, 1912

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Introduction

Last November I had the opportunity to collect a number of micromollusks in Masachapa, west Nicaragua. From the sediment gathered at the shoreline I extracted an interesting specimen that, upon closer study, I considered to be a cognate species of the well-known western Atlantic *Retilaskeya bicolor* (C. B. Adams, 1845).

The puzzle began when I tried to identify the Masachapa shell at the specific level, and realized that there were no species assigned to *Retilaskeya* in the Panamic Province; moreover, my specimen from Masachapa appeared in Keen (1971: 415, fig. 554) as *Eumetula intercalaris* (Carpenter, 1845). Keen, presumably following Bartsch (1911), also listed two congeners: *E. bimarginata* (C. B. Adams, 1852), from Panamá, and *E. eucosmia* (Bartsch, 1911), from the Galápagos Islands.

Discussion

Thiele described the genus *Eumetula* as follows: "Shell small, turriculate, colorless: initial whorl moderately large, roundish, smooth or densely ribbed; the subsequent whorls with smooth or somewhat tuberculate ribs; columellar process weakly twisted; aperture below with distinct indentation" (In Bieler & Mikkelsen, 1992:218). Thiele designated the Magellanic and Antarctic species *Eumetula dilecta* Thiele, 1912, as the type species.

Eumetula dilecta was figured by Wenz (1940: 779) (see Figures 1a, 1b). It was also pictured and described in detail by Castellanos & Landoni (1988: 15, pl. 1, fig. 2) (see Figure 2). There are two salient points in the description made by Castellanos and Landoni: that *E. dilecta* has a protoconch of two whorls ("2 vueltas"), and that the siphonal canal is poorly developed, creating a rounded peristome ("obviamente poco desarrollado el canal sifonal, dando un peristoma de forma redondeada").

Eumetula was originally placed by Thiele in the

family Cerithiopsidae; however, throughout the years it has suffered a bumpy ride. It has been placed in the family Triforidae by Marshall (1980), in the family Eumetulidae, subfamily Eumetulinae by Golikov & Satarobogatov (1975), again in the subfamily Eumetulinae by Ponder & Warén (1988), and in the family Newtoniellidae by Korobkov (1955), subfamily Eumetulinae (Bouchet & Rocroi (2005: 254).

Bartsch (1911) had originally placed *Eumetula bimarginata*, *E. eucosmia*, and *E. intercalaris* in the genus *Eumeta* Mörch, 1868 (type species *Eumeta arctica* Mörch, 1857). However, the generic name *Eumeta* had already been erected by Walker in 1855, so it was replaced by *Laskeya* Iredale, 1918.

In his treatment of *Eumetula*, Thiele (in Bieler & Mikkelsen, 1992: 325) considered *Laskeya* a subgenus of *Eumetula*, and separated the two subgenera on radular differences only, as the type species of *Laskeya* had the same basic conchological characters as *Eumetula*, including a lecithotrophic protoconch.

Dall (1927: 97) considered *Laskeya* to be a subgenus of *Cerithiopsis*, stating that it is "characterized conchologically by its short blunt nucleus as compared to the styliform nucleus of typical *Cerithiopsis* and its strong axial ribbing." Marshall (1978) treated *Laskeya* as a full genus, conceding that he had not seen the type species, *Laskeya arctica*, but basing his conclusion partially on the fact that Watson (1885) stated that the protoconch of *L. arctica* is "cylindrical, and consists of three convex short, broadish nearly equal whorls," and also in Jeffrey's statement that "the point [of *L. arctica*] is blunt and obliquely twisted inwards." However, recent workers seem to agree that *Laskeya* is a junior synonym of *Eumetula*.

When Marshall erected the genus *Retilaskeya* (1978: 75), he defined it as having a "planktotrophic larval type, of 3½-4½ regularly expanding convex whorls. First 1½ (embryonic) whorls finely granulated throughout"; the anterior canal is "poorly developed, gently inclined away from aperture, wide open, widely

notched, not produce.” The type of *Retilaskeya*, *R. zelandica* (Figure 3) is described by Marshall as having a pale yellowish to golden brown protoconch, and a teleoconch that is “either uniformly translucent pale yellowish white to pale yellowish brown, or with variable spiral bands of pale to dark reddish or yellowish brown. Banded specimens often with base a similar shade to bands.” The genus *Retilaskeya* has consistently been placed in Cerithiopsidae (e.g., Rosenberg, 2005).

The shell structure and coloring of the western Atlantic *Retilaskeya bicolor* (Figures 6-7) and those of the Panamic *Eumetula intercalaris* (Figures 8-9) are remarkably similar. The holotype of *E. intercalaris* (USNM 15432, Figure 8) is rather worn, decollate, and faded. It was mistakenly labeled in Bartsch (1911: 565) as USNM 15342 (Ellen Strong, pers. comm.). Bartsch describes the specimen as “wax yellow, with the posterior line of tubercles on each whorl light brown”; it is also “decidedly channeled anteriorly.” The fresh specimen from Masachapa shows a golden-brown protoconch of approximately 4 whorls (Figure 9b), and a teleoconch with dark-gray early whorls; later whorls yellowish-orange, with the posterior line of tubercles grayish-orange (Figure 9a).

Eumetula bimarginata is described in Turner (1956) as “wax color, dark brown on the upper whorls”, with a siphonal canal “rather short, recurved” (p. 35). An image of the lectotype is included in Turner (1956, pl. 9, fig. 2, p. 111) and is copied here (Figure 10). There is no description of the protoconch in Turner; however, when Bartsch (1911: 566) published his paper on the west American *Eumeta*, he described the nucleus of *Eumetula bimarginata* as having 4½ whorls, “the first half turn smooth; the remainder well rounded, separated by a constricted suture, marked by curved, quite regular, slender, distantly spaced, axial riblets”; the aperture is “very strongly channeled anteriorly”, and the columella is “very stout, light brown, curved and twisted, provided with a moderately strong fold at its anterior border.” The specimen described and sketched by Bartsch (1911) (USNM 195212, p. 566) is pictured here (Figure 11); however, when the specimen was located for photography it was discovered that it was badly affected by Byne’s disease, and some of the characters described by Bartsch are not as clear (Ellen Strong, pers. comm.).

Retilaskeya bicolor has been placed in *Retilaskeya* because it shares many conchological similarities with *R. zelandica*, particularly a granulated protoconch (Rolán & Espinosa, 1992: 40) of regularly expanding convex whorls (Figure 6b) and a well-colored shell with

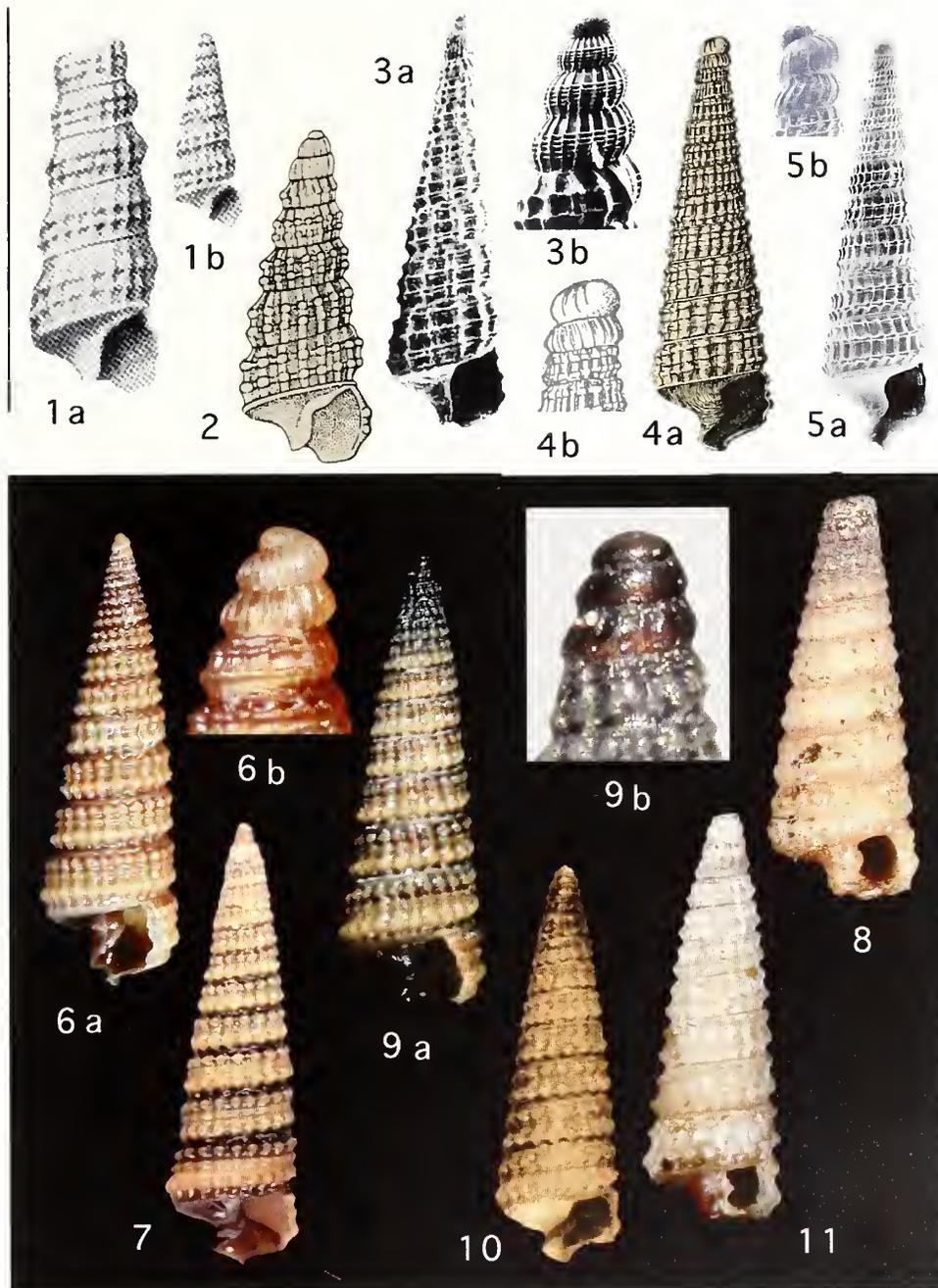
a brown base. Moreover, the radula of *R. bicolor* has shown close similarities with that of *R. zelandica* (Rolán & Espinosa, 1992: 43, figs. 5-6).

The similarities between the western Atlantic *Retilaskeya bicolor* and the Panamic “*Eumetula*” *bimarginata* and “*E.*” *intercalaris* are remarkable, both in shell structure and coloring. Conversely, the genus *Eumetula* contains a group of species with white shells, lecithotrophic protoconchs and very poorly developed anterior canal (see Figures 1, 2). Although the anterior canal of *Retilaskeya zelandica* is also poorly developed, it is more defined than that of *Eumetula dilecta* (see Figure 3). Moreover, in their key to the genera of Cerithioidea, Bouchet & Warén (1993: 587) distinguish *Eumetula* from other Cerithioidea genera by having the periphery of the shell with one broad, strong cord, and the base with one very thin cord, the latter character lacking in the Panamic species assigned to *Eumetula*.

“*Eumetula eucosmia* (Bartsch, 1911: 567-568) is conchologically different from the two other Panamic taxa assigned to *Eumetula*. The shell has a lecithotrophic protoconch of two and one half whorls, is “strongly channeled anteriorly” and has a white shell. Although it has the same lecithotrophic protoconch of *Eumetula*, the nuclear whorls are larger and project “beyond the outline of the first post-nuclear turn.” Moreover, the distinctly drawn out siphonal canal of “*Eumetula eucosmia* is unlike that of *Eumetula*, which is characterized by a poorly developed siphonal canal.

The conchological characters of “*Eumetula eucosmia* follow those of the genus *Cerithiella* Verrill, 1882, type species *Cerithiella metula* (Lovén, 1846) (Figures 5a, 5b). The type species is characterized by an inflated, lecithotrophic protoconch that may expand beyond the outline of the first teleoconch whorl (Figure 5b), has a strongly channeled anterior canal (Figure 5a), and is white. The genus *Cerithiella* was originally placed in Cerithiopsidae but recent authors have placed it, together with *Eumetula*, in the family Newtonellidae Korobkov, 1955 (Bouchet & Warén, 2005: 254). Rosenberg (2005) places both *Eumetula* and *Cerithiella* in Cerithiopsidae. The suprageneric placement of these genera is beyond the scope of this work.

The three Panamic taxa treated in this paper are very rare in collections. I requested specimens from curators of the larger west coast malacological museums, as well as the owners of the more important collections of Panamic shells, and all in vain. This is presumably the reason why the generic placement of the three taxa treated above have remained unquestioned for nearly a century.



Figures 1-11. (1) *Eumetula dilecta* Thiele, 1912; after Wenz (1940:779, fig. 2257), Gauss Station, Antarctica. (2) *Eumetula dilecta* Thiele, 1912; after Castellanos & Landoni (1988:31, pl. 1, fig. 2), 5 mm. (3) *Retilaskeya zelandica* Marshall, 1978, holotype; after Marshall (1978: 106, fig. 10, H, J), 4.90 mm. (4) "*Eumetula*" *eucosmia* (Bartsch, 1911), holotype; after Bartsch (1911:568, fig. 3), U.S. Fisheries station 2808 in 1160 m, 8.3 mm. (5a) *Cerithiella metula* (Lovén, 1846); after Bouchet & Warén (1993: 591, fig. 1299), DISCOVER station 97543, 7.6 mm. (5b) *Cerithiella metula* (Lovén, 1846); after Bouchet & Warén (1993: 596, fig. 1313), off Bergen 60°07'N, 04°54'E, in 240-250 m. (6) *Retilaskeya bicolor* (C. B. Adams, 1845), Palm Beach Inlet, Palm Beach Co., Florida, 8.7 mm. Images by Marlo Krisberg (M. Krisberg coll.). (7) *Retilaskeya bicolor* (C. B. Adams, 1845), Bocas del Toro, NW Panam . 9°22.027'N, 82°14.336'W, EFG 25542, 8.7 mm. (8) "*Eumetula*" *intercalaris* (Carpenter, 1845), holotype, USNM 15432, Guacomayo [sic. (Guacamayo)], Mexico, 5.7 mm. Image by Ellen Strong, USNM (9) "*Eumetula*" *intercalaris* (Carpenter, 1845), Masachapa, W. Nicaragua, EFG 28760, 6 mm. (10) "*Eumetula*" *bimarginata* (C. B. Adams, 1845), holotype, "Panama"; after Turner (1956: 111, fig. 2), 4.4 mm. (11) "*Eumetula*" *bimarginata* (C. B. Adams, 1845), U. S. Fisheries station 2799, 177 m, USNM 195212, 4.3 mm. Image by Ellen Strong, USNM.

Conclusions

It is my opinion that "*Eumetula*" *bimarginata* and "*E.*" *intercalaris* are congeneric with *Retilaskeya bicolor*. However, the peculiar twist of the anterior canal of the three species is somewhat troublesome, as *R. zelandica* lacks such a twist. Perhaps when live specimens of the two Panamic species are collected, their radula may show that they deserve a taxon of their own. On the other hand, "*Eumetula*" *eucosmia* does seem to have a more secure placement in *Cerithiella*.

Acknowledgments

My thanks to Ellen Strong, Curator of mollusks, National Museum of Natural History, for locating and photographing specimens presented in this study, to Marlo Krisberg, Merritt Island, Florida, for allowing me to use his images of *Retilaskeya bicolor*, and to Harry G. Lee, Jacksonville, Florida, Richard E. Petit, North Myrtle Beach, South Carolina, Antonio Monteiro, Lisbon, Portugal, and José Leal, Director, Bailey-Matthews Shell Museum, Sanibel, Florida, for providing me with literature I requested. This study could not have been completed without their support. I also would like to thank the anonymous reviewers for correcting errors and making suggestions that improved the readability of this paper.

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THE ARK CLAM *BARBATIA REEVEANA* FROM MISSION BAY

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Large Panamic Arcidae bivalves have been found intermittently in Southern California. While collecting at Rocky Point on Fiesta Island in Mission Bay, San Diego, I found a clam that appeared unique. The strong radial sculpturing was diagnostic of Arcidae and a few minutes spent with the *Bivalve Sea Shells of Western North America* confirmed the identity as *Barbatia reeveana* d'Orbigny, 1848.

The clam was attached to the underside of a moderate-sized rock at approximately +1 foot above mean low tide. When attempting to remove the clam, I was surprised with how strongly the byssal threads held it to the rock. The clam was maintained alive for

approximately a week so that others could examine the specimen. Within the first 24 hours new byssal threads attached the clam to the side of the container.

The clam measured 81 mm in length, 45 mm in height, and 26 mm in thickness. The right valve (Figure 1a) has a pronounced byssal gap, while the left valve (Figure 1b) has only a small notch opposite the byssal gap of the right valve. The figures document the distribution of the periostracum.

This is the third species of large Arcidae found in Mission Bay. The other two species are, *Anadara tuberculosa* (Sowerby, 1833) reported by Hertz & Hertz, 1992, and *Anadara multicostata* (Sowerby, 1833) reported by the author in 2008.

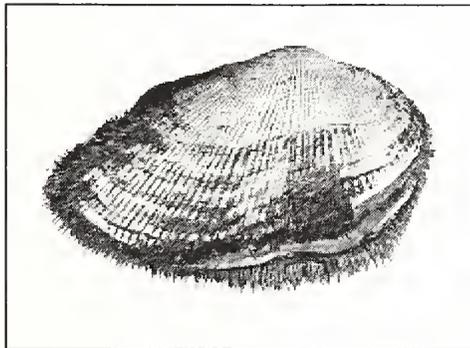


Figure 1a. Right valve showing byssal gap.

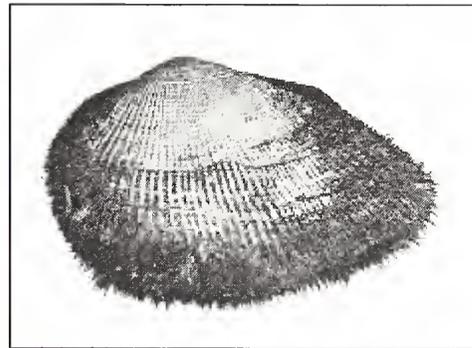


Figure 1b. Left valve groove and slight notch on lower left valve opposite byssal gap.

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THE FESTIVUS

A publication of the San Diego Shell Club

Volume XLI

Special Issue

June 11, 2009

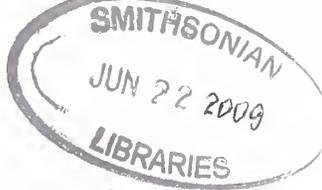


Chitons (Mollusca: Polyplacophora) Known from Benthic Monitoring Programs in the Southern California Bight

Timothy D. Stebbins and Douglas J. Eernisse

COVER PHOTO

Live specimen of *Lepidozona* sp. A occurring on a piece of metal debris collected off San Diego, southern California at a depth of 90 m.
Photo provided courtesy of R. Rowe.



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

June 11, 2009

Number:6

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 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$15.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

HOW AND WHY THE EARLIEST MOLLUSKS BUILT SHELLS

Michael Vendrasco of California State University, Fullerton, will give a presentation on how fossils of the most ancient mollusks show clear traces of shell micro-

structure, the crystal arrangements of the shell, and reveal information about how the shell in mollusks originated and evolved.

Meeting date: June 18, 2009

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting May 21, 2009

The meeting was called to order by President Carole Hertz at 7:34 pm with 15 members present. The minutes from the previous meeting were approved as published in *The Festivus* and the treasurer's report was given by Silvana Vollero.

Paul Tuskes encouraged participation in the Mission Bay Survey and reported on some new finds during the past month. The 2009 tides and locations were published in the January 2009 issue of *The Festivus* and are also on the Club's home page.

Our speaker for the evening was Benjamin Wollman, of Wollman's Classic Prints. Ben gave a fascinating discussion regarding the history of the print process, from wood carvings, to copper, stone, and steel. Wood blocks for printing were documented from the 1st Century AD in China. The hand printing process caught on in Europe much later and reached a peak in quality in the late 1800s.

The prints he receives and sells are from old publications that are no longer complete with remaining text in poor condition and are called breakers. Most of his prints are 100-200 years old. These early hand colored prints were not always accurate to form or color

but represented the concept and style of the time. Ben and his son Mark displayed dozens of shell and fish prints among others.

The meeting was adjourned early at 8:12 pm and people enjoyed the snacks while viewing the prints and discussing the printing processes.

The shell drawing was won by Evelyn Smith and the refreshments were provided by Evelyn Smith and Carole and Jules Hertz.

Paul Tuskes

Too Late for the Roster

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The Club's Mission Bay Survey Project

There is only one minus tide this month on June 27th at 7:42 a.m. It's a -0.3 ft and though this isn't fantastic, it can be fun, and hopefully productive, to meet at Fiesta Island for this tide. For further information, contact Paul Tuskes [858-274-5829].

IN MEMORIAM

Joseph "José" Johnston 1933-2009

It is with regret that we report the passing of Joseph "José" Johnston in April after suffering from a debilitating illness. He and his wife Kirstie Kaiser shared interests in scuba diving, sports and travel and José was very supportive of her work with mollusks. He is survived by Kirstie and his four children, 3 grandchildren and 2 great-grandchildren from a previous marriage.

CHITONS (MOLLUSCA: POLYPLACOPHORA) KNOWN FROM BENTHIC MONITORING PROGRAMS IN THE SOUTHERN CALIFORNIA BIGHT

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Abstract: About 36 species of chitons possibly occur at depths greater than 30 m along the continental shelf and slope of the Southern California Bight (SCB), although little is known about their distribution or ecology. Nineteen species are reported here based on chitons collected as part of long-term, local benthic monitoring programs or less frequent region-wide surveys of the entire SCB, and these show little overlap with species that occur at depths typically encountered by scuba divers. Most chitons were collected between 30-305 m depths, although records are included for a few from slightly shallower waters. Of the two extant chiton lineages, Lepidopleurida is represented by Leptochitonidae (2 genera, 3 species), while Chitonida is represented by Ischnochitonidae (2 genera, 6-9 species) and Mopaliidae (4 genera, 7 species). The lepidopleurids *Leptochiton rugatus* and *Hanleyella oldroydi* are two of the most common chitons, accounting for ~35% of all SCB specimens, while a second recognized species of *Leptochiton*, *L. nexus*, is also reported. *Lepidozona* (Chitonida: Chitonina: Ischnochitonidae) is the most diverse genus in this study, represented by *L. golischi*, *L. mertensii*, *L. radians*, *L. retiporosa*, *L. scrobiculata*, and three provisional species (*Lepidozona* spp. A-C). Of these, *L. retiporosa* and *L. scrobiculata* are most common, together comprising ~29% of the chitons sampled. *Callistochiton* (Ischnochitonidae) is represented by *C. palmulatus*. Mopaliidae (Chitonida: Acanthochitonina) is represented by *Dendrochiton gothicus*, *D. thamnoporos*, *Mopalia imporcata*, *M. lowei*, *M. phorminx*, *Placiphorella mirabilis*, and *Tonicella venusta*. Details are presented of the distribution, abundance, size, and co-occurrence of the observed chiton species, and a key is provided to those species expected to live within the studied depths of the SCB. Additionally, several species not collected during this study but considered likely to occur or as dubious records are discussed.

Introduction

Chitons (Mollusca: Polyplacophora) are a diverse and ancient group of marine mollusks, which include more than 940 living (Schwabe, 2005; D. J. Eernisse, unpublished compilation) and about 430 fossil (Puchalsky et al., 2008) recognized species worldwide. Although chitons occur from the intertidal to deep ocean trenches, most faunal and ecological studies have focused on relatively shallow water species. For example, the chitons living in intertidal to shallow subtidal habitats along the ecologically diverse western coast of North America (West Coast) are fairly well known, having been covered in a number of regional or site specific natural history guides, taxonomic keys, or other useful sources (e.g., Burghardt & Burghardt,

1969; Brusca et al., 1971; Smith, 1975; Allen, 1976; Brusca & Brusca, 1978; McLean, 1978; Haderlie & Abbott, 1980; Putman, 1980; Kozloff, 1983, 1996; O'Clair & O'Clair, 1998; Sliker, 2000; Lamb & Hanby, 2005; Eernisse et al., 2007). In contrast, with the exception of the preliminary study by Eernisse (1998), no studies have specifically addressed the chiton fauna occurring at depths > 30 m of this region. This cutoff depth is visited only rarely by scuba divers and few of the species seen by divers or in the intertidal occur below 30 m.

More than 30 species of chitons representing 15 genera and six families are likely to occur in waters deeper than 30 m along the continental shelf and slope

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of the Southern California Bight (SCB), which ranges from Point Conception, California, USA to Cabo Colonet, Baja California, México (see Table 1). Except for general geographic and bathymetric range information listed in monographs and other taxonomic works (e.g., Ferreira, 1978, 1979a, 1979b, 1982, 1983; Kaas & Van Belle, 1985a, 1985b 1987, 1990, 1994; Watters, 1990; Clark, 1994, 1999), little information is available concerning the presence of many species in these relatively deep southern California waters. Much of the shelf and slope benthos of the region is composed of soft sediments, which are the focus of several large benthic monitoring programs associated with major municipal wastewater outfalls (see City of Los Angeles, 2007, 2008; Orange County Sanitation District, 2007; City of San Diego, 2008a, 2008b; Los Angeles County Sanitation Districts, 2008). Although soft sediments are typically considered unsuitable habitat for chitons, the presence of various types of hard substrates scattered across the sea floor provides refuges for these animals and also exposes them to incidental capture by regular benthic or epibenthic sampling activities (e.g., Mullineaux, 1987; Eernisse, 1998). In southern California, these chiton microhabitats often include small rocks, rocky outcroppings or reefs, mollusk shells and shell fragments, as well as man-made debris such as bottles, cans, and larger pieces of glass, metal, plastic or even rubber (TDS, personal observation). This study summarizes the SCB benthic chiton fauna collected by the above monitoring programs over the past two decades or more.

Methods

Most of the chitons examined in this study were collected as part of the long-term ocean monitoring programs conducted by the City of San Diego, City of Los Angeles, Los Angeles County Sanitation Districts, and Orange County Sanitation District. Additional specimens were collected by these or other agencies during several large-scale regional monitoring projects that spanned the entire SCB. These bight-wide surveys included the 1994 Southern California Bight Pilot Project (SCBPP) and subsequent Bight'98, Bight'03 and Bight'08 regional monitoring efforts in 1998, 2003 and 2008, respectively (e.g., Bergen et al., 1998, 2001; SCBPP, 1998; Ranasinghe et al., 2003, 2007). Samples containing chitons were typically collected using

standard benthic sampling (e.g., Van Veen grabs) or trawling (e.g., otter trawl) gear and procedures. It is worth noting that this sampling has not targeted rocky areas, e.g., using biological (rock) dredge gear, and such future sampling could turn up additional chiton species.

All chitons collected were examined and identified using dissecting and compound microscopes. Body lengths were measured to the nearest 0.1 mm from the anterior-most margin of the girdle in front of valve I (head valve) to the posterior-most girdle margin behind valve VIII (tail valve) with the chitons flattened as much as possible. Lengths for excessively curled or damaged specimens were estimated.

Higher-level chiton systematics and phylogeny have been in a state of flux and the focus of subsequent research for a number of years (e.g., Smith, 1960; Kaas & Van Belle, 1980, 1985a, 1985b, 1987, 1990, 1994, 1998; Van Belle, 1983, 1985, 1999; Eernisse, 1984; Sirenko, 1993, 1997, 2006; Buckland-Nicks, 1995, 2008; Kaas et al., 1998; Okuso et al., 2003). The classification expressed in Table 1 follows Eernisse et al. (2007), which is supported by recent molecular studies by D. J. Eernisse (unpublished; see also Eernisse, 2004a, 2004b, 2006, 2007, 2008a, 2008b; Kelly & Eernisse, 2008; Vendrasco et al., 2008). This arrangement is similar to the recent system proposed by Sirenko (2006) but differs in its reassignment of *Dendrochiton* and *Tonicella* to Mopaliidae Dall, 1889, and not Tonicellidae Simroth, 1894, as in Sirenko's classification. Starobogatov & Sirenko (1975) derived Tonicellidae from Simroth's (1894: 321) "Tribus" (= tribe) Tonicelloidea without any proposed change in composition. Simroth (1894) clearly intended this taxon to correspond to one of three "Ischnochitoninae" lineages depicted in Pilsbry's earlier proposed phylogeny (reprinted in Simroth, 1894: 326). Tonicelloidea as envisioned by Pilsbry and Simroth grouped four disparate genera (including *Tonicella*) whose least inclusive grouping would presently correspond with Chitonida. In contrast, Sirenko's (2006) composition of Tonicellidae is similar to Lepidochitonidae Iredale, 1914, of other authors (e.g., Ferreira, 1982, or as subfamily within Ischnochitonidae in Kaas & Van Belle, 1985b). We use Lepidochitonidae here instead of Tonicellidae because Lepidochitonidae *sensu* Eernisse et al., 2007, is exclusive of *Tonicella*, which instead is considered part of Mopaliidae (see

Table 1. Systematics and bathymetric distribution of chitons likely to occur in waters deeper than 30 m in the Southern California Bight (SCB); classification follows Eernisse et al. (2007); * = species reported from SCB benthic monitoring programs; † = not included in key; I = intertidal.

Taxon/Species	Depth Range	Sources ‡
Class Polyplacophora Gray, 1821		
Order Lepidopleurida Thiele, 1910		
Suborder Lepidopleurina Thiele, 1910		
Family Leptochitonidae Dall, 1889		
<i>Hanleyella</i> Sirenko, 1973		
<i>Hanleyella oldroydi</i> (Bartsch MS, Dall, 1919) *	18 - 455 m	7, 10, 13, 24
<i>Leptochiton</i> Gray, 1847		
<i>Leptochiton americanus</i> Kaas and Van Belle, 1985	400 - 1400 m	13
<i>Leptochiton</i> cf. <i>belknapi</i> Dall, 1878	160 - 4206 m	15, 19, 23
<i>Leptochiton nexus</i> Carpenter, 1864 *	1 - 144 m	7, 10, 13, 24
<i>Leptochiton rugatus</i> (Carpenter in Pilsbry, 1892) *	1 - 458 m	7, 10, 13, 24
<i>Leptochiton</i> sp. *	116 m	23, 24
<i>Deshayesiella</i> Carpenter MS, Dall, 1879		
<i>Deshayesiella spicata</i> (Berry, 1919)	18 - 467 m	20, 23
<i>Oldroydia</i> Dall, 1894		
<i>Oldroydia percrassa</i> (Dall, 1894)	1 - 730 m	7, 10, 13
Order Chitonida Thiele, 1910		
Suborder Chitonina Thiele, 1910		
Family Chaetopleuridae Plate, 1899		
<i>Chaetopleura</i> Shuttleworth, 1853		
<i>Chaetopleura gemma</i> Carpenter MS, Dall, 1879	1 - 50 m	12, 15
Family Ischnochitonidae Dall, 1889		
<i>Callistochiton</i> Carpenter MS, Dall, 1879		
<i>Callistochiton crassicosatus</i> Pilsbry, 1893	1 - 732 m	7, 9, 17, 18
<i>Callistochiton decoratus</i> Carpenter MS, Pilsbry, 1893	1 - 72 m	7, 9, 17, 18
<i>Callistochiton palmulatus</i> Carpenter MS, Dall, 1879 *	1 - 85 m	7, 9, 17, 18, 24
<i>Lepidozonia</i> Pilsbry, 1892		
<i>Lepidozonia goltschi</i> (Berry, 1919) *	75 - 1281 m	1, 2, 7, 24
<i>Lepidozonia mertensii</i> (von Middendorff, 1847) *	1 - 100 m	7, 8, 15, 24
<i>Lepidozonia radians</i> (Carpenter in Pilsbry, 1892) *	1 - 150 m	7, 16, 24
<i>Lepidozonia retiporosa</i> (Carpenter, 1864) *	1 - 1463 m	7, 8, 15, 24
<i>Lepidozonia scabricostata</i> (Carpenter, 1864) †	1 - 1460 m	7, 8, 15
<i>Lepidozonia scrobiculata</i> (von Middendorff, 1847) *	1 - 200 m	5, 7, 8, 15, 24
<i>Lepidozonia willetti</i> (Berry, 1917)	13 - 274 m	7, 8, 15
<i>Lepidozonia</i> sp. A *	101 m	24
<i>Lepidozonia</i> sp. B *	305 m	24
<i>Lepidozonia</i> sp. C *	90 m	24
<i>Stenoplax</i> Carpenter MS, Dall, 1879		
<i>Stenoplax corrugata</i> (Carpenter in Pilsbry, 1892)	1 - 107 m	15
<i>Stenosemus</i> von Middendorff, 1847		
<i>Stenosemus stearnsii</i> (Dall, 1902)	412 - 704 m	16
Suborder Acanthochitonina Bergenhayn, 1930		
Family Acanthochitonidae Pilsbry, 1893		
<i>Acanthochitona</i> Gray, 1821		
<i>Acanthochitona avicula</i> (Carpenter, 1864)	1 - 36 m	21, 22

Table 1 (continued)

Taxon/Species	Depth Range	Sources †
Family Lepidochitonidae Iredale, 1914		
<i>Lepidochitona</i> Gray, 1821		
<i>Lepidochitona beanii</i> Carpenter, 1857	I - 230 m	6, 11, 14
Family Mopaliidae Dall, 1889		
<i>Dendrochiton</i> Berry, 1911		
<i>Dendrochiton flectens</i> (Carpenter, 1864)	I - 38 m	11, 14
<i>Dendrochiton gothicus</i> (Carpenter, 1864) *	I - 230 m	11, 14, 24
<i>Dendrochiton semiliratus</i> Berry, 1927	38 -141 m	11, 14
<i>Dendrochiton thamnopus</i> (Berry, 1911) *	I - 38 m	11, 14, 24
<i>Mopalia</i> Gray, 1847		
<i>Mopalia acuta</i> (Carpenter, 1855)	I - 40 m	17
<i>Mopalia imporcata</i> Carpenter, 1864 *	I - 120 m	17, 24
<i>Mopalia lowei</i> Pilsbry, 1918 *	I - 17 m	17, 24
<i>Mopalia phorminx</i> Berry, 1919 *	18 - 183 m	17, 24
<i>Placiphorella</i> Carpenter MS, Dall, 1879		
<i>Placiphorella mirabilis</i> Clark, 1994 *	28 - 155 m	3, 17, 24
<i>Placiphorella pacifica</i> Berry, 1919	155 - 2000 m	3, 17, 23
<i>Tonicella</i> Carpenter, 1873		
<i>Tonicella venusta</i> Clark, 1999 *	I - 140 m	4, 24

† Primary sources: (1) Berry, 1919a; (2) Berry, 1925; (3) Clark, 1994; (4) Clark, 1999; (5) Clark, 2004; (6) Eernisse, 1986; (7) Eernisse, 1998; (8) Ferreira, 1978; (9) Ferreira, 1979a; (10) Ferreira, 1979b; (11) Ferreira, 1982; (12) Ferreira, 1983; (13) Kaas & Van Belle, 1985a; (14) Kaas & Van Belle, 1985b; (15) Kaas & Van Belle, 1987; (16) Kaas & Van Belle, 1990; (17) Kaas & Van Belle, 1994; (18) Pilsbry, 1892-1893; (19) Schwabe, 2008; (20) Sirenko & Clark, 2008; (21) Sliker, 2000; (22) Watters, 1990; (23) R. N. Clark, personal communication; (24) present study.

above). Genera such as *Cyanoplax* and *Nuttallina* within Lepidochitonidae are common in southern California but are not addressed here because they are largely restricted to intertidal or shallow subtidal depths. Of the taxa considered subfamilies of Ischnochitonidae by Van Belle (1983; also Kaas & Van Belle, 1985-1998), we follow Eernisse et al. (2007) in considering Chaetopleuridae and Lepidochitonidae to be distinct from Ischnochitonidae while, unlike Sirenko (2006), we retain *Callistochiton* (part of Van Belle's Callistoplacinae) within Ischnochitonidae. Likewise, we recognize the priority of Leptochitonidae Dall, 1889 in

preference to Lepidopleuridae Pilsbry, 1892, and use it to also include *Oldroydia* and *Deshayesiella*, not separating these genera to Protochitonidae Ashby, 1925, as in Sirenko (2006). Based on preliminary molecular evidence, it is likely that the monotypic *Oldroydia* Dall, 1894, with type species *Lepidopleurus (Oldroydia) percussus* Dall, 1894 (currently *Oldroydia percussa*), could eventually be considered a junior synonym of *Deshayesiella* Carpenter MS, Dall, 1879, whose members are mostly found in the western Pacific (D. J. Eernisse, in preparation).

Key to Benthic Chitons of the Southern California Bight

1. Lateral and pleural areas of intermediate valves distinct from jugal region, latero-pleural areas sculptured with numerous, elongate, teardrop-shaped pustules, jugum with deeply incised longitudinal striations; girdle with sutural tufts of very long, straight, smooth spicules *Acanthochitona avicula*
- Valves not sculptured as above 2
2. Girdle greatly expanded anteriorly, much wider around head valve than tail valve; mouth region with conspicuous cephalic lappets extending anteriorly; intermediate valves at least 4 times wider than long, depressed in lateral areas 3
- Girdle not expanded anteriorly, equally wide around head and tail valves; mouth region surrounded by simple platform, without lappets; intermediate valves less than 4 times as wide as long, with straight or convex lateral areas 4
3. Tegmentum of valves pinkish or greenish grey and streaked or speckled with white, brown or other colors *Placiphorella mirabilis*
- Tegmentum of valves colored solid white, although some orange or black deposits may be present *Placiphorella pacifica* *
4. Gill rows not separated by interspace, with left and right rows forming a nearly continuous arch surrounding the anus; gills merobranchial, restricted to about posterior third of pallial groove; disarticulated valves without insertion plates 5
- Gill rows separated by distinct interspace, with left and right rows not reaching the anus; gills holobranchial, extending at least half or more the length of the pallial groove; disarticulated valves with insertion plates . 11
5. Head valve, lateral areas of intermediate valves, and tail valve with randomly arranged, prominent, relatively tall tubercles; central areas with longitudinal rows of smaller, flatter pustules; dorsal girdle with tufts of long, smooth, calcareous needles up to 400 µm long scattered among shorter spicules *Hanleyella oldroydi*

* Follows R. N. Clark (personal communication) in recognizing *Placiphorella pacifica* Berry, 1919, as a valid eastern Pacific species, although Kaas & Van Belle (1994) consider this a junior synonym of *P. atlantica* (Verrill & S. I. Smith, 1882).

- Valve sculpturing not as above, without prominent tubercles or pustules; girdle with or without long needlelike spines, but not usually in dense tufts if present 6
- 6. Valves heavy with coarse, irregular sculpturing on end valves and latero-pleural areas of intermediate valves; jugal region usually distinct, forming a raised and relatively smooth ridge compared to latero-pleural areas; posterior edges of intermediate valves curved or distinctly beaked (V-shaped); girdle encroaches conspicuously between valves (~ 50% valve width or more); dorsal girdle surface with scattered smooth, needlelike spicules up to 500 µm long (may be broken off) 7
- Valves thin with mostly fine, granulose sculpturing, with or without raised, round to oval granules; jugum not distinct; intermediate valves rectangular with more or less straight posterior edges and small or inconspicuous apices; girdle does not encroach noticeably between the valves; girdle with or without long spicules 8
- 7. Intermediate valves with “a long jugal area characteristically projecting forward for almost half the length of the tegmentum” (Sirenko & Clark, 2008: 1) and with a higher “ratio of jugal length to the length of the postmucronal area” (Sirenko & Clark, 2008: 4) than in the next choice *Oldroydia percrassa*
- Intermediate valves “lacking long, distinct and projecting jugal area” (Sirenko & Clark, 2008: 1), with a lower “ratio of jugal length to the length of the postmucronal area” (Sirenko & Clark, 2008: 4) than in the previous choice *Deshayesiella spicata*
- 8. Tegmental sculpture of minute granules forming subgranulose riblets; riblets arranged into radiating series on head valve, lateral areas of intermediate valves and postmucronal area of tail valve, and into longitudinal rows on central areas and antemucronal area of tail valve 9
- Tegmental sculpture roughly granulose, with raised, well separated, round to oval granules 10
- 9. Girdle distinctly spiculose, with long needlelike spines to 400 µm scattered dorsally amongst mostly short (~ 70 µm), oval, smooth spicules; postmucronal slope distinctly concave; black caps of major lateral teeth of radula bicuspid, moderately elongate, inner denticle much larger than outer denticle *Leptochiton nexa*
- Girdle not distinctly spiculose, but comprised dorsally of mostly rectangular, ribbed scales not longer than ~ 60 µm, although longer, ribbed spicules to 140 µm are occasionally evident, especially at the valve sutures; postmucronal slope generally straight, often vertical in southern California deep-water specimens, with or without small depression just below mucro; black caps of major lateral teeth of radula unicuspid, very long and sharply pointed *Leptochiton rugatus*
- 10. Head valve much smaller than other valves, about one-half the size of tail valve and 70% the width of intermediate valves; tegmental sculpture of raised granules organized in chains, arranged longitudinally in central areas and more or less radially in lateral areas and on end valves; girdle covered dorsally with mostly blunt, striated spicules up to 100 µm, and longer, almost smooth needlelike spines up to 375 µm along edges of valves; black caps of major lateral teeth of radula bicuspid, inner denticle shorter than outer denticle *Leptochiton americanus*
- Head valve about as large as tail valve and similar in width to intermediate valves; tegmentum sculptured with round granules, arranged quincunxially and not in chains; girdle covered dorsally with elongate, bluntly pointed scales or spicules, ~ 100-150 µm long, each scale with 3-4 riblets; black caps of major lateral teeth of radula unicuspid, long and sharply pointed *Leptochiton cf. belknapi* †

† *Leptochiton cf. belknapi* may represent two similar, but distinct nominal species in SCB waters according to R. N. Clark (personal communication): *L. belknapi* Dall, 1878, and *L. mesogonus* Dall, 1902.

11. Girdle covered dorsally with strongly imbricating oval to nearly rectangular-shaped scales, or conical scale-like spicules or corpuscles 12
- Girdle without imbricating scales or spicules, dorsal surface covered with minute, non-overlapping corpuscles, giving a granular or sandy appearance, with or without short pointed spicules, slender spines, dendritic bristles or flexible hairs 25
12. Head and tail valves with very heavy, prominent ribs 13
- Head and tail valves without prominent ribs, although there may be distinct radiating rows of globular tubercles 15
13. Tail valve bulging prominently above other valves, shaped like a fist (may not be developed in small specimens), mucro anterior and not raised relative to highly convex postmucronal slope; head valve sculptured with about 9 massive, pustulose radial ribs separated by wide sulci, posterior ribs often bifurcated; lateral areas of intermediate valves highly raised, sculptured similar to head valve with 2 radial ribs separated by narrow groove; girdle covered dorsally with small, oval, imbricating scales (~ 70 x 130 µm), each with 10-12 fine riblets *Callistochiton palmulatus*
- Tail valve not prominently bulging, mucro subcentral to terminal and higher than postmucronal slope; head valve with about 7 or 11 radial ribs; girdle scales with 5-8 broad ribs or 10-14 sharp riblets 14
14. Mucro high and terminal, postmucronal slope nearly vertical; head valve with about 7 stout ribs separated by wide sulci, radial ribs diverging into pustular to scalloped subribs; lateral areas of intermediate valves highly raised and sculptured similar to head valve, with single strong radial ridge diverging laterally into 3-4 subribs; girdle covered dorsally with small, oval, imbricating scales (~ 90 x 160 µm), each with 5-8 broad ribs *Callistochiton crassicostatus*
- Mucro of intermediate height and subcentral, postmucronal slope straight to slightly convex; head valve with about 11 scalloped ribs without subribs, ribs separated by narrow, relatively shallow sulci; lateral areas of intermediate valves raised and sculptured similar to head valve with 2 distinct scalloped radial ribs; girdle covered dorsally with oval, imbricating scales (~ 140 x 220 µm), each scale with 10-14 sharp riblets *Callistochiton decoratus*
15. Head valve, postmucronal area of tail valve, and raised lateral areas of the intermediate valves with 4-6 irregular, concentric corrugations; girdle covered dorsally with small, taller than wide (~ 96 x 72 µm), slightly bent, ribbed, round-topped scales *Stenoplax corrugata*
- Valves without irregular concentric corrugations, although a few weak growth lines may be present . . . 16
16. Imbricating girdle elements juxtaposed, whitish, glossy, much taller than wide (up to 430 x 160 µm); tegmentum of head valve, lateral areas, and postmucronal area of tail valve sculptured with fine, beaded, divaricating radial riblets; apophyses not connected by a jugal lamina (requires disarticulation) *Stenosemus stearnsii*
- Girdle elements armor like, consisting of strongly overlapping, usually wider than tall, oval to rectangular shaped scales; tegmentum not as above, either smooth with weak granulations or strongly sculptured with various types of ridges and/or tubercles; apophyses connected by a jugal lamina that is notched where it connects on each side (requires disarticulation) 17

17. Tegmentum of all valves appearing almost uniformly smooth with weak, granular sculpturing; color variable, often mottled with olive, brown, orange, yellow, or occasionally white; girdle scales approximately rectangular, wider than tall (~270 x 170 µm), each scale with about 12 fine striations *Lepidozona radians*
- Tegmentum distinctly sculptured with various combinations and arrangements of raised pustules, tubercles, pits and ridges, often arranged in radial or longitudinal rows; head valve, lateral areas of intermediate valves, and postmucronal area of tail valve usually similarly sculptured and distinct from central areas 18
18. Central areas of intermediate valves with longitudinal to arching diagonal rows of distinct but shallow pits, but without conspicuous longitudinal ridges; end valves and lateral areas of intermediate valves with obsolete radial rows of minute, sparsely set, round, usually bead-like tubercles; girdle scales relatively small, nearly as tall as wide (~144 x 120 µm), with faint longitudinal striations; color often uniform brown or reddish-brown and mottled with white in southern California specimens, but also occasionally tan or apricot *Lepidozona retiporosa*
- Central areas of intermediate valves with distinct longitudinal ridges that may or may not extend across the jugum, sometimes latticed and appearing pitted between; girdle scales usually wider than tall, small (~100 µm) to large (~450 µm), with or without striations, and with or without nipples at top 19
19. Tegmental sculpture of head valve, lateral areas of intermediate valves, and postmucronal area of tail valve highly variable, without raised, neatly separated tubercles, but usually with irregular pustules arranged in radial ribs, elongated pustules along posterior sutures usually protruding to give a serrated appearance; central areas of intermediate valves with well-spaced, longitudinal ridges extending across the jugum, often latticed in between; girdle scales rectangular (~180 x 130 µm), slightly convex with distinct longitudinal striations; tegmentum color variable, usually of greens or browns *Lepidozona scrobiculata*
- Tegmentum of end valves and lateral areas not as above, sculptured with neatly separated tubercles of various sizes and shapes (minute and round, button-like, globular, digitate), sutural ribs not appearing serrated; central areas with closely set or well-spaced longitudinal ridges, with or without distinct latticing 20
20. Tegmentum of end valves and lateral areas of intermediate valves sculptured with small, neatly separated, roundish (bead-like) tubercles 21
- Tegmentum of valves without small bead-like tubercles, but sculptured with relatively large button-like (flat and round), globular or digitate tubercles 22
21. Tegmentum mostly microgranulose, with sparsely set bead-like tubercles arranged in ill-defined radial rows, distance between tubercles at least several times their width (~5 tubercles per row); central areas with closely set, often beaded, longitudinal ridges without distinct cross-hatching; girdle scales oval, moderately convex, with distinct longitudinal striations; color mostly a uniform orange brown, with or without creamy white banding *Lepidozona golischi* ‡
- Tegmentum of end valves and lateral areas sculptured with radiating ribs separated by fine distinct grooves or sulci, each rib bearing numerous, closely set bead-like tubercles, distance between tubercles 1-3 times their width (~6-12 tubercles per row); central areas with distinct cross-hatching between longitudinal ribs; girdle scales strongly convex or bulbous, with faint longitudinal striations, and crowned with a ribbed nipple (often broken off) *Lepidozona willetti*

‡ *Lepidozona golischi* formerly synonymized with *L. scabricostata* (Carpenter, 1864) (see Ferreira, 1978; Kaas & Van Belle, 1987), but considered in Clark (2008) and herein as a distinct species (*L. scabricostata* not included in key).

22. Central areas of intermediate valves appearing deeply pitted with longitudinal ridges distinctly cross-hatched; tegmentum with widely spaced digitate tubercles or closely set flat or slightly raised round tubercles; girdle scales only slightly convex with distinct longitudinal striations 23
- Central areas not pitted, without distinct cross-hatching, although faint horizontal latticing may be apparent between the prominent longitudinal ridges; tegmental sculpture of closely set, button-like or globular to digitate tubercles, distance between tubercles about 1-2 times their width; girdle scales relatively large (>400 µm), strongly convex, with or without weak striations, and crowned with a ribbed nipple (often broken off) . . . 24
23. Tegmentum of end valves and lateral areas of intermediate valves sculptured with radiating rows of well-separated, digitate tubercles, distance between tubercles at least several times their width; tegmentum and girdle coloration of banded reddish-browns and tans (color based on single specimen) *Lepidozona* sp. A
- Tegmentum of end valves and lateral areas sculptured with relatively flat or slightly raised, round, closely set tubercles, distance between tubercles about 1-2 times their width; tegmentum and girdle coloration mostly tan to light orange with perhaps a darker jugal ridge (color based on single specimen) *Lepidozona* sp. B
24. Head valve, lateral areas of intermediate valves, and posterior region of tail valve sculptured with rows of tall, globular to sometimes digitate tubercles; longitudinal ridges prominent throughout central areas, clearly extending across jugum; girdle scales typically smooth or with nearly obsolete longitudinal striations; color generally reddish-brown and blotched with lighter or darker tones *Lepidozona mertensii*
- Head valve, lateral areas, and posterior region of tail valve sculptured with rows of numerous, flattened, button-like tubercles; longitudinal ridges of central areas becoming faint or obsolete across the jugum; girdle scales usually with faint longitudinal striations apparent; color reddish-brown with white banding on some posterior valves (color based on single specimen) *Lepidozona* sp. C
25. Girdle nude dorsally with microscopic elements appearing uniformly granular or sandy, without conspicuous spicules, spines, bristles, or hairs 26
- Girdle with conspicuous dorsal spicules, spines, bristles, or hairs scattered variably over a more or less granular or sandy surface 27
26. Central areas of intermediate valves sculptured with 12-16 fine lateral riblets on each side, the remainder of the tegmentum evenly microgranulose; tegmentum color variable but mostly greens or reds *Dendrochiton gothicus*
- Tegmental sculpture smooth throughout; tegmentum color typically orange or pink, end valves and lateral areas with white zigzag lines, pleural areas with 2-5 large white flammules, although colors may be faint *Tonicella venusta*
27. Girdle beset dorsally with spicules of different sizes and shapes or slender, hyaline spines, without conspicuous bristles or hairs 28
- Girdle beset dorsally with dendritic processes, bristles or flexible hairs 29
28. Tegmentum sculptured with conspicuous, raised, spherical tubercles arranged in radiating, branching rows on head valve and lateral areas of the intermediate valves, and forming beaded lirae in central areas; girdle covered with spicules or spines of different types and sizes (smooth or ribbed, slender or thick, curved or straight); tegmental color usually orange, rarely green, often with tiny black pigment spots, tail valve often black and spotted with white *Chaetopleura gemma*

- Tegmentum smooth to the naked eye, microgranulose, color variable; girdle with long (> 500 µm), slightly curved, slender hyaline spines or spicules interspersed or occurring in bunches of 3-4 at sutures *Lepidochitona beanii*
- 29. Tegmentum evenly microgranulose, head valve and lateral areas of intermediate valves appearing smooth, central areas with or without fine longitudinal riblets 30
- Tegmentum coarsely sculptured, with or without strong radial, pustulose ribs 32
- 30. Central areas with longitudinal riblets or grooves; girdle with tufts of plumose setae, with or without stalked calcareous processes; setae restricted to sutures only or occurring both near the sutures and as a supramarginal row around the girdle 31
- Central areas smooth, without riblets; girdle without distinct tufts of plumose setae, but with isolated corneous setae or hairs up to 1000 µm long that bear stalked, calcareous spicules arising from a groove along one side; setae located near sutures and around end valves, but not in a supramarginal row . . . *Dendrochiton flectens*
- 31. Plumose setae without stalked calcareous spicules, consisting of tufts of long, curved, yellowish hairs surrounding a single thicker, branching bristle; setal tufts located near sutures, around the end valves, and as a supramarginal row; postmucronal slope concave *Dendrochiton thamnopus*
- Plumose setae with stalked calcareous spicules, consisting of tufts of 3-6 fragile, branching, horny processes up to 1000 µm long; setal tufts present only at the sutures; postmucronal slope straight *Dendrochiton semiliratus*
- 32. Head valve with 8 weak, thread-like radiating ribs, tegmentum of head valve and lateral areas of intermediate valves pitted by oblique, curved decussations, central areas with numerous fine, longitudinal lirae; girdle densely covered with small, stout, blunt-topped spicules up to 55 x 14 µm, and sparsely scattered long, hollow, grooved chitinous setae with 2 series of shorter, stalked, chitinous hairs arising from the grooves. . . *Mopalia acuta*§
- Head valve with prominent, annulated to nodulose radial ribs, intermediate valves sculptured similarly with the 2 heaviest ribs defining the extent of each lateral area; girdle setae not as above 33
- 33. Girdle setae wispy, many as long as the girdle is wide, each with sparse lateral branches; central areas of intermediate valves with distinct longitudinal riblets, between which is a dense lattice of irregular, much finer lateral subribs; head valve with about 8-10 heavy radiating ribs, interspersed by one or more radiating rows of shorter but distinct pustules, similar rows of short pustules between the heavy defining ribs of the lateral areas; mucro subcentral *Mopalia phorminx*
- Girdle setae relatively stout, appearing bushy with dense lateral branches, although branching may be less pronounced in juveniles; central areas with or without distinct longitudinal riblets; mucro nearly terminal 34
- 34. Setae with slender, usually recurved, bristles arranged in numerous indistinct rows, setal shaft visible between bristles, bristles angled away from setal shaft at their attachment point; central areas with distinct longitudinal riblets, between which are much finer lateral subribs; head valve with about 10 annulated, cordlike, or almost smooth radial ribs, lateral areas bounded by similar diagonal and sutural ribs, transverse nodules defining the annuli of the radial ribs fused and not separated, interspaces between radial ribs sculptured with mostly coalesced granules not arranged in radial rows *Mopalia imporcata*

§Follows Eernisse et al. (2007) in treating *Mopalia acuta* (Carpenter, 1855) as a somewhat deeper water species distinct from the similar *M. plumosa* Carpenter in Pilsbry, 1893, which was formerly considered a junior synonym of *M. acuta*.

- Setae long, stout and bearing sharply pointed white or yellow tinged spicules that entirely encircle the shaft; central areas without distinct longitudinal riblets, appearing pitted with outwardly curving ribbing crossed by more or less finer lateral riblets, although some ribbing may appear less curved and more longitudinally pronounced in juveniles; head valve with 7-10 coarsely nodulose radial ribs, lateral areas with similar diagonal and sutural ribs, nodules distinctly separate, interspaces between heavy ribs of head valve and lateral areas of intermediate valves with irregular, radiating rows of elongated granules *Mopalia lowei*

Results

We report 19 species of chitons from mostly deep-water habitats ranging throughout the SCB, including 16 described and three provisional (undescribed) species (Table 2). A fourth possible new species is also reported based on a single small juvenile. The chitons reported were collected between 1988 and 2009 at 66 different sampling sites ranging from northern Baja California to the northern Channel Islands and Point Conception (Figure 1, Appendix A). Several species are distributed widely throughout the region, while others are so far restricted to one or a few locations. Most individuals were collected from depths between 30 and 305 m, which were the primary focus of this study. Records for a few species collected from slightly shallower waters (9-18 m) by SCB benthic monitoring programs are also included because we expect these will eventually be found in deeper water. As in Eernisse (1998), we found the chiton fauna at the depths sampled herein to be largely distinct in comparison to the species commonly found in either shallower or deeper waters. Information is presented below for each species regarding their relative abundance, size, geographic distribution, bathymetric range, and co-occurrence with other chitons in the region.

Family Leptochitonidae Dall, 1889

***Hanleyella oldroydi* (Bartsch MS, Dall, 1919)**
(Plate 1, Figure 2)

Hanleyella oldroydi is reported to occur along the West Coast from Koscusko Island, Alaska to Cabo San Quintin, Baja California at depths ranging from 18 to 455 m (Ferreira, 1979b; Baxter, 1983; Kaas & Van Belle, 1985a; Eernisse, 1998). This species was one of the most commonly encountered chitons in the present study, occurring in ~22% of the SCB samples containing chitons. All *H. oldroydi* examined in this study were collected in deep waters ranging from 50 to 191 m at sites located off of San Diego, Palos Verdes,

Santa Monica Bay and the northern Channel Islands. A total of 26 specimens of *H. oldroydi* have been examined so far, representing approximately 11% of the chitons collected. The maximum length of SCB specimens is 7.4 mm (mean = 4.2 mm), which is consistent with published records for this small species (see Ferreira, 1979b; Kaas & Van Belle, 1985a). *Hanleyella oldroydi* is commonly collected in samples with another lepidopleurid, *Leptochiton rugatus*, although the bathymetric range for the latter species includes the intertidal (see below). Other chitons collected at the same sites include *Leptochiton nexus*, *Lepidozона radians*, *L. mertensii*, *L. retiporosa*, *L. scrobiculata*, and possibly three undescribed species (*Lepidozона* spp. A and C, and *Leptochiton* sp.).

***Leptochiton nexus* Carpenter, 1864**
(Plate 1, Figure 3)

Leptochiton nexus is known to occur along the West Coast from Cohen Island, Alaska to Punta Abrejos, Baja California, as well as in the Gulf of California at depths ranging from the intertidal to 144 m (Ferreira, 1979b; Kaas & Van Belle, 1985a). This chiton is reported here for the SCB from seven specimens collected at six sites located off of San Diego, Palos Verdes, Santa Monica Bay and the northern Channel Islands at depths of 18-82 m. The maximum length of the SCB specimens is 9.3 mm (mean = 5.9 mm), which is less than half the size that *L. nexus* typically reaches (see Ferreira, 1979b; Kaas & Van Belle, 1985a). Other chitons collected with *L. nexus* in the present study include *Hanleyella oldroydi*, *Leptochiton rugatus*, and *Lepidozона retiporosa*.

***Leptochiton rugatus* (Carpenter in Pilsbry, 1892)**
(Plate 1, Figure 4)

Certain recent authors (Ferreira, 1979b; Kaas & Van Belle, 1985a) have considered *Leptochiton rugatus* (Carpenter in Pilsbry, 1892) to be widely distributed

Table 2. Summary of chitons collected by benthic monitoring programs in the Southern California Bight (SCB) from 1988-2009.

Species	Number of Specimens	Number of Samples (Sites)	Body Length	Depth Range of SCB Sites
Leptochitonidae				
<i>Hanleyella oldroydi</i>	26	20 (13)	1 - 7.4 mm	50 - 191 m
<i>Leptochiton nexus</i>	7	6 (6)	3.5 - 9.3 mm	18 - 82 m
<i>Leptochiton rugatus</i>	60	33 (23)	1.2 - 8.5 mm	14 - 305 m
<i>Leptochiton</i> sp.	1	1	3 mm	116 m
Ischnochitonidae				
<i>Callistochiton palmulatus</i>	2	2 (2)	7 - 13 mm	80 - 85 m
<i>Lepidozonia golischi</i>	3	2 (2)	20.5 - 23 mm	98 - 101 m
<i>Lepidozonia mertensii</i>	3	3 (3)	13 - 15 mm	56 - 85 m
<i>Lepidozonia radians</i>	7	6 (6)	3.8 - 10 mm	9 - 150 m
<i>Lepidozonia retiporosa</i>	46	22 (19)	2.5 - 19 mm	55 - 305 m
<i>Lepidozonia scrobiculata</i>	24	18 (15)	5.8 - 24 mm	14 - 101 m
<i>Lepidozonia</i> sp. A	1	1	12.1 mm	101 m
<i>Lepidozonia</i> sp. B	1	1	13 mm	305 m
<i>Lepidozonia</i> sp. C	1	1	19.5 mm	90 m
Mopaliidae				
<i>Dendrochiton gothicus</i>	41	5 (1)	1 - 5.5 mm	16 - 18 m
<i>Dendrochiton thamnopus</i>	9	5 (5)	1.6 - 9.3 mm	15 - 38 m
<i>Mopalia imporcata</i>	3	3 (3)	3.5 - 15 mm	38 - 69 m
<i>Mopalia lowei</i>	1	1	5 mm	17 m
<i>Mopalia phorminx</i>	2	2 (2)	20 - 24 mm	100 - 130 m
<i>Placiphorella mirabilis</i>	4	2 (2)	17 - 43 mm	43 - 104 m
<i>Tonicella venusta</i>	1	1	~10 mm	15 m

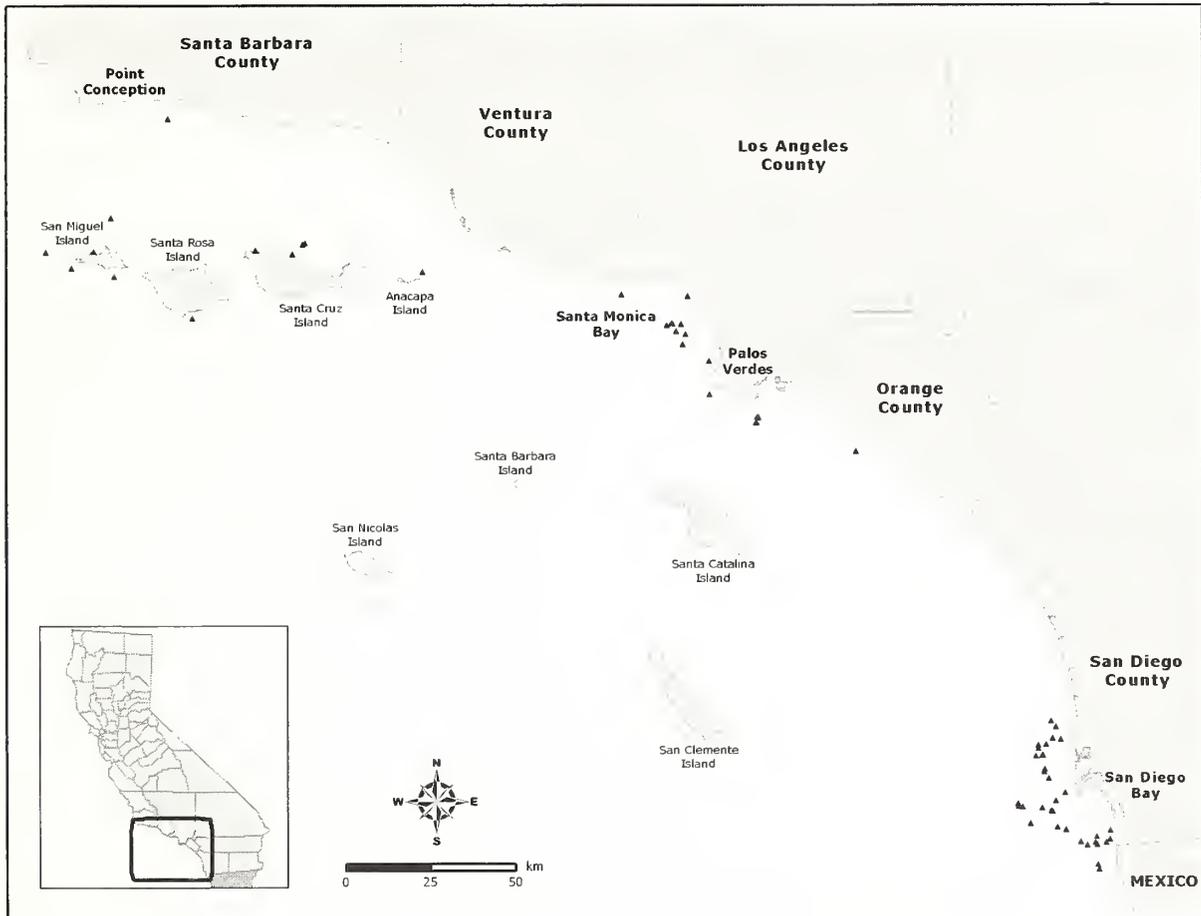


Figure 1. Stations (▲) where chitons have been collected by benthic monitoring programs in the Southern California Bight ($n = 66$; see Appendix A). A few symbols overlap for sites located close together; 3 stations of unknown coordinates not shown, including 1 site off Point conception (150 m) and 2 sites off Palos Verdes (100 and 130 m).

throughout the North Pacific, occurring in the Sea of Japan, the Okhotsk Sea, the Bering Sea, along the West Coast from Alaska to Magdalena Bay, Baja California, and in the Gulf of California at depths ranging from the intertidal to 458 m. Other authors (e.g., Saito, 2000) regard the northwestern Pacific *Leptochiton assimilis* (Thiele, 1909) as distinct. Recent molecular studies have revealed even further distinctions (D. J. Eernisse and R. P. Kelly, unpublished), but based on its nearby type locality, those in at least the intertidal to shallow subtidal of California are still regarded as *L. rugatus*, whereas the identity of those from deeper water is still somewhat uncertain. This deeper water form of *L. rugatus* is the most common and abundant chiton encountered in the present study, occurring in ~36% of all samples. Specimens of this chiton have been collected at depths ranging from 14 to 305 m throughout the SCB, including sites located off of San Diego, Palos Verdes, Santa Monica Bay, Point Conception and the northern Channel Islands. A total of 60 specimens have been examined so far, which represents about 25% of the chitons collected in the region. SCB benthic specimens of *L. rugatus* in these deeper waters are relatively small with a maximum length of 8.5 mm (mean = 3.8 mm), while the maximum recorded size for the species is around 16 mm (see Ferreira, 1979b; Kaas & Van Belle, 1985a). *Leptochiton rugatus* has been collected with a number of other SCB chitons, including especially *Hanleyella oldroydi* and *Lepidozonia retiporosa*. Other chitons that co-occurred at sites with *Leptochiton rugatus* were *L. nexus* and possibly another undescribed species of *Leptochiton*, as well as at least three members of *Lepidozonia*: *L. radians*, *L. scrobiculata*, and *L. sp. B*.

Leptochiton sp.

We agree with R. N. Clark (personal communication) that a single specimen of *Leptochiton* could be distinct from *L. rugatus*. However, the specimen is small (3 mm length) and further work is needed to verify whether this chiton actually represents a nominal or new species or is merely a somewhat odd juvenile of *L. rugatus*. This specimen was collected at a depth of 116 m at a site located north of Point Loma, San Diego where *L. rugatus* and *Hanleyella oldroydi* also occur.

Family Ischnochitonidae Dall, 1889

Callistochiton palmulatus Carpenter MS, Dall, 1879
(Plate 2, Figure 5)

Callistochiton palmulatus is reported to occur along the West Coast from Mendocino County, northern California to San Pablo Point, Baja California at depths ranging from the intertidal to 82 m (Pilsbry, 1892-93; Ferreira, 1979a; Kaas & Van Belle, 1994; Eernisse, 1998). This chiton is reported here from two specimens collected at separate sites off San Diego at depths of 80-85 m, which represents a slight increase in the bathymetric range for this species. This chiton has also been observed as perhaps the most common chiton collected from rock dredges off San Pedro (DJE, personal observation), where it is often found inside empty mudstone burrows left behind by burrowing bivalves (e.g., *Adula* spp.). The maximum length of the SCB specimens is 13 mm (mean = 10 mm), which is consistent with published size records for this species (see Ferreira, 1979a; Kaas & Van Belle, 1994). Both specimens of *C. palmulatus* reported off San Diego were collected along with *Lepidozonia mertensii*.

Lepidozonia golischi (Berry, 1919) (Plate 2, Figures 6-7)

Lepidozonia golischi was originally described by Berry (1919a) as a member of *Ischnochiton* based on a specimen collected at a depth of 100 fathoms (~183 m) off of Santa Monica, California. Ferreira (1978) subsequently synonymized *L. golischi* with *Lepidozonia scabricostata* (Carpenter, 1864) in his review of the temperate eastern Pacific *Lepidozonia*, and this species has since been reported to occur from the intertidal to depths of 1460 m along the West Coast from the Gulf of Alaska to Sebastian Vizcaino Bay, Baja California (see Ferreira, 1978; Baxter, 1983; Kaas & Van Belle, 1987; Clark, 1991; Eernisse, 1998).

Three chitons that fit this general morphology were collected in the present study at two sites off San Diego at depths of 98-101 m. The maximum length of these specimens is 23 mm (mean = 22 mm). Although we at first identified these chitons as *L. scabricostata*, comparison with the approximately 7 mm long holotype of that species (USNM 16268; see Figure 6a herein) revealed significant differences. As also noted by Berry (1917) and Ferreira (1978), the central regions of the *L. scabricostata* holotype's intermediate valves, in particular, are very similar to those of *L. willetti* (not reported in this study), even though their girdle scales differ substantially. The central areas of these two species are alike in their lattice-like sculpturing with cross-hatching. In between the left and right central areas, the jugal region differs, with longitudinal ribbing

extending across the jugum in *L. willetti*, whereas the *L. scabricostata* holotype has almost quincunxially arranged granules on its jugum without longitudinal ribbing. Unlike Ferreira (1978), we also found the central regions of the *L. scabricostata* holotype to differ substantially from the lectotype of *Ischnochiton (L.) golischi* (hereafter as *L. golischi*) at the Santa Barbara Museum of Natural History (SBMNH 34395; see Figure 6b herein), with the longitudinal ribs of *L. golischi* extending across the jugal region similar to *L. willetti*. Unlike either *L. willetti* or *L. scabricostata*, the spaces between the finely beaded longitudinal ribs of the *L. golischi* lectotype lack strong cross hatching and instead have only irregularly scattered granular pustules. Like *L. willetti*, or even more like *L. retiporosa* (see below), the head valve and the lateral areas of the intermediate valves of the *L. golischi* lectotype have radiating rows of small, raised and rounded (bead-like) tubercles. In contrast, such bead-like tubercles appear lacking in *L. scabricostata*, although this can only be assumed for the missing end valves of the holotype. The lateral areas of this specimen, however, are quite different from *L. golischi* with small irregular pustules developing along the posterior edges that are more similar to that seen in *L. scrobiculata* (see below). Comparison of the three San Diego specimens of *L. golischi* collected as part of this study (e.g., Figure 7) with the *L. golischi* lectotype from the SBMNH (Figure 6b) and specimens identified as *L. scabricostata* for the Santa Maria Basin area at depths between 75-123 m (see Figures 3.2C-F in Eernisse, 1998) confirmed these differences and that these chitons are all the same species. Consequently, we here in concur with the treatment of Clark (2008: 80-81) in resurrecting *L. golischi* as a distinct species from *L. scabricostata* (Carpenter, 1864). Additional comparisons with specimens identified as *L. scabricostata* collected off San Diego at depths between 110-1281 m and housed in the Scripps Institution of Oceanography Benthic Invertebrate Collection (SIO Cat. Nos. M1208 and M1389) reveal these chitons to be *L. golischi* as well. Overall, this gives a confirmed depth range for *L. golischi* of 75-1281 m based on the SBMNH type material and specimens examined during this study or that of Eernisse (1998). Other chitons that co-occurred with *L. golischi* in this study were *Lepidozonia retiporosa*, *L. scrobiculata*, and *Lepidozonia* sp. A.

As mentioned above, *L. golischi* also bears similarities to another common species of *Lepidozonia* in the SCB, *L. retiporosa*, especially in terms of its sparsely set, minute round tubercles on the end valves and lateral areas of the intermediate valves. However, *L. golischi* differs markedly in the sculpturing of the central areas,

especially in its possession of well-separated longitudinal riblets that are unlike anything seen in *L. retiporosa*. The above distinctions mostly agree with Clark (2008). The one discrepancy, however, is that Clark mentions *L. golischi* as being sculptured with “relatively large, often scattered pustules...,” which seems quite different from the minute round or bead-like tubercles noted herein for this species.

Finally, besides finding clear differences between the primary type material of *L. golischi* and *L. scabricostata*, we have further considered whether *L. scabricostata* is distinct from other nominal species of *Lepidozonia* discussed in this paper, given that the type specimen of this species was collected at comparable (but slightly shallower) depths off Santa Catalina Island. Our suspicion is that the small holotype of *L. scabricostata* (Figure 6a) is merely a juvenile specimen of *L. scrobiculata*, one of the most commonly dredged chitons in the SCB. It is our experience that juvenile specimens of *L. scrobiculata* resemble this holotype, especially in terms of the small irregular pustules that appear to be developing along the posterior edges of the intermediate valves. If true, *Lepidopleurus scabricostus* Carpenter, 1864, would then become a junior synonym of *Chiton scrobiculatus* von Middendorff, 1847. However, we stop short of proposing such a synonymy here, pending more detailed morphological comparisons of the holotype of *L. scabricostata* with confirmed *L. scrobiculata* juveniles.

***Lepidozonia mertensii* (von Middendorff, 1847)**
(Plate 3, Figure 8)

Lepidozonia mertensii occurs along the West Coast from Auke Bay, Alaska to Sacramento Reef, Baja California from the intertidal to depths of 100 m (Ferreira, 1978; Kaas & Van Belle, 1987). Reports from northern Japan waters (Taki, 1938) are doubtful and need to be confirmed. This chiton is reported here for the SCB from three specimens collected off of San Diego and Santa Monica Bay at depths between 56 and 85 m. The maximum length of the two SCB specimens that could be measured is 15 mm (mean = 14 mm), while the third individual was broken and disarticulated. This overall body size is relatively small for this species, which typically reaches lengths ~40 mm and may exceed 50 mm in some individuals (see Ferreira, 1978; Kaas & Van Belle, 1987). *Lepidozonia mertensii* has been found to co-occur with *Hanleyella oldroydi*, *Lepidozonia retiporosa*, and *Callistocheiton palmulatus* in the present study.

***Lepidozonia radians* (Carpenter in Pilsbry, 1892)**
(Plate 3, Figure 9)

Lepidozonia interstincta (Gould, 1852) (with *L. radians* considered a junior synonym) has been previously reported to occur in the Aleutian Islands and along the West Coast from Prince William Sound, Alaska to Catalina Island, California from the intertidal to depths of 72 m (Kaas & Van Belle, 1990). However, Eernisse et al. (2007) restored the more commonly used name for California specimens, *Lepidozonia radians* (Carpenter in Pilsbry, 1892) (formerly *Ischnochiton radians*), as distinct from the more northern *L. interstincta*. These two species are very similar except for range differences, coloration, and consistent DNA sequence differences (DJE, unpublished data). *Lepidozonia interstincta*, which is uniformly tan in color, is probably the only species present in Alaska and extends south to at least the subtidal of the San Juan Islands, Washington, whereas the more variably colored *L. radians* extends north to at least the intertidal of Port Hardy at the northern end of Vancouver Island, and south to the intertidal of some cold-water upwelling sites south of Ensenada, Baja California, México, including new southern range extension records near Colonet (DJE, personal observation). *Lepidozonia radians* is not generally found in the intertidal of southern California but is known from seven specimens in the present study collected at depths of 9-150 m ranging from northern Baja California to Point Conception and the northern Channel Islands. These records extend the maximum depth range of this species from 72 to 150 m and would be new southernmost records except for the previously mentioned Baja California specimens. The chitons reported here represent two primary color morphs. Specimens from off northern Baja and San Diego were mottled with olive-green and/or browns (e.g., Figure 7a), while specimens from off Point Conception and Santa Cruz Island were mostly white (e.g., Figure 7b). The maximum length of the SCB specimens is 10 mm (mean = 7 mm), which is rather small compared to the 28 mm in length this species or the similar *L. interstincta* may reach (see Kaas & Van Belle, 1990). Other chitons that co-occur with *L. radians* in SCB waters include *Hanleyella oldroydi*, *Leptochiton rugatus* and *Lepidozonia scrobiculata*.

***Lepidozonia retiporosa* (Carpenter, 1864)**
(Plate 4, Figure 10)

Lepidozonia retiporosa is reported to occur along the West Coast from Kosciusko Island, Alaska to the

southern tip of Baja California from the intertidal to depths of 1463 m (Kues, 1974; Ferreira, 1978; Baxter, 1983; Kaas & Van Belle, 1987; Eernisse, 1998). This species represents one of the most common chitons and the second most abundant species in the present study, occurring in ~24% of the samples and comprising ~19% of all individuals. A total of 46 *L. retiporosa* were collected at depths ranging from 55 to 305 m at sites located off of San Diego, Palos Verdes, Santa Monica Bay and the northern Channel Islands. Many SCB specimens of *L. retiporosa* are relatively large with a maximum length of 19 mm (mean = 11 mm), while the maximum size previously known for this species is 17 mm (see Ferreira, 1978; Kaas & Van Belle, 1987). *Lepidozonia retiporosa* co-occurs with a number of other SCB chitons, including *Hanleyella oldroydi*, *Leptochiton nexus*, *L. rugatus*, *Lepidozonia golischi*, *L. mertensii*, *L. scrobiculata*, *Lepidozonia* spp. A, B and C, and *Mopalia phorminx*.

***Lepidozonia scrobiculata* (von Middendorff, 1847)**
(Plate 4, Figure 11)

Lepidozonia scrobiculata is reported from along the West Coast from Sonoma County, California to Thurloe Head on the outer coast of Baja California, and its vertical distribution extends from the intertidal to depths of 200 m (Ferreira, 1978; Kaas & Van Belle, 1987; Clark, 2004). The name, *L. scrobiculata*, which Clark (2004) demonstrated was the senior synonym of the name used for over 90 years, *L. sinudentata* (Carpenter in Pilsbry, 1892), refers to a highly variable species that is one of the most commonly encountered chitons in the present study. Specimens of *L. scrobiculata* occurred in ~20% of the SCB samples, which were collected at depths from 14 to 101 m located off of northern Baja California, San Diego, Palos Verdes, Santa Monica Bay, and the northern Channel Islands. A total of 24 specimens of *L. scrobiculata* were examined, which represents about 10% of the chitons collected. The maximum length of these specimens is 24 mm (mean = 13.5 mm), which is nearly as large as the maximum size reported for this species (see Ferreira, 1978; Kaas & Van Belle, 1987). *Lepidozonia scrobiculata* occurs on a variety of substrates (e.g., rocks, metal, plastic and glass debris) collected by either benthic grabs or in trawl samples. One specimen from off northern Baja was found living adjacent to the operculum on the large turban snail *Megastrea turbanica* (Dall, 1910). Many species of southern California chitons co-occur with *L. scrobiculata*, including *Hanleyella oldroydi*, *Leptochiton rugatus*, *Lepidozonia golischi*, *L. radians*, *L. retiporosa*,

Lepidozona sp. A, *Dendrochiton gothicus*, *D. thamnopus*, *Mopalia lowei*, and *Placiphorella mirabilis*.

***Lepidozona* sp. A**
(Plate 5, Figure 12)

A presently unidentified 12.1 mm long specimen of *Lepidozona*, referred to herein as *Lepidozona* sp. A, resembles but differs from the more southerly *L. guadalupensis* Ferreira, 1978 (known from Guadalupe Island, Baja California) as well as *L. mertensii* in terms of tegmental sculpturing, an opinion that is shared by R. N. Clark (personal communication). *Lepidozona* sp. A can be distinguished from these two species by the morphology of its girdle scales, which are only slightly convex (relatively flat) with each scale bearing about eight distinct longitudinal striations or ridges (see Figure 12e). In contrast, the scales of both *L. guadalupensis* (see Figures 32-33 in Ferreira, 1978) and *L. mertensii* (Figure 8e herein and Figures 20-21 in Ferreira, 1978; see also Kaas & Van Belle, 1987) are strongly convex or bulbous appearing, often mammillated, and at best may appear only weakly striated under normal magnification. Furthermore, the impression of striation in *L. guadalupensis* scales is due to rows of minute pustules present on their outer surface (see Ferreira, 1978), which appears unlike anything observed in *Lepidozona* sp. A. This chiton, also appears somewhat similar to another provisional species reported in this study, *Lepidozona* sp. B (see below), in terms of the distinctly cross-hatched and strongly pitted central areas, but may be distinguished from this and other members of the genus by the additional combination of characters given in the key. *Lepidozona* sp. A was collected southwest of Point Loma, San Diego at a depth of 101 m. Several other species of *Lepidozona* were collected with this chiton, including *L. golischi*, *L. retiporosa*, and *L. scrobiculata*.

***Lepidozona* sp. B**
(Plate 5, Figure 13)

A second unidentified specimen of *Lepidozona* measuring 13 mm in length was collected at a depth of 305 m at a site located west of Palos Verdes. This chiton appears identical with specimens of another unidentified *Lepidozona* collected at a depth of 425 m from the Santa Lucia Bank off of San Luis Obispo County north of the SCB (R. N. Clark, personal communication). This species, referred to here as *Lepidozona* sp. B, appears unique compared to other known West Coast members

of the genus, from which it can be distinguished by the combination of characters given in the key. Although this chiton bears some similarity to *Lepidozona* sp. A in the tegmental sculpturing of the central areas (see above), these two provisional species can be easily distinguished from each other by the morphology of their tubercles, which are round and flat or only slightly raised in *Lepidozona* sp. B compared to elongated or digitate in *Lepidozona* sp. A. Other species collected with *Lepidozona* sp. B were *Leptochiton rugatus* and *Lepidozona retiporosa*.

***Lepidozona* sp. C**
(Plate 6, Figure 14)

A third unidentified specimen of *Lepidozona* measuring 19.5 mm in length was collected at a depth of 90 m at a site located off San Diego. This chiton, referred to here as *Lepidozona* sp. C, is similar to *L. mertensii* (see above) and *L. willetti* (not reported in this study) in terms of the morphology of the girdle scales, which are strongly convex and crowned with a ribbed nipple unless broken off. However, the flat button-like tubercles of *Lepidozona* sp. C, which are especially prominent on the end valves, are clearly distinct from the large, globular to digitate tubercles of *L. mertensii* or the small, bead-like tubercles of *L. willetti*. *Lepidozona* sp. C also differs from *L. willetti* in lacking distinct narrow sulci that separate the radial rows of tubercles on the end valves and lateral areas of the intermediate valves. This species also appears similar to another undescribed species of *Lepidozona* reported for depths below 10 m ranging from the Cortez Bank, southern California to Sacramento Reef, Baja California Norte (R. N. Clark, personal communication). Other SCB chitons collected with *Lepidozona* sp. C include *Hanleyella oldroydi* and *Lepidozona retiporosa*.

Family Mopaliidae Dall, 1889

***Dendrochiton gothicus* (Carpenter, 1864)**
(Plate 6, Figure 15)

Dendrochiton gothicus is known to occur along the western coast and offshore islands of North America from Santa Cruz Island, southern California to Isla Asunción, Baja California from the intertidal to depths of 230 m (Ferreira, 1982; Kaas & Van Belle, 1985b). Although often found in deep waters, *D. gothicus* is reported here from only a single monitoring station (5 samples) in Santa Monica Bay at a depth of 16-18 m. A total of 41 specimens of *D. gothicus* were present in

these samples, however, which accounts for ~17% of all chitons examined in this study. The maximum length of the SCB specimens is 5.5 mm (mean = 3.4 mm), which is about half the size often reached by this small species (see Ferreira, 1982; Kaas & Van Belle, 1985b as *Lepidochitona gothica*). In rock dredges off San Pedro, this species has normally been found attached to coralline algae including juvenile specimens as small as about 1 mm in length (DJE, unpublished observation). Other chitons that co-occur with *D. gothicus* include *Leptochiton nexus*, *Lepidozona scrobiculata*, *Dendrochiton thamnopus*, and *Mopalia lowei*.

***Dendrochiton thamnopus* (Berry, 1911)**
(Plate 6, Figure 16)

Dendrochiton thamnopus has been previously reported to occur from the intertidal to depths of 29 m along the western coast and offshore islands of North America from Bodega Bay, California to Punta Abreojos, Baja California (Ferreira, 1982; Kaas & Van Belle, 1985b as *Lepidochitona (Dendrochiton) thamnopus*). This species is reported from nine specimens in the present study with a maximum length of 9.3 mm (mean = 5.6 mm), which is consistent with published records for this small species (see Ferreira, 1982; Kaas & Van Belle, 1985b). These chitons were collected at depths of 15-38 m, which represents a slight extension of the depth range for this species, including one site off northern Baja California at a depth of 29 m, two sites off San Diego at a depths of 27-38 m, one site in Santa Monica Bay at a depth of 17 m, and one site just off San Miguel Island in the northern Channel Islands at a depth of 15 m. The specimen of *D. thamnopus* from northern Baja was found living on the sides of *Megastrea turbanica* at a site where *Lepidozona scrobiculata* was also collected from another individual of this large turban snail. The specimen collected near San Miguel Island was found along with another chiton, *Tonicella venusta*, living on a rock covered with a flat, encrusting red coralline alga similar to *Lithothamnion* (D. B. Cadien, personal communication). Other SCB chitons that occur at the same sites with *D. thamnopus* include *Leptochiton nexus*, *Dendrochiton gothicus*, *Mopalia imporcata*, and *M. lowei*.

***Mopalia imporcata* Carpenter, 1864**
(Plate 7, Figure 17)

Mopalia imporcata is reported to occur along the West Coast from Kachemak Bay, Alaska to Punta Santo

Tomás, Baja California at depths ranging from the intertidal to 120 m (Clark, 1991; Kaas & Van Belle, 1994). This chiton is reported here from three individuals, including a tiny juvenile collected at a depth of 46 m off of Santa Rosa Island, northwestern Channel Islands, and two adults collected off San Diego and Santa Monica Bay at depths of 38 and 69 m, respectively. These specimens measured 3.5, 13.5 and ~15 mm in length, respectively, while the maximum reported size for this species is 23 mm (see Kaas & Van Belle, 1994). Another species of chiton collected with *M. imporcata* off San Diego was *Dendrochiton thamnopus*.

***Mopalia lowei* Pilsbry, 1918**
(Plate 7, Figure 18)

Mopalia lowei is known to occur along the entire coast of California at depths ranging from the intertidal to shallow subtidal (Kaas & Van Belle, 1994). This chiton is reported here from a single specimen collected in Santa Monica Bay at a depth of 17 m. The specimen was a juvenile with a body length of 5 mm compared to a maximum length of 30 mm reported for this species (see Kaas & Van Belle, 1994). Other SCB chitons that co-occur with *M. lowei* include *Lepidozona scrobiculata* and *Dendrochiton gothicus*.

***Mopalia phorminx* Berry, 1919**
(Plate 7, Figure 19)

Mopalia phorminx is considered a rather uncommon chiton with a reported distribution along the West Coast ranging from Prince William Sound, Alaska to San Pedro, California at depths ranging from 18 to 183 m (Clark, 1991; Kaas & Van Belle, 1994). This chiton is reported here from two specimens collected at separate sites off Palos Verdes at depths of 100 and 130 m, although the exact locations of these sites are currently unknown (D. B. Cadien, personal communication). The maximum length of the SCB specimens is 24 mm (mean = 22 mm), which is relatively large for this species (see Kaas & Van Belle, 1994). This species co-occurs with *Lepidozona retiporosa*.

***Placiphorella mirabilis* Clark, 1994**
(Plate 8, Figure 20)

Placiphorella mirabilis occurs from Santa Barbara, southern California to Isla Cedros, Baja California at depths of 28-155 m (Clark, 1994; Kaas & Van Belle, 1994, as *Placiphorella* species 1). This species is known

from a total of four specimens in the present study that were collected during trawls conducted as part of the Southern California Bight Pilot Project in 1994. These chitons occurred at two different sites off San Diego, which ranged in depth from 43 to 104 m. The maximum length of the SCB specimens of *P. mirabilis* is 43 mm (mean = 24.5 mm), which is rather large compared to previous records for this species (see Clark, 1994). Another chiton found with *P. mirabilis* was *Lepidozonia scrobiculata*.

***Tonicella venusta* Clark, 1999**

(Plate 8, Figure 21)

Tonicella venusta occurs along the West Coast from south-central Alaska to Isla Cedros, Baja California from the intertidal to depths of 140 m (Clark, 1999). This chiton is reported here from a single specimen collected at a depth of 15 m just off of San Miguel Island, the westernmost of the northern Channel Islands. It should be noted that this island has a chiton fauna that is more normally typical of central California, not southern California. The chiton was curled with an estimated length of ~ 10 mm, which is consistent with published size records for this species (see Clark, 1999). This specimen of *T. venusta* was found living with *Dendrochiton thamnopus* on a rock covered with a flat, encrusting red coralline alga (~ *Lithothamnion*) that was brought up in the jaws of a benthic grab (D. B. Cadien, personal communication).

Discussion

The present study brings to 16 the number of described chiton species known to occur along the continental shelf and upper slope of the Southern California Bight (SCB) in waters mostly deeper than 30 m based on collections provided by benthic monitoring programs in the region, plus three provisional species as well as a fourth possibly undescribed species (see Tables 1 and 2). Of the two extant chiton lineages, Lepidopleurida is represented only by Leptochitonidae (3 species), while Chitonida is represented by Chitonina: Ischnochitonidae (6 described and 3 provisional species) and Acanthochitonina: Mopaliidae (7 species). Seventeen other species are also likely to occur based on published bathymetric and geographic distributions (see Table 1 and below), which brings the region's estimated chiton fauna for these deeper waters to about 36 species. In contrast, Eernisse (1998) reported only six species in material collected in a survey of relatively deep waters (50-250 m) of the Santa Maria Basin and Western Santa

Barbara Channel (all also sampled here), but he cautioned that these were limited samples with at least another 13 species likely to occur in the region (i.e., 19 species total), probably living in rockier bottoms than generally sampled in this study.

It is notable that although the total number of chiton species is relatively high in the SCB benthos, only three of about 12 total extant taxa typically ranked at a family level worldwide are present and the diversity of genera within these three families is not impressive. The genera that are most diverse are also the most diverse in the northern Pacific. This is similar to chitons living in shallow waters along the West Coast, where higher-level taxonomic diversity is low but certain genera (e.g., *Cyanoplax*, *Lepidozonia*, *Mopalia*, *Tonicella*) are either exclusively northern Pacific or else are by far most diverse there. Our review thus supports the general pattern that both the shallow and moderately deep fauna of the northern Pacific has both a high degree of endemism, with relatively few higher taxa present, but those taxa that are present are impressively species-rich.

The general lack of overlap between the chiton fauna above or below about 30 m depth has implications for the extent of population connectivity of cooler water "northern" species that so far have not been reported in shallow water off southern California. These have been found in shallow water from especially the coolest sides of the northern and western Channel Islands, and also from the intertidal of known upwelling sites south of Punta Banda, northern Baja California, in the southernmost SCB. Are these apparently disjunct populations actually connected to central California through individuals living at depths > 30 m off mainland southern California? Our results suggest not. Assuming that these species have not merely been overlooked in shallower water along southern California shores, we propose that it is more likely that population connectivity, if it occurs at all, must be the result of relatively long-distance dispersion of larvae from central California. Given the predominantly warm nature of any return currents to central California via the Davidson countercurrent, and the relatively rare occurrence of such southern "refugia," it could be much less likely that planktonic larvae from southern disjunct "cool water" populations could be expected to recruit back to central California. The existence of such "peripheral isolate" shallow water southern populations could reflect ongoing processes of genetic isolation that could be producing incipient species. This opportunity for speciation, combined with climate-related latitudinal shifts over geological time, could help explain the high diversity of certain species-rich genera in the shallow waters of the

cool temperate West Coast. Most previous emphasis in the literature has been on the parallel situation of northern refuge populations of warm temperate species in the anomalously warm parts of central California, such as Monterey Bay. This latter well-documented pattern of northern refugia is probably most important for taxa extending north from the warmer latitudes, whereas southern refugia are probably more important to those taxa whose primary diversification has been in the cool northern Pacific (e.g., Kelly & Eernisse, 2008).

Two of the four most widely distributed and abundant chitons encountered in this study are lepidopleurids of the family Leptochitonidae; each occurred in at least 22% of the samples. These common species include *Leptochiton rugatus* (Figure 4) and *Hanleyella oldroydi* (Figure 2), which together comprised more than 35% of the chitons examined. As mentioned previously, a new study (Eernisse & Kelly, unpublished) has provided DNA-based evidence that what we have referred to as *L. rugatus* is actually an undescribed deep-water species, which is part of a complex of northern Pacific species related to the "true" *L. rugatus* of shallow waters. A second *Leptochiton* species, *L. nexus* (Figure 3), is reported from several specimens, while a third and possibly new species of *Leptochiton* is known from a single small individual. At least two other species of *Leptochiton* that are presently known from only depths of 160 m or below, *L. americanus* and *L. cf. belknapii*, could also occur along the SCB continental shelf and slope (see Ferreira, 1979b; Wu & Okutani, 1984; Kaas & Van Belle, 1985a, 1987; Schwabe, 2008; also R. N. Clark, personal communication). Multiple specimens of another lepidopleurid, all identified as *Oldroydia percrassa*, have been regularly collected in rock dredge samples taken off southern California (DJE, personal observation). Their identities need to be reevaluated in light of Sirenko & Clark's (2008) recent revival of the similar *Deshayesiella spicata* (Berry, 1919) from off San Diego and elsewhere along the West Coast (see below and also Kaas & Van Belle, 1985a).

Chitonina: Ischnochitonidae is represented by *Lepidozonia* and *Callistochiton*. *Lepidozonia* is the most diverse of the SCB chiton genera that occur at depths below 30 m, being represented here by five described species, including *L. golischi*, *L. mertensii*, *L. radians*, *L. retiporosa*, and *L. scrobiculata* (Figures 6-11). Of these, *L. retiporosa* and *L. scrobiculata* are the most common species, with each occurring in at least 20% of the samples and together accounting for about 29% of the chitons examined. Additionally, three likely new species of this genus, herein designated *Lepidozonia*

spp. A, B and C, are reported (Figures 12-14). The genus *Callistochiton* is represented by a single species, *C. palmulatus* (Figure 5), which is known from two records in the present study. However, this species is probably much more common in deeper SCB waters than indicated here, having frequently been observed to live in vacant mussel bore holes in soft mudstone collected off San Pedro, Los Angeles County (DJE, personal observation). Two other species of *Callistochiton*, *C. crassicostatus* and *C. decoratus*, may also occur in deep water habitats of the region (see Ferreira, 1979a; Kaas & Van Belle, 1994; also see below).^{Endnote} Additional genera and species of Chitonina that may occur in the SCB at the depths sampled in this study are *Chaetopleura gemma*, *Stenoplax corrugata* (see below), and *Stenosemus stearnsii* (see Ferreira, 1983; Kaas & Van Belle, 1987, 1990).

Acanthochitonina: Mopaliidae is represented by four genera with seven species. These include *Dendrochiton gothicus* and *D. thamnopus* (Figures 15-16), *Mopalia imporcata*, *M. lowei* and *M. phorminx* (Figures 17-19), *Placiphorella mirabilis* (Figure 20), and *Tonicella vennsta* (Figure 21). Each of these species occurred in no more than five samples in this study and, with the exception of *D. gothicus*, was represented by at most a few individuals. Additional Acanthochitonina species likely to occur in relatively deep waters of the region include *Acanthochitona avicula* within Acanthochitonidae, *Lepidochitona beanii* within Lepidochitonidae, and *Mopalia acuta*, *Dendrochiton flectens*, *D. semiliratus* and *Placiphorella pacifica* within Mopaliidae (e.g., Ferreira, 1982; Kaas & Van Belle, 1985b, 1994; Eernisse, 1986; Watters, 1990; Clark, 1994). Another species within Mopaliidae, *Katharina tunicata*, has also long been reported to range as far south as Santa Catalina Island and the Coronado Islands, and to occasionally reach depths down to 40 m (e.g., Pilsbry, 1893; Oldroyd, 1927; Ricketts et al., 1985; Kaas & Van Belle, 1994). We do not include *K. tunicata* as part of the SCB benthic fauna discussed herein as we consider this normally intertidal chiton unlikely to occur in any subtidal samples from > 30 m depth. Additionally, aside from its presence in fossil deposits near San Pedro (see Berry, 1922), we have been unable to verify any records of the species south of San Luis Obispo County in central California.

Two additional chitons have been recorded previously from monitoring activities in the region, but are considered dubious records and are not included here as part of the SCB fauna. These include the lepidopleurid, *Hanleya hanleyi*, and an unidentified species of *Ischnochiton* (i.e., *Ischnochiton* sp. in

SCAMIT, 1994, 1996).

The *H. hanleyi* record was based on a single chiton collected off Point Conception in 1977 by the Southern California Coastal Water Research Project (SCCWRP). Unfortunately, the specimen was disposed of long ago (D. Tsukada, personal communication), and therefore the identification could not be verified. However, we agree with Ferreira (1979b) that *Hanleya* is not present in Pacific waters, or at least not in the eastern Pacific. Ferreira attributed previous eastern Pacific references to *H. hanleyi* by Oldroyd (1927), Smith (1947a, 1947b), Smith & Gordon (1948), and Jakovleva (1952) as probable misidentifications of juvenile *Oldroydia percrassa* (Dall, 1894). We agree that this is a good possibility, but it might alternatively be the nominal species that Sirenko & Clark (2008) have recently revived, *Deshayesiella spicata* (Berry, 1919). These authors regard *D. spicata* to be highly similar to *O. percrassa* but with a less conspicuously elevated jugal ridge and less projecting jugal articulation (the latter seen only in disarticulated valves). *Deshayesiella spicata* was first proposed as *Hanleya spicata* by Berry (1919b) and we have included it in our key, directly quoting their (Sirenko & Clark, 2008) primary distinctions between these nominal species. The contrast is complicated by the small size (4.5 mm length) of the holotype of *D. spicata* and the fact that this holotype has not yet been contrasted with typical *O. percrassa* of a similar size. It remains to be seen whether future studies will confirm these as distinct species or find instead that the differences reflect intraspecific variation, perhaps due to microhabitat differences experienced by the chitons. Larger “*spicata*” specimens similar to those described by Sirenko & Clark (2008) have been observed by one of us (DJE), taken by rock dredges off San Pedro in Los Angeles County, whereas several typical specimens of *O. percrassa* have been observed from slightly shallower depths off Point Loma in San Diego County (see below) and from the subtidal of Monterey County, central California (A. Draeger, personal communication). A third possibility is that the “*Hanleya hanleyi*” animal was a misidentification of *Hanleyella oldroydi*, which is relatively common in SCB samples, and may bear a superficial resemblance to *Hanleya* to non-chiton workers in terms of valve and girdle morphology.

It is unknown which species or even which genus the unidentified “*Ischnochiton*” may represent. Although one species of *Stenosemus* (considered by some a subgenus of *Ischnochiton*), *S. stearnsii*, could range into the shelf and upper slope depths sampled off southern California as noted above, this species is so far known

from only much deeper waters (> 400 m) and has not been confirmed by benthic monitoring programs in the region. It is more likely that the specimen represented a misidentification of *Lepidozonia radians* or *L. retiporosa*, which are each known from the present study. Both species have previously been placed within *Ischnochiton*, probably because neither has the pronounced dorsal sculpturing apparent in other members of *Lepidozonia*, and their assignment to *Lepidozonia* partly depends on valve features only visible after valves are disarticulated (e.g., “jugal plate separated from apophyses by small notches” in Kaas & Van Belle, 1987). Another, somewhat doubtful, possibility is that the specimen could have been *Ischnochiton newcombi* Carpenter in Pilsbry, 1892 (type locality “California, Sta. Catalina Island”), which is only known from the holotype (see Kaas & Van Belle, 1990).

Finally, it is remarkable that southern California still lacks a complete treatment of chitons for shallower depths than those covered here. While intertidal chitons are relatively well known, very little is known about subtidal chitons accessible by SCUBA. Three examples were brought to light by the recent examination of collections made by the late David Mulliner while diving about one mile off the coast of Point Loma, San Diego, each species which is also likely to occur in deeper waters of the region (see Table 1). The first is a lot of five specimens of typical *Oldroydia percrassa* (Plate 9, Figure 22), which were collected at depths of 15-18 m in October 1972. We fully expect that this species will eventually be collected at depths that were the focus of this study. Likewise, two lots of *Callistoichiton decoratus* (Figure 23), representing 15 specimens also collected from 15-18 m in 1972 and 1975, reveal that this species is relatively common at those depths, and it seems likely it may also occur in deeper waters of the region. Finally, a single individual of the rare *Stenoplax corrugata* (Figure 24), which was the first specimen either of us had ever seen, was collected at 18-20 m in February 1973 and originally identified as “*Stenoplax* sp.” After we had studied this specimen, DJE collected a second *S. corrugata* specimen off San Pedro using a rock dredge (February 29, 2008; length ~35 mm; 23-29 m on a rock). Again, it is likely that this species occurs at the depths treated herein, but has been missed because of its rarity or because it is restricted to a specific unsampled rocky bottom habitat. It is our hope that we can next undertake a companion contribution on the intertidal and shallow subtidal chitons of southern California and northern Baja California, but we will need the similar cooperation of those dedicated to discovering the habitat and ecology of chitons accessible by diving.

Endnote

As part of this study we also investigated a suggestion made by Coan (1985) and adopted in Turgeon et al. (1998) to recognize little-known descriptions provided by Josiah Keep in 1887 for two species of *Callistochiton* that occur in southern California waters. If valid this would a) affect the authority for *C. decoratus* giving priority to Keep (1887) instead of Carpenter MS, Pilsbry, 1893, and b) make *C. crassicosatus* Pilsbry, 1893, a junior synonym of *C. fimbriatus* Keep, 1887. The additional description of *C. palmulatus* Carpenter MS in Keep (1887) would not have similar priority because this name was validated earlier as *C. palmulatus* Carpenter MS, Dall, 1879, a name for which Ferreira (1979a) has designated a neotype. Below is a summary of our findings.

Briefly, Keep (1887) provided short descriptions of *C. decoratus*, *C. palmulatus*, and *C. fimbriatus*, in this order and all attributed to Carpenter's manuscript. No figures were provided in support of these descriptions and, unfortunately, no specimens identified as *C. decoratus* or *C. fimbriatus* exist in all that apparently remains of the Keep Collection, which is now housed at Tohoku University (Sendai, Japan). There is one *Callistochiton* included in the collection, a complete set of disarticulated valves, identified on the outside of the vial as "*Callistochiton palmulatus* Cpr Monterey" (H. Saito and J. Nemoto, personal communication). Further complicating matters, our study of the images of these valves provided courtesy of J. Nemoto have revealed that they correspond instead to *C. crassicosatus*.

Based on our review of the available information, we feel that Keep's descriptions of *C. decoratus* and *C. fimbriatus* are inadequate to distinguish these taxa from each other or any other species of *Callistochiton*. Additionally, given the sparse and inadequate descriptions of these species in Keep (1887), the lack of identified specimens of either *C. decoratus* or *C. fimbriatus* in the Keep Collection, and the misidentification of Keep's *C. palmulatus* material, we do not believe it is possible to reliably determine which species of *Callistochiton* Keep was referring to in each of his descriptions. Thus, we consider Keep's designations of these two species in 1887 to be *nomina dubia*, and herein retain *Callistochiton crassicosatus* Pilsbry, 1893, and *Callistochiton decoratus* Carpenter MS, Pilsbry, 1893, as the oldest available names and authorities for these chitons (see Table 1).

Acknowledgments

We thank the staff of the City of San Diego's ocean monitoring program for assistance collecting, processing and providing information on many of the chitons examined herein, including especially Kelvin Barwick (now with Orange County Sanitation District), Dan Ituarte, Megan Lilly, Rick Rowe, Wendy Storms and Ron Velarde. We are especially grateful to Kelvin Barwick for photographic assistance with many specimens, Rick Rowe for taking the photographs of live specimens of *Hanleyella oldroydi* (Figure 2b) and *Lepidozona* sp. C (cover), Dan Ituarte for advice and help preparing or restoring several of the final images, and to Dawn Olson for preparing the map in Figure 1. We greatly appreciate the assistance of Don Cadien (Los Angeles County Sanitation Districts), Tony Phillips (City of Los Angeles), and Christina Thomas and George Robertson (Orange County Sanitation District) for providing specimens and sampling information from their respective monitoring programs. We also thank Ananda Ranasinghe of SCCWRP for tracking down some elusive station information for the 1994, 1998 and 2003 SCB regional surveys. We thank David and Margaret Mulliner for donation of their chiton collections to the University of Michigan Museum of Zoology (UMMZ), some of which were photographed for this paper (Figures 22-24). Dr. Diarmaid ÓFoighil of UMMZ arranged a loan of this material for study. We also appreciate the assistance of Paul Valentich-Scott and Patricia Sadeghian of the Santa Barbara Museum of Natural History for providing digital images (e.g., Figure 6b) or type specimens of several chitons for comparative purposes. We thank Greg Rouse and Harim Cha of the Scripps Institution of Oceanography for the loan of specimens from SIO's Benthic Invertebrate Collection. We also thank Eugene Coan (Santa Barbara Museum of Natural History), Hiroshi Saito (National Museum of Nature and Science, Tokyo), Jun Nemoto (Museum of Natural History at Tohoku University, Sendai), and Gary Rosenberg (Academy of Natural Sciences, Philadelphia) for providing information regarding nominal species of *Callistochiton* described briefly by Josiah Keep in 1887. We also appreciate the assistance of Enrico Schwabe (Zoologische Staatssammlung München, Germany) in tracking down and providing us with a 19th century reference. We are grateful to Anthony Draeger (Kensington, CA) for useful comments on an early draft of the manuscript and for

subsequent discussions, as well as for providing the digital image used herein of the *Lepidozona scabricostata* holotype (Figure 6a). We also sincerely thank Roger Clark (Eagle Mountain, UT) who provided much advice, kindly reviewed and confirmed many of the identifications, and for useful comments and suggestions that greatly improved our final manuscript. Finally, we thank *The Festivus* Editor-in-Chief, Carole Hertz, for her help and patience while we finished this paper. TDS acknowledges support from the City of San Diego, Metropolitan Wastewater Department (Environmental Monitoring and Technical Services Division). DJE acknowledges a sabbatical fellowship supported by the National Evolutionary Synthesis Center (NESCent), NSF #EF-0423641.

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SPECIES PLATES
(Figures 2-24)

and

APPENDIX A

PLATE 1
(Figures 2-4)

Figure 2. *Hanleyella oldroydi* (Bartsch MS, Dall, 1919). (a) Dorsal view of specimen, 4 mm length, collected west of Mission Bay, San Diego County, California at a depth of 18 m; (b) Lateral view of live specimen, ~5 mm length, collected southwest of Point Loma, San Diego County, California at a depth of 90 m.

Figure 3. *Leptochiton nexus* Carpenter, 1864. Dorsal view of 9.3 mm long specimen collected just south of San Miguel Island, northern Channel Islands, California at a depth of 71 m.

Figure 4. *Leptochiton rugatus* (Carpenter *in* Pilsbry, 1892). Specimen, 5.4 mm length, collected southwest of La Jolla, San Diego County, California at a depth of 117 m: (a) Dorsal view of whole animal; (b) Lateral view of whole animal.

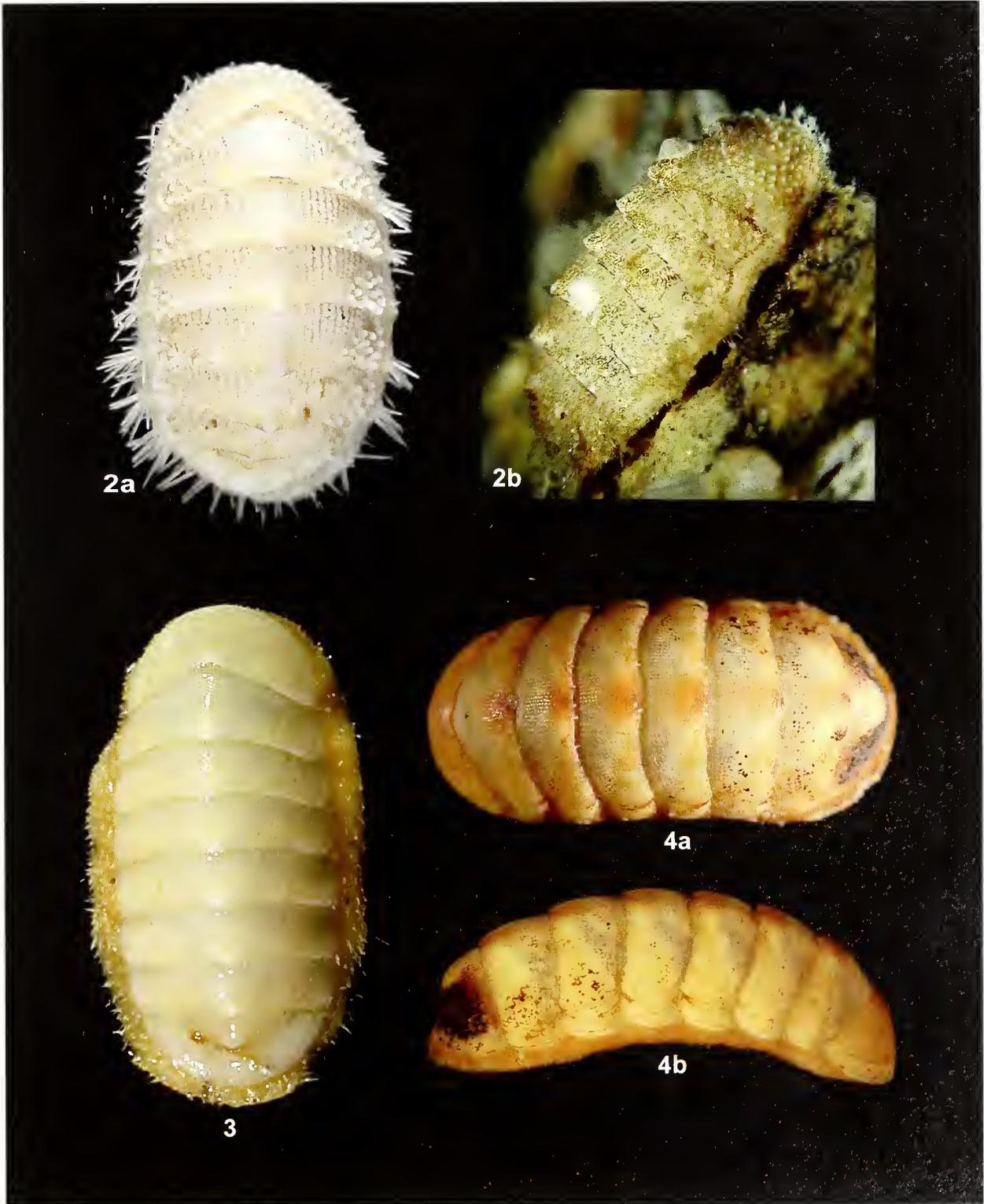


PLATE 2
(Figures 5-7)

Figure 5. *Callistochiton palmulatus* Carpenter MS, Dall, 1879. Dorsal-lateral view of 13 mm long specimen with typical bulging, fist-shaped tail valve, collected southwest of La Jolla, San Diego County, California at a depth of 85 m.

Figure 6. Type specimens of *Lepidozona scabricostata* (Carpenter, 1964) and *Ischnochiton (Lepidozona) golischi* Berry, 1919. (a) Dorsal view of holotype of *L. scabricostata* (USNM 16268; image courtesy of A. Draeger); (b) Dorsal view of lectotype of *I. (L.) golischi* (SBMNH 34395; image courtesy of P. Valentich-Scott and P. Sadeghian); (c) Enlarged view of lateral and central areas of *I. (L.) golischi* lectotype.

Figure 7. *Lepidozona golischi* (Berry, 1919). Specimen, 22.5 mm length, collected west of Imperial Beach, San Diego County, California at a depth of 98 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

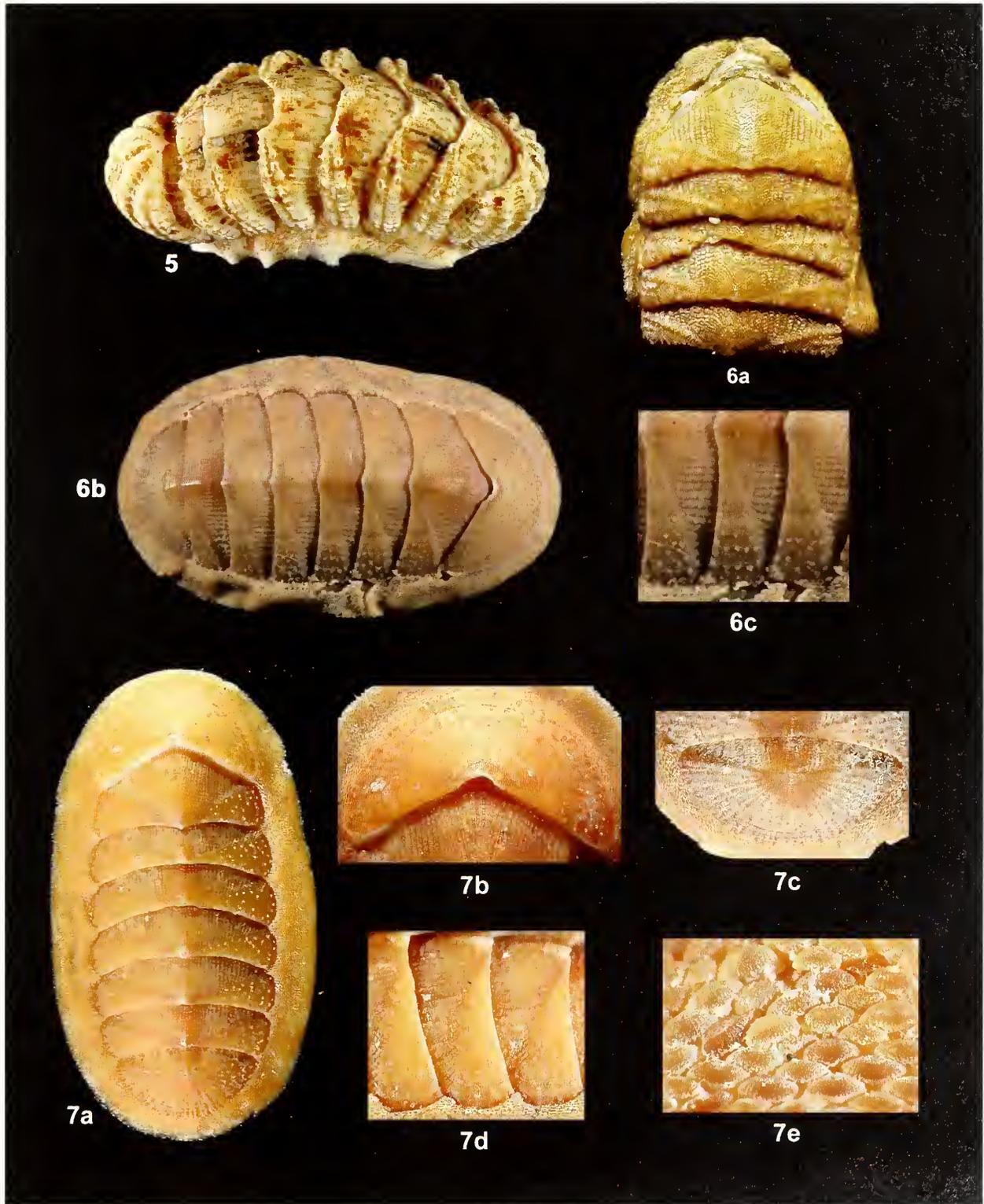


PLATE 3
(Figures 8-9)

Figure 8. *Lepidozona mertensii* (von Middendorff, 1847). Specimen, 15 mm length, collected west of Imperial Beach, San Diego County, California at a depth of 80 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

Figure 9. *Lepidozona radians* (Carpenter *in* Pilsbry, 1892). (a) Dorsal view of olive green and brown specimen, 6.9 mm length, collected west of the Tijuana River, San Diego County, California at a depth of 14 m; (b) Girdle scales of previous chiton; (c) Dorsal view of white specimen, 7.4 mm length, collected off Santa Cruz Island, northern Channel Islands, California.

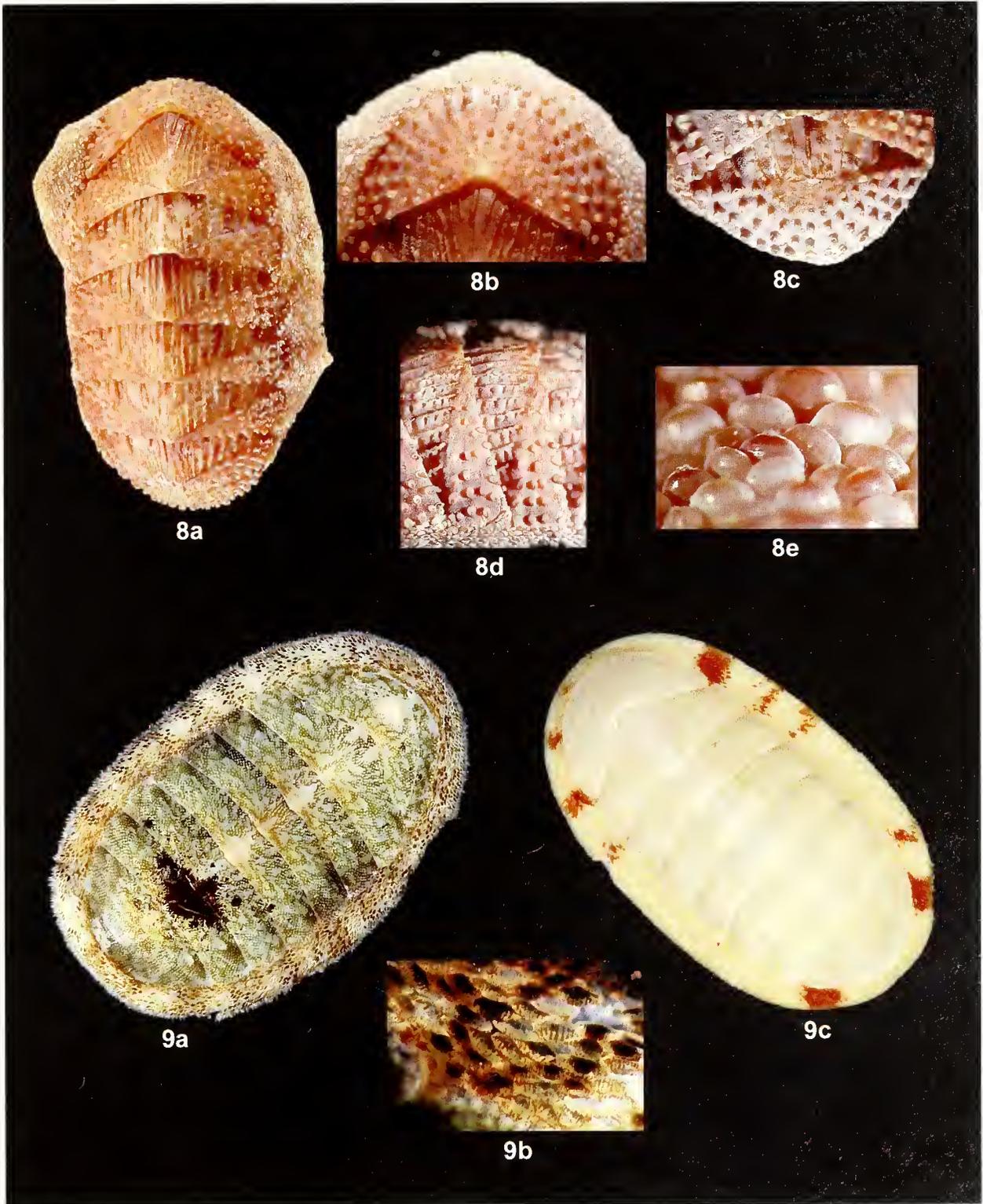


PLATE 4
(Figures 10-11)

Figure 10. *Lepidozona retiporosa* (Carpenter, 1864). Specimen, 17 mm length, collected west of Imperial Beach, San Diego County, California at a depth of 98 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

Figure 11. *Lepidozona scrobiculata* (von Middendorff, 1847). Specimen, 15.8 mm length, collected west of the Tijuana River, San Diego County, California at a depth of 28 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

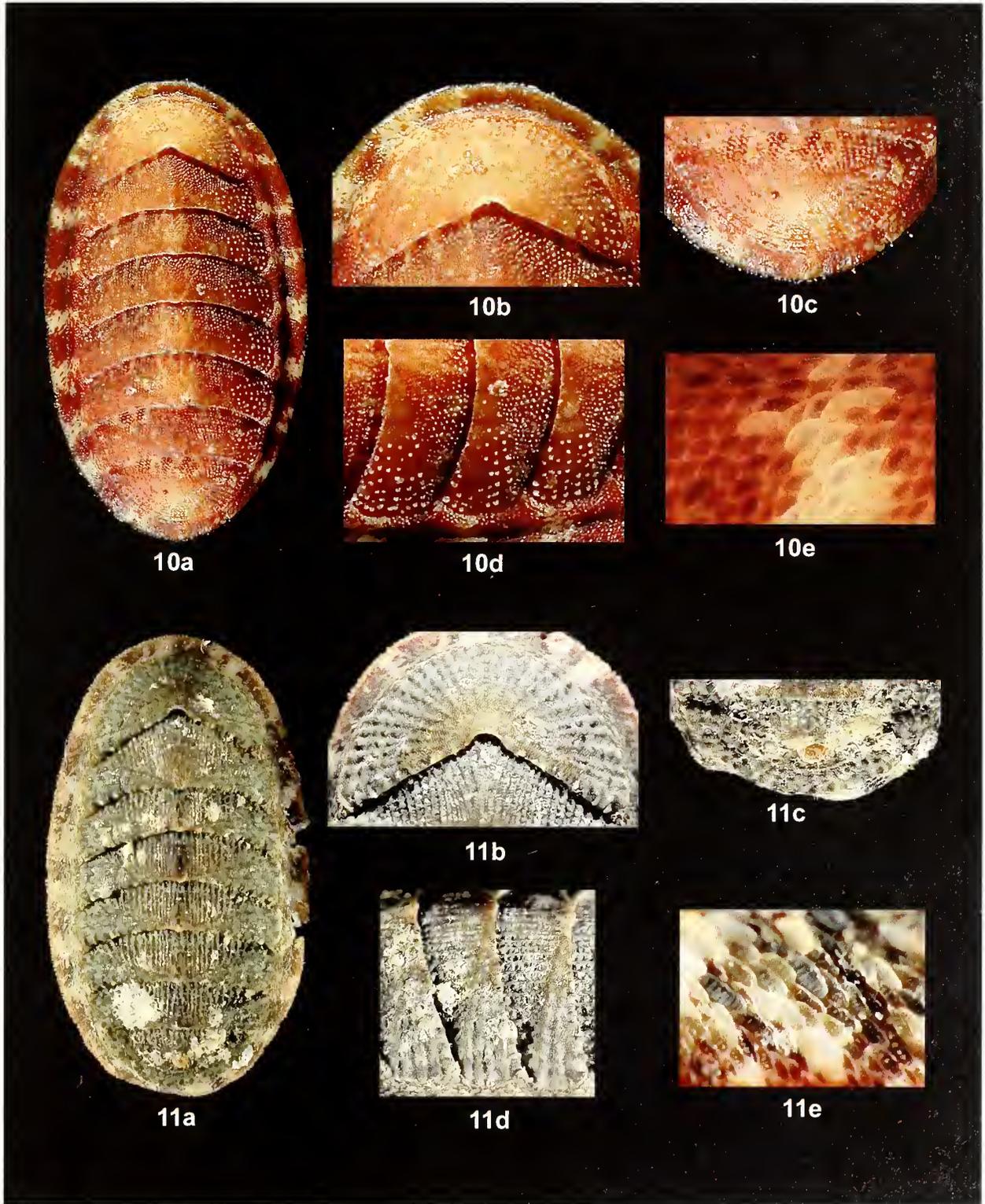


PLATE 5
(Figures 12-13)

Figure 12. *Lepidozona* sp. A. Specimen, 12.1 mm length, collected southwest of Point Loma, San Diego County, California at a depth of 101 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

Figure 13. *Lepidozona* sp. B. Specimen, 13 mm length, collected off Palos Verdes, Los Angeles County, California at a depth of 305 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.



12a



12b



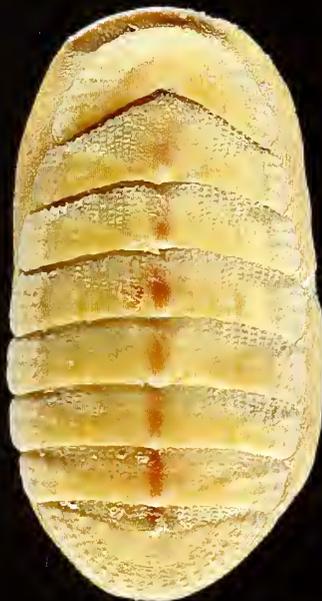
12c



12d



12e



13a



13b



13c



13d



13e

PLATE 6
(Figures 14-16)

Figure 14. *Lepidozona* sp. C. Specimen, 19.5 mm length, collected southwest of Point Loma, San Diego County, California at a depth of 90 m: (a) Dorsal view of whole animal; (b) Head valve region; (c) Tail valve region; (d) Lateral areas of intermediate valves; (e) Girdle scales.

Figure 15. *Dendrochiton gothicus* (Carpenter, 1864). Dorsal view of 5.2 mm long specimen collected in Santa Monica Bay, Orange County, California at a depth of 17 m.

Figure 16. *Dendrochiton thamnopus* (Berry, 1911). (a) Dorsal view of 6 mm long specimen collected west of La Jolla, San Diego County, California at a depth of 27 m; (b) Dorsal view of 7.3 mm long specimen collected southwest of the Tijuana River, San Diego County, California at a depth of 38 m.

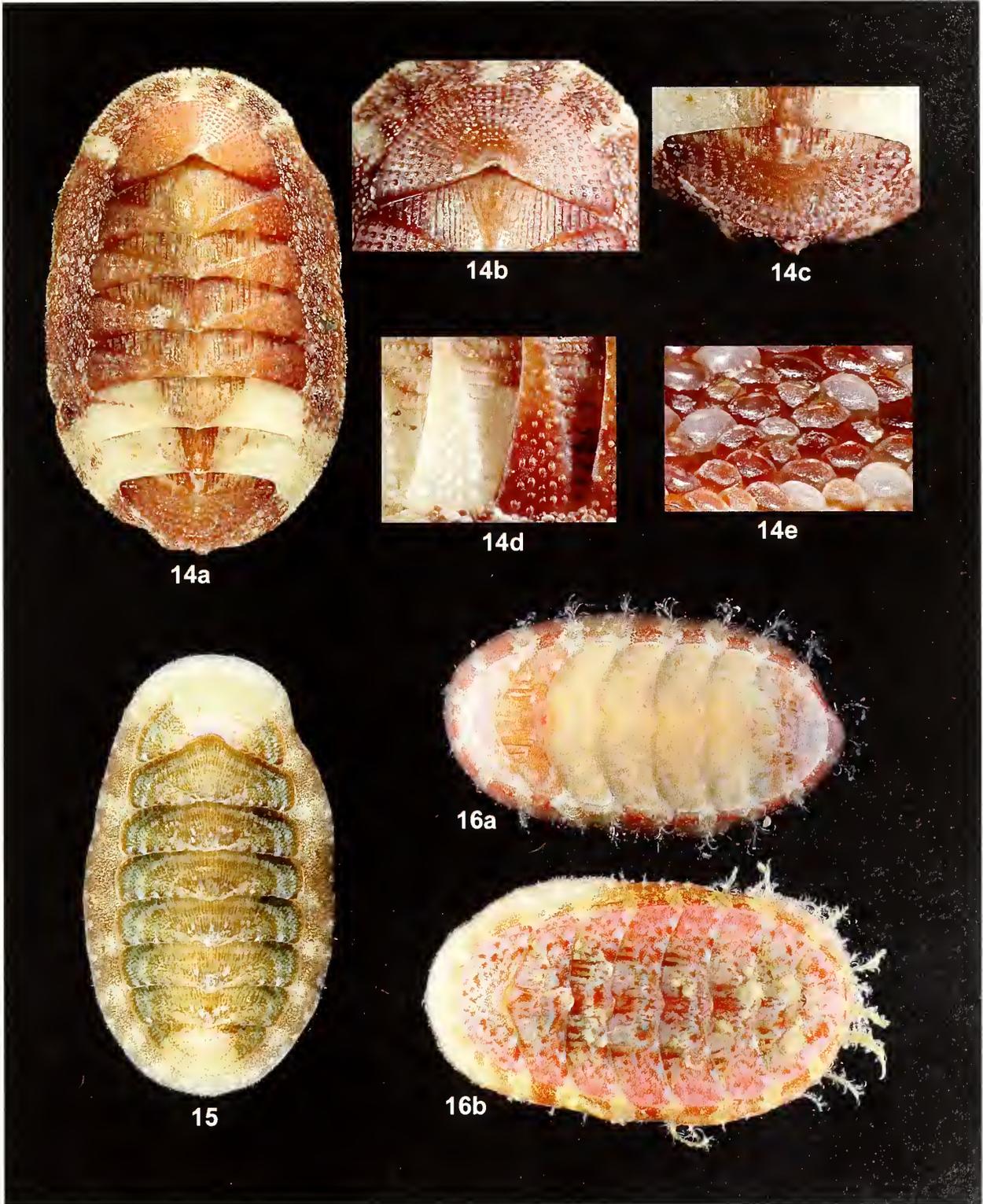


PLATE 7
(Figures 17-19)

Figure 17. *Mopalia imporcata* Carpenter, 1864. (a) Dorsal view of juvenile chiton, 3.5 mm length, collected just south of Santa Rosa Island, northern Channel Islands, California at a depth of 46 m; (b, c) Close-ups of girdle bristles of juvenile chiton; (d) Anterior end of 15 mm long adult chiton collected in Santa Monica Bay at a depth of ~69 m; (e) Close-up of girdle bristle of adult chiton.

Figure 18. *Mopalia lowei* Pilsbry, 1918. Juvenile chiton, 5 mm length, collected in Santa Monica Bay, Orange County, California at a depth of 17 m; (a) Dorsal view of whole animal; (b) Close-up of girdle bristles.

Figure 19. *Mopalia phorminx* Berry, 1919. Specimen, 20 mm length, collected off Palos Verdes, Los Angeles County, California at a depth of 100 m: (a) Dorsal view of whole animal; (b) Close-up of girdle bristles.

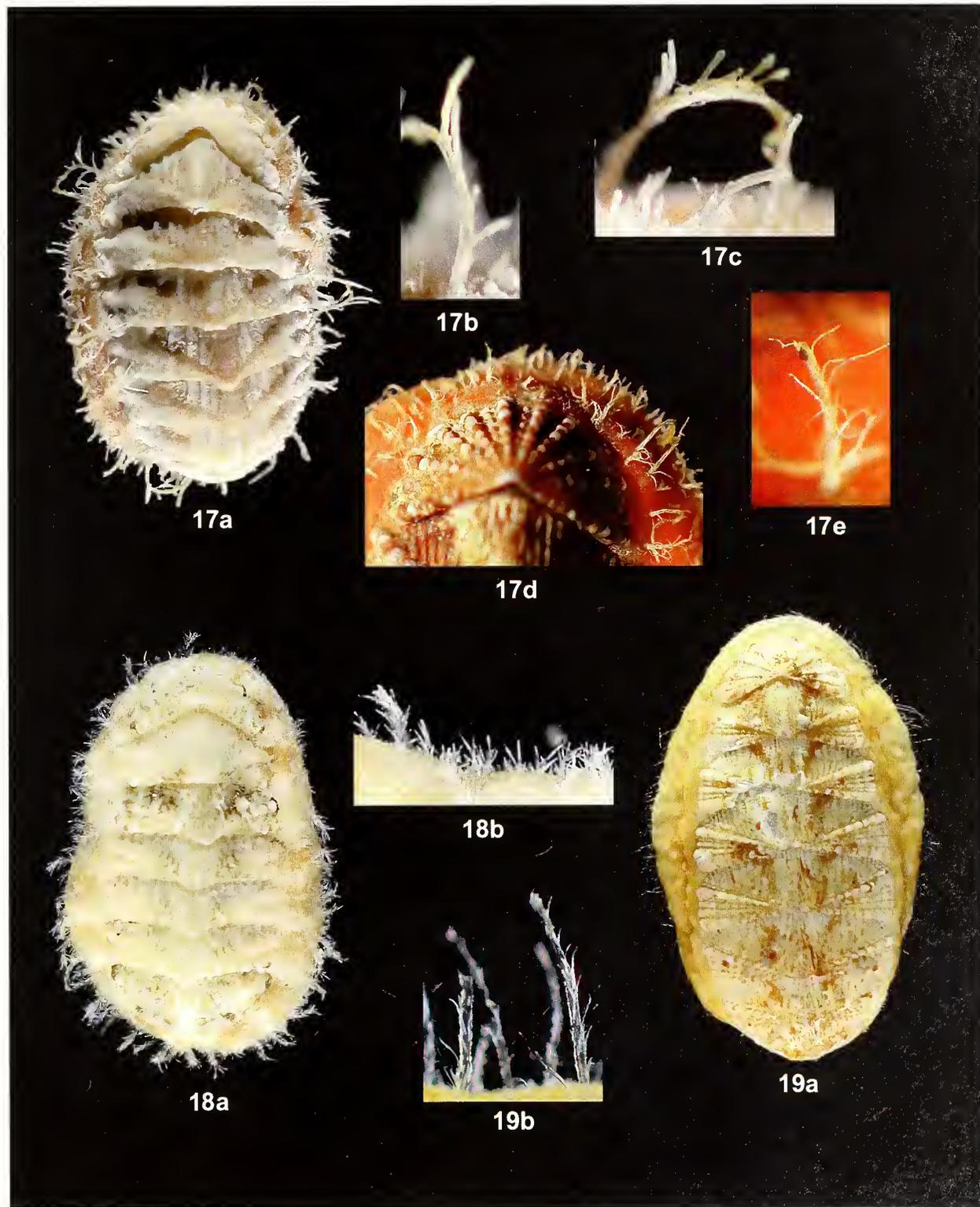
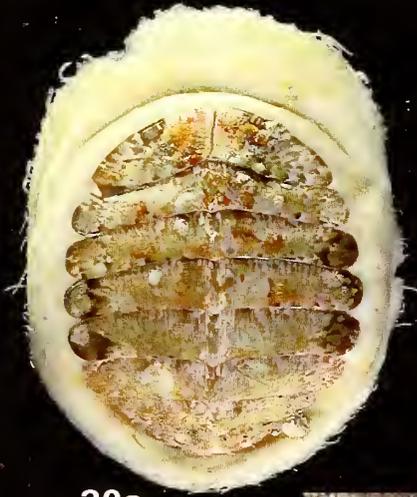


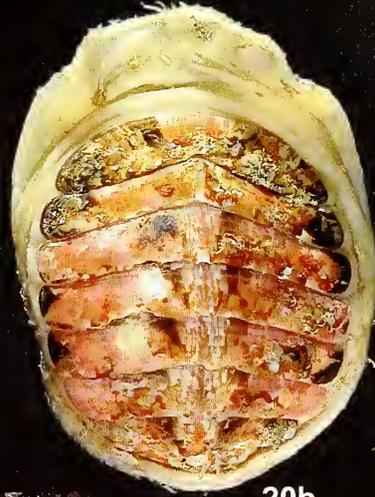
PLATE 8
(Figures 20-21)

Figure 20. *Placiphorella mirabilis* Clark, 1994. Specimens collected southwest of La Jolla, San Diego County, California at a depth of 104 m: (a) Dorsal view of ~17 mm preserved “green” specimen; (b) Dorsal view of ~18 mm preserved “red” specimen; (c) Dorsal view of live specimen, ~25 mm length, showing typical girdle pigmentation.

Figure 21. *Tonicella venusta* Clark, 1999. Curled specimen, ~10 mm length, collected just off the eastern side of San Miguel Island, northern Channel Islands, California at a depth of 15 m: (a) Dorsal view of whole animal showing valves I-VI; (b) Enlarged view of valves III-VI.



20a



20b



20c



21a



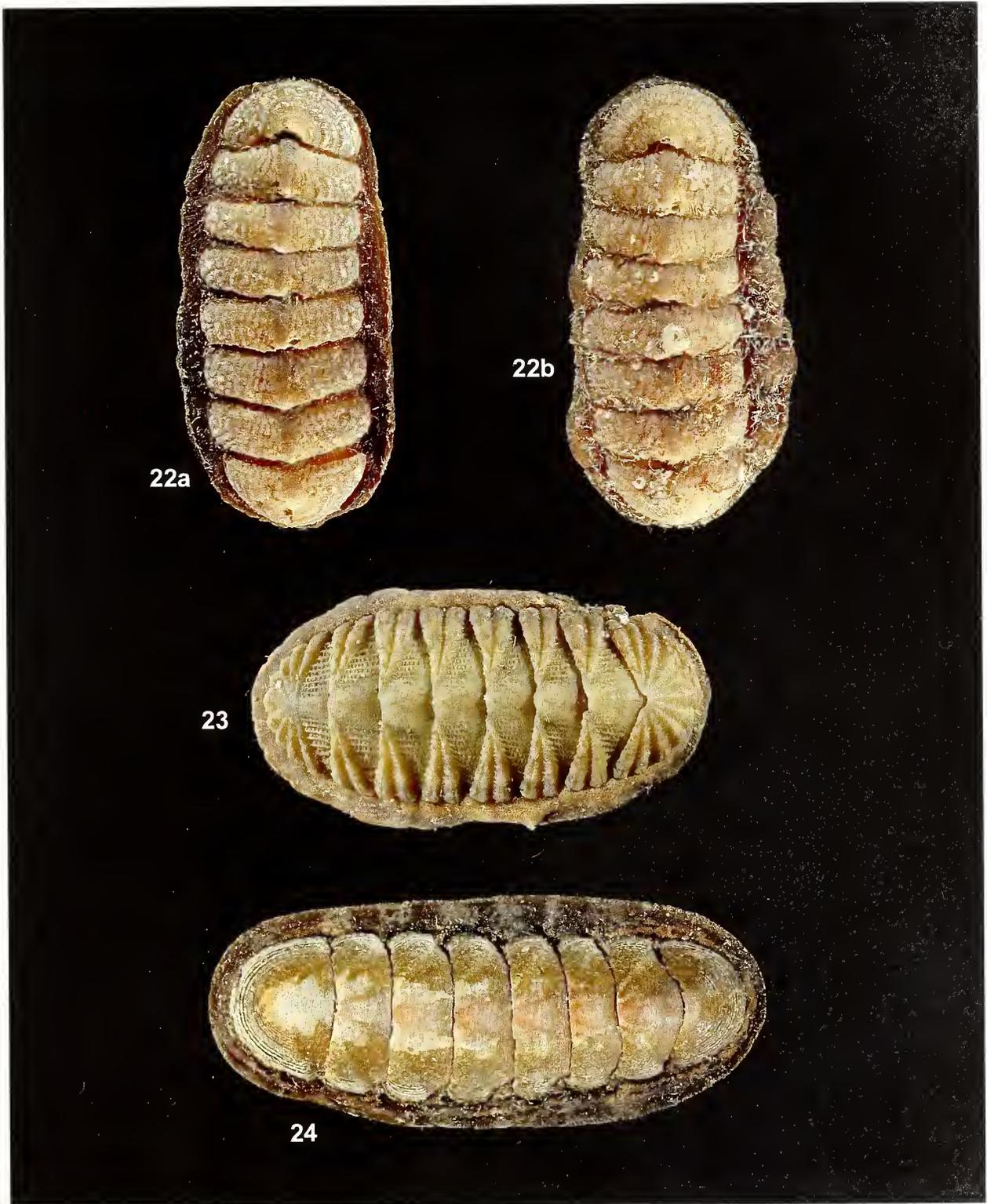
21b

PLATE 9
(Figures 22-24)

Figure 22. *Oldroydia percrassa* (Dall, 1894). Specimens collected by D. Mulliner, scuba diving, 1 mile offshore of Point Loma, San Diego County, California, depth of 50-60 ft, Oct. 1972, (UMMZ Cat. No. 252687): (a) Dorsal view of 22 mm specimen; (b) Dorsal view of 21 mm specimen with girdle spines intact (not broken off).

Figure 23. *Callistochiton decoratus* Carpenter MS, Pilsbry, 1893. Dorsal view of specimen, 20 mm length, collected by D. Mulliner, scuba diving, 1 mile offshore of Point Loma, San Diego County, California, depth of 50-60 ft, Oct. 1972, (UMMZ Cat No. 252668).

Figure 24. *Stenoplax corrugata* (Carpenter in Pilsbry, 1892). Dorsal view of specimen, 24.5 mm length, collected by D. Mulliner, scuba diving, 1 mile offshore of Point Loma, San Diego County, California, depth of 60-65 ft, Feb. 1973, (UMMZ Cat. No. 252650).



Appendix A. List of stations from North to South where chitons have been collected in the Southern California Bight (SCB) by regular or regional benthic monitoring programs (see Figure 1). Species collected at each site from single or multiple samples are indicated (N = number of chiton samples/station). Monitoring programs principally responsible for sampling each station are City of San Diego (CSD), Orange County Sanitation District (OCSD), City of Los Angeles (CLA), Los Angeles County Sanitation Districts (LACSD), 1994 SCB Pilot Project (SCBPP), and 1998, 2003 and 2008 SCB Regional Monitoring Programs (Bight'98, Bight'03, Bight'08). Main regions within the SCB where chitons were collected include northern Baja California (BC), San Diego (SD), Orange County (OC), Palos Verdes (PV), Santa Monica Bay (SMB), Point Conception (PC), and the northern Channel Islands (CI), the latter including sites off San Miguel Island (SMI), Santa Rosa Island (SRI), Santa Cruz Island (SCI), and Anacapa Island (AI). * = coordinates unknown (stations not shown in Figure 1).

Station	N	Depth (m)	Latitude (°N)	Longitude (°W)	Monitoring Program	Region	Species Present
103	1	93	34.421	120.184	SCBPP	PC	<i>H. oldroydi</i>
PC-1	1	150	*	*	LACSD	PC	<i>L. rugatus</i> , <i>L. radians</i>
2480	1	106	34.150	120.355	Bight'98	CI(SMI)	<i>L. rugatus</i>
2477	1	15	34.058	120.405	Bight'98	CI(SMI)	<i>D. thamnopus</i> , <i>T. venusta</i>
4255	1	207	34.052	120.558	Bight'03	CI(SMI)	<i>L. rugatus</i>
2491	1	95	34.011	120.475	Bight'98	CI(SMI)	<i>L. rugatus</i>
4159	1	71	33.995	120.337	Bight'03	CI(SMI)	<i>L. nexus</i> , <i>L. rugatus</i>
4417	1	46	33.890	120.082	Bight'03	CI(SRI)	<i>M. imporcata</i>
2538	1	120	34.101	119.729	Bight'98	CI(SCI)	<i>L. radians</i>
2518	1	112	34.097	119.737	Bight'98	CI(SCI)	<i>L. rugatus</i> , <i>L. retiporosa</i>
2493	1	44	34.079	119.888	Bight'98	CI(SCI)	<i>L. scrobiculata</i>
2479	1	84	34.069	119.770	Bight'98	CI(SCI)	<i>L. rugatus</i>
4029	1	75	34.034	119.352	Bight'03	CI(AI)	<i>H. oldroydi</i> , <i>L. nexus</i> , <i>L. rugatus</i> , <i>L. retiporosa</i> , <i>Lepidozoua</i> sp.
E1	1	150	33.988	118.714	CLA	SMB	<i>L. rugatus</i>
A1	6	15-18	33.986	118.502	CLA	SMB	<i>L. nexus</i> , <i>L. scrobiculata</i> , <i>D. gothicus</i> , <i>D. thamnopus</i> , <i>M. lowei</i>
NB1	1	70	33.913	118.555	CLA	SMB	<i>L. nexus</i> , <i>L. rugatus</i>
Z2	2	60	33.912	118.521	CLA	SMB	<i>L. retiporosa</i> , <i>L. scrobiculata</i>
D1	1	74	33.912	118.550	CLA	SMB	<i>L. retiporosa</i>

Station	N	Depth (m)	Latitude (°N)	Longitude (°W)	Monitoring Program	Region	Species Present
FA13	1	82	33.907	118.568	CLA	SMB	<i>L. nexus</i>
Short Bank	2	56	33.893	118.538	CLA	SMB	<i>H. oldroydi</i> , <i>L. mertensii</i> , <i>L. retiporosa</i>
FA10	1	54	33.885	118.508	CLA	SMB	<i>L. rugatus</i>
7415	1	69	33.856	118.516	Bight'08	SMB	<i>M. imporcata</i>
T0-60	1	~ 60	33.814	118.431	LACSD	PV	<i>L. retiporosa</i>
T1-1000	1	305	33.726	118.427	LACSD	PV	<i>L. rugatus</i> , <i>L. retiporosa</i> , <i>Lepidozonia</i> sp. B
V50	1	50	33.667	118.269	LACSD	PV	<i>H. oldroydi</i>
V80/V50	1	48-90	33.667	118.273	LACSD	PV	<i>L. scrobiculata</i>
E40	1	40	33.666	118.268	LACSD	PV	<i>L. rugatus</i>
E60	1	60	33.655	118.274	LACSD	PV	<i>L. nexus</i>
E-80	1	82	33.652	118.276	LACSD	PV	<i>L. retiporosa</i>
TA-100	1	100	*	*	LACSD	PV	<i>M. phorminx</i>
TA-130	1	130	*	*	LACSD	PV	<i>L. retiporosa</i> , <i>M. phorminx</i>
T3	1	55	33.581	117.956	OCS	OC	<i>L. retiporosa</i>
2015	1	109	32.868	117.332	CSD	SD	<i>L. rugatus</i>
2137	1	48	32.852	117.314	CSD	SD	<i>L. rugatus</i>
B5	1	62	32.821	117.327	CSD	SD	<i>H. oldroydi</i> , <i>L. retiporosa</i>
2655	1	27	32.818	117.301	CSD	SD	<i>D. thamioporus</i> , <i>L. scrobiculata</i>
1767	1	85	32.805	117.347	SCBPP	SD	<i>C. palmulatus</i> , <i>L. mertensii</i>
2145	1	117	32.803	117.370	CSD	SD	<i>L. rugatus</i>
1774	1	104	32.793	117.370	SCBPP	SD	<i>P. mirabilis</i>
B11	8	88	32.776	117.356	CSD	SD	<i>H. oldroydi</i> , <i>L. rugatus</i> , <i>L. retiporosa</i>
2023	3	89-91	32.775	117.358	CSD	SD	<i>H. oldroydi</i> , <i>L. rugatus</i> , <i>L. radians</i>
B13	4	116	32.773	117.377	CSD	SD	<i>H. oldroydi</i> , <i>L. rugatus</i> , <i>Leptochiton</i> sp.
SD14	1	100	32.738	117.349	CSD	SD	<i>L. retiporosa</i>



Station	N	Depth (m)	Latitude (°N)	Longitude (°W)	Monitoring Program	Region	Species Present
2663	1	130	32.731	117.352	CSD	SD	<i>L. rugatus</i>
SD13	1	101	32.714	117.338	CSD	SD	<i>L. golischi</i> , <i>L. scrobiculata</i>
A16	1	61	32.676	117.284	CSD	SD	<i>H. oldroydi</i>
SD9	3	88-92	32.654	117.314	CSD	SD	<i>L. retiporosa</i> , <i>L. scrobiculata</i>
2125	1	157	32.645	117.433	CSD	SD	<i>L. rugatus</i> , <i>L. retiporosa</i>
2035	1	149	32.639	117.431	CSD	SD	<i>L. retiporosa</i>
7029	1	150	32.636	117.417	Bight'08	SD	<i>L. rugatus</i>
2189	1	191	32.635	117.357	CSD	SD	<i>H. oldroydi</i>
2190	1	99	32.628	117.328	CSD	SD	<i>H. oldroydi</i>
SD8	3	90-99	32.626	117.323	CSD	SD	<i>H. oldroydi</i> , <i>L. retiporosa</i> , <i>Lepidozonia</i> sp. C
4388	1	141	32.593	117.391	Bight'03	SD	<i>H. oldroydi</i> , <i>L. retiporosa</i>
SD7	1	98-101	32.584	117.307	CSD	SD	<i>L. golischi</i> , <i>L. retiporosa</i> , <i>L. scrobiculata</i> , <i>Lepidozonia</i> sp. A
2336	1	9	32.577	117.143	Bight'98	SD	<i>L. radians</i>
2095	1	80	32.577	117.281	CSD	SD	<i>C. palmulatus</i> , <i>L. mertensi</i>
SD19	1	28	32.558	117.185	CSD	SD	<i>L. scrobiculata</i>
2334	1	14	32.552	117.143	Bight'98	SD	<i>L. rugatus</i> , <i>L. radians</i> , <i>L. scrobiculata</i>
2001	1	43	32.546	117.232	SCBPP	SD	<i>L. scrobiculata</i> , <i>P. mirabilis</i>
2335	1	18	32.545	117.155	Bight'98	SD	<i>L. scrobiculata</i>
SD18	1	30	32.543	117.189	CSD	SD	<i>L. scrobiculata</i>
I16	1	23	32.538	117.183	CSD	SD	<i>L. scrobiculata</i>
I13	1	38	32.538	117.212	CSD	SD	<i>D. thamnopus</i> , <i>M. imporcata</i>
SM152	1	31	32.485	117.179	CSD	BC	<i>L. radians</i>
SD15	1	29	32.473	117.175	CSD	BC	<i>L. scrobiculata</i> , <i>D. thamnopus</i>



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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLI

July 9, 2009

Number:7

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Annual dues are payable to San Diego Shell Club.
 Membership (includes family). Domestic \$20.00;
 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

Effects of Human Trampling and Seasonal Sand Movement on Micromollusks of Intertidal Algal Communities

Tonya Huff received her Ph.D. from Scripps in 2005 and has been an adjunct professor at several colleges

and universities. She starts as a tenure track professor at Riverside City College in the fall.

Meeting date: July 16, 2009

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting June 18, 2009

The meeting was called to order by Benjamin Pister at 7:45 pm. The previous minutes were accepted as published in *The Festivus* and the treasurer's report was presented. Wes Farmer passed along a request from the Balboa Park Botanical Society. They are looking for someone to work in the Botanical Garden office from 10 am to 2 pm on Thursdays as a volunteer. For more details contact Wes.

Our June speaker was Dr. Michael Vandrascio, of California State University, Fullerton, who gave an excellent presentation regarding the development of shells by mollusks during the Cambrian period approximately 340 million years ago. Many of the best preserved mollusks of that period are found in phosphate deposits. This was a period of evolutionary experimentation with shell formation, structure, and function. The microstructure of shell deposition demonstrated a number of mechanisms for shell formation, but for the most part only four methods and combinations persist to the present time. An unexpected find was the similarity in the microstructure of brachiopods to those of early mollusks.

It is assumed that shell formation protected the soft tissues from strong predators. We know that shells serve many other purposes. But defense may have been the initial trigger. Excellent photos of shell microstructure and its role in evaluating evolutionary relationships were presented.

The meeting was adjourned at 9:00 pm and members had a chance to visit with the speaker and enjoy the refreshments brought by Paul Tuskes and Benjamin Pister. The door prize was won by John LaGrange.

Paul Tuskes

Too Late for the Roster

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UPCOMING MEETINGS OF INTEREST

The next SCAMIT (Southern California Association of Marine Invertebrate Taxonomists) meeting will be Monday, July 13 at City of San Diego labs. It will be on Digital Imaging. Dan Ituarte will lead a discussion on editing techniques and software. Nick Haring will demonstrate image stacking software and lab/field lighting setups. Dan will be preparing take home information and would like to know how many persons plan to attend.

The workshop is not on taking the pictures, but on editing them once you have them in your computer. I would say that it could be of benefit to beginners or practiced individuals. Dan will provide an overview of software tools he likes to use and techniques to improve your images. If you plan to attend, please RSVP to Dan at DIuarte@sandiego.gov by Thursday, July 9.

For further information or questions, contact Larry Lovell, Biologist II, Marine Biology Laboratory, County Sanitation Districts of Los Angeles, S. Figueroa St., Carson, CA 90745, or mail to: llovell@lacsd.org

Next year's WSM (Western Society of Malacologists) annual meeting (2010) will be a combined meeting with the AMS (American Malacological Society). It will be held in San Diego at San Diego State University. The approximate dates are from Friday June 27-29th. It should be a great meeting so mark your calendars now. Further details will be sent as the time gets closer.

THE CLUB'S ANNUAL SEPTEMBER PARTY

Once again the Club's September party will be held at the home of Debbie and Larry Catarius. It will be held on Saturday, September 12th. As is usual it will be a potluck with beverages provided by the Club and will begin about 4 pm.

Further details will be announced at the July meeting. This is always a fun party – so save the date.

NAME CHANGES FOR TWO WELL-KNOWN PANAMIC SPONDYLIDS

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Abstract: *Spondylus crassisquama* Lamarck, 1819, is the earliest valid name for the well-known Panamic *S. princeps* Broderip, 1833. *Spondylus dubius* Broderip, 1833, from the Gulf of Tehuantepec, and *S. basilicus* Reeve, 1856, from an unknown locality are also junior synonyms of *S. crassisquama*. The original description and figure of *S. linguafelis* G. B. Sowerby II, 1847, does not fit the Hawaiian species that has been given this name, a species also known from offshore islands in the Panamic Province. Instead *S. linguafelis* is an uncommon, heavy, large Philippine spondylid. The valid name for the long-spined, much-sought-after Hawaiian species is instead *S. gloriosus* Dall, Bartsch & Rehder, 1938. G.B. Sowerby's type of *S. linguafelis* is lost, and a neotype is here selected.

Keywords: *Spondylus crassisquama*, *Spondylus princeps*, *Spondylus gloriosus*, *Spondylus linguafelis*, Hawaii, Panamic Province, Philippine Islands.

Introduction

Thanks to the books and the many papers of the late Kevin Leslie Lamprell, the global spondylids are today much better known. His first book, *Spiny Oyster Shells of the World* (1986), included many misunderstandings and errors. His second book, *Spiny Oysters* (2006), is without doubt the best yet on spondylids. It was based on a large collection with many types depicted for the first time and twenty years of additional experience. Skoglund & Mulliner (1996) published an overview of the genus *Spondylus* of the Panamic Province in *The Festivus*. However, recent study of type materials has demonstrated that some significant nomenclatural changes need to be made.

Lamprell (2006) demonstrated that the earlier valid name for the Panamic *S. calcifer* Carpenter, 1857, is *S. limbatus* Sowerby II, 1847, which also had an erroneous type locality, and this was confirmed by Coan & Valentich-Scott (2008). With Skoglund & Mulliner's paper taken as base, except for the synonymizing of *princeps* with *crassisquama* (with two further synonyms), the synonymizing of *calcifer* with *limbatus*, the replacement of *linguafelis* by *gloriosus*, and corrections in the BMNH-type numbers, their distributional and other findings hold. But there are still some issues in this challenging family in the Panamic Province.

A major problem concerns Lamarck's *S. crassisquama* (sometimes misspelled as *crassisquamata*). Lamarck's type of this species was well depicted by Chenu (1843). Lamarck gave "les mers de l'Inde" as its type locality. As a result, most subsequent authors have interpreted this species as being from the Indo-Pacific, for example, Chenu (1845) as a valid Indian Ocean species, Lamprell (1986) as Mediterranean and Red Sea taxon, and Oliver (1992) as valid Red Sea species. Then, in 2006, Lamprell concluded that it was synonymous with the Indo-Pacific *S. foliaceus* Schreibers, 1793. Finally, Finet & Lamprell (2008) depicted Lamarck's type material and reiterated its synonymy with *S. foliaceus*. However, when I studied the type material of this species, I realized that nothing similar occurs in the Indo-Pacific but, instead, this species is to be found in Panamic waters, as stated by G. B. Sowerby II (1847) and Fulton (1915).

Another major issue affects *S. linguafelis*. For 30 years, this species has been recorded from Hawaii and on offshore islands of the Panamic Province (Kay, 1979; Skoglund & Mulliner, 1996; Severns, 2000; Lamprell, 2006). Due to its unique features, it is one of the most sought-after and expensive spondylids in shell-sales.

However, the distinctive species actually described by G. B. Sowerby II (1847) was well understood by

Reeve (1856), Fulton (1915), and obviously also by Dall, Bartsch & Rehder (1938). Furthermore, in the Philippines a few huge, heavy specimens have been found, appearing very close to Sowerby's original description. The obvious discrepancy between the original description of *linguafelis* and the Pacific specimens so labeled is the other reason for this article.

Institution Abbreviations:

BMNH, The Natural History Museum, London
MHNG, Musée d'Histoire Naturelle, Geneva,
Switzerland

Spondylus crassisquama Lamarck, 1819

Figures 1-4

Spondylus crassi-squama Lamarck, 1819

Lamarck, 1819: 191; Chenu, 1843: pl. 6, fig. 2; 1845: 4; G. B. Sowerby II, 1847: 422, pl. 85, fig. 17, pl. 86, fig. 28, pl. 88, fig. 45; Reeve, 1856: pl. 2, fig. 9, pl. 6, fig. 24; Fulton, 1915: 356; Finet & Lamprell, 2008: 5, pl. 10, fig. 44a-b.

Spondylus princeps Broderip, 1833 [new synonymy]

Skoglund & Mulliner, 1996: 99.

Spondylus dubius Broderip, 1833 [confirmed synonymy]

Broderip, 1833: 4; Fulton, 1915: 356.

Spondylus basilicus Reeve, 1856 [confirmed synonymy]

Reeve, 1856: pl. 11 fig. 41; Fulton, 1915: 356.

Spondylus princeps unicolor, auctt., non Sowerby II, 1847

Skoglund & Mulliner, 1996: 99.

Type Material & Localities: *S. crassisquama* (Figures 1, 2a,b) – lectotype (here designated): MHNG 1089/5, fig.1, single left valve, length 116 mm, height 114 mm; “les mers de l’Inde” (originally stated) and “Oc. Indien” (label), here corrected to Ecuador, Panamic Province.

Original Description: *Sp. testa utrinque rubra, longitudinaliter costata et sulcata; costis squamiferis distantibus; squamis crassis subspathulatis, interdum palmatis.* [Squama (scale or shingle) is a noun.]

S. princeps Broderip, 1833

Holotype, BMNH 1950.8.28.1 length and height 133 mm, Isla La Plata, “Colombia” (= Ecuador). The BMNH number is here corrected, but the specimen figured by Skoglund & Mulliner in Figs.

14-15 is the holotype.

S. dubius Broderip, 1833 (Figure 3)

Holotype, BMNH 1952.5.10.7 (Fig. 3), 125 mm, Gulf of Tehuantepec, México. The size and BMNH catalogue number is here corrected, but the specimen depicted by Skoglund & Mulliner (1996: figs. 38-39) is the holotype.

S. basilicus Reeve, 1856 (Figure 4)

Syntypes, BMNH 1996058 (Fig. 4), length 89 mm, height 78 mm and length 90 mm, height 80 mm, no locality. Two BMNH syntypes exist. Skoglund & Mulliner (1996: fig. 41) depicted the smaller syntype.

Additional description, distribution, range and habitat information is found in Skoglund & Mulliner, 1996: 99-102. In two specimens I've studied, I noted that the hinge teeth in both valves are brown, making *S. crassisquama* even more variable in this regard than previously noted.

Discussion: Finet & Lamprell (2008) stated that the annotation in Lamarck's *Animaux sans vertèbres* (1819) noted that a single valve of this species was in his possession. They qualified the large single valve in the MHNG as a “possible holotype”. However, Lamarck (1819) based his original description of *crassisquama* on specimens in his possession and in the Paris Museum and in the Dufresne Collection. His own valve, still present at MNHG, which fits his original description, is here selected as lectotype to ensure stability of this name.

Lamarck's specimen is virtually identical to a specimen I obtained by diving in the Bahía San Carlos area, Sonora, México (Figure 2). However, the presence of a Panamic specimen in Lamarck's hands that early makes an origin from Ecuador or Perú more likely (G. Coan, personal communication, January 2009). Therefore, Ecuador is here selected as type locality.

G. B. Sowerby II (1847) and Reeve (1856) considered Chemnitz (1783: pl. 69, figs. E-F) to be the same species. Schreibers (1793: 158), who first provided an available Latin name for these figures, termed it *Spondylus pictorum*, erroneously with a Mediterranean locality. However, as concluded by Lamprell (2006: 66), neither Chemnitz' figure nor Schreibers' description conform to *crassisquama*, but represent instead the Indo-Pacific *Spondylus foliaceus* Schreibers, 1793. Size, sculpture, border, and orange yellow color are unlike *crassisquama*, but fit *foliaceus*.



Figures 1-7. 1) *Spondylus crassisquama*, lectotype herein, MHNG, 116 mm (2) *Spondylus crassisquama*, coll. author, Bahía San Carlos, Sonora, México, 135 mm (3) *Spondylus dubius*, holotype, BMNH 120 mm (4) *Spondylus basilicus*, syntypes, BMNH 90 and 89 mm (5) *Spondylus foliaceus*, coll. author, Mactan, Philippines, 72 mm (6) *Spondylus foliaceus*, coll. author, Cebu, Philippines, 81 mm (7) *Spondylus linguafelis*, neotype herein, BMNH, 127 mm.

Compared to typical Indo-Pacific *S. foliaceus* (Figures 5, 6), the Panamic *S. crassisquama* differs as follows: Most obvious is the broad colored border along the entire margin. As stated and well-depicted by Skoglund & Mulliner this was also seen in all *crassisquama* observed and is clearly seen in Lamarck's lectotype. *Spondylus foliaceus* has a much narrower and generally much weaker colored marginal band, and the marginal crenulations are finer. Furthermore, the sculpture is distinct: *Spondylus crassisquama* has more ribs with strong interstitial ribbing, whereas *foliaceus* generally has 5-6 strong ribs with large, often upright spines and interstitially bare ribs. In addition, the red uniform color of the *crassisquama* lectotype is typically found in Panamic specimens, whereas *foliaceus* is usually mauve-white, brownish to bright orange.

The lectotype of *crassisquama* is 116 mm. The Panamic species is a large bivalve with adults generally above 100 mm, exceptionally reaching over 200 mm. *Spondylus foliaceus* is a medium-sized bivalve, around 70-80 mm or 94 mm (Chemnitz' specimen), but rarely exceeding 100 mm. It is unlikely that Lamarck's single valve should be the largest *foliaceus* known.

Finally, no alternative is known. None of the more than a thousand specimens of various species of the genus and more than 50 Indo-Pacific species studied conform to the lectotype of *S. crassisquama*. None of the Caribbean, Mediterranean, West African, Japanese, or Hawaiian species is close to Lamarck's.

Because Lamarck's name has been validly used many times after 1899, for example, by Fulton (1915) as a valid Panamic species and recently by Oliver (1992) as a valid Red Sea species, a "reversal of precedence" allowed by the *Code of Zoological Nomenclature* is not possible, and because type material is extant, a petition to suppress Lamarck's name is even less justified. In addition, a lectotype is present and was figured more than 150 years ago. Finally, the species was consistently recognized by British authors from 1847 until 1915.

- S. princeps* Broderip, 1833, has been protected from homonymy by *S. princeps* Schreibers, 1793 (ICZN Case 3014, 2000). Today, however, the situation is different because of Lamarck's still-earlier species.
- S. dubius* Broderip, 1833, was accepted as a synonym of *crassisquama* by G. B. Sowerby II (1847), Reeve (1856), and Fulton (1915). Skoglund & Mulliner (1996) depicted *S. dubius*, but excluded it from this synonymy due to its short spines and the white hinge teeth. Lamprell (2006), obviously lacking an alternative, included it as "possible

synonym" of *princeps*. The BMNH holotype indeed shows comparatively short spines. But the structure of the ribs and spines conforms well with *princeps*. The broad, colored border is typical, and the hinge teeth, although now almost white, show clear traces of brown in natural light. Furthermore, there is no other known species that is closer to *dubius* than *crassisquama*. The old synonymy of British authors is here reinstated, and Broderip's original type locality is deemed to have been correct.

- S. basilicus* Reeve, 1856, was accepted as a synonym of *S. crassisquama* by Fulton (1915). Skoglund & Mulliner (1996) depicted the smaller syntype, but excluded it from this synonymy due to the white teeth and unknown locality. Lamprell (2006), lacking an alternative, included it again under *princeps* as "possible synonym". The syntypes conform in spines and rib structure, as well as the comparatively broad border and fit *crassisquama* better than *limbatus*. The hinge teeth of the upper valve are visibly brown, those of the lower valve whitish. I see no reason not to follow Fulton and to reinstate this synonymy.
- S. unicolor* Sowerby II, 1847, is here considered a *nomen dubium*. The type from the Gruner Collection seems to be lost, no locality was given, and it has been variously interpreted.

Spondylus linguafelis G. B. Sowerby II, 1847
Figures 7-9

- Spondylus lingua-felis* G. B. Sowerby II, 1847
G. B. Sowerby II, 1847a: 87; 1847b: 420, pl. 88, fig. 50; Reeve, 1856: pl. 7, fig. 27; Gonzáles Hidalgo, 1905: 382; Fulton, 1915: 332.

Type Material and Localities: *S. linguafelis* - Neotype (**here selected** BMNH 1998101/1; fig. 7); type locality unknown (as originally stated), Philippines (here clarified), 127 mm.

Original Description: *Spond. testa ovali, crassa, area cardinali et auriculis magnis; costis numerosis, vix elevatis, spinis brevibus, aequalibus, numerosis armatis; colore fusco, subtus croceo.*

Also important is Sowerby's comparison: "A much more solid shell than *S. asperrimus*, with the hinge large; the color is a uniform dark brown, which is shown in the interior by a well defined border. The shell is covered by nearly equal ribs, which are armed by

short thick, lightly curved prickles. The interstices are smooth. In the collection of Mr. Gruner, Bremen.”

Additional Description: Cat-tongue, as in the species name, describes the sculpture of this species well. The short, strong spines are not broken, but stay naturally very short in all specimens seen. The ribbing is regular, without any clear partition. The inner margins are narrow and dark colored, corresponding to the exterior color; the marginal crenulations are comparatively fine and regular. The muscle scars are flat, and the hinge teeth brown in both valves. The typical color is a uniform brownish-red color, the spines equally or somewhat lighter colored. The umbonal portion is whitish, dark sprinkled. *Spondylus linguafelis* is unusually heavy for an Indo-Pacific species and as such close to the Panamic *S. limbatus* and *S. crassisquama*.

History: *Spondylus linguafelis* is an uncommon species. To date, only five specimens are known. Three of these are the missing but well depicted original Gruner specimen, the neotype, and a second specimen from Reeve’s BMNH series (Figure 8), all these without locality data. The BMNH material possibly came from the Philippines. Further known are two specimens from the Philippines in the author’s collection (Figure 9); one from Olango Island, from 73 m, and a larger specimen probably from Cebu. In addition, González (1905) reported a specimen from Basilan Island in the Philippines. True *S. linguafelis* was not correctly depicted in over 150 years. Because this Philippine species is virtually unknown, it may well be present under erroneous names in other collections. The sparse available data indicate a broad Philippine distribution, probably in deeper water than most spondylids.

Discussion: G. B. Sowerby II (1847) described this species from a specimen in the Gruner Collection, Bremen, Germany, from an unknown locality; neither Polynesia, nor Hawaii, was mentioned, as erroneously stated by subsequent authors. The Gruner Collection was sold and partly acquired by Loebbecke. However, in the Loebbecke Museum, Düsseldorf, no *S. linguafelis* stemming from the Gruner Collection can be located (personal communication, J. Boscheinen, October 2007). Thus, the type is considered lost.

Reeve (1856: pl. 7, fig. 27) depicted a specimen from the Cuming Collection that fits the above characters precisely. This specimen was painted by the original author and was accepted by subsequent experts **is here designated as neotype** to fix the concept of this

species. Furthermore, Reeve’s lot contains a second specimen, slightly smaller, very close in color and morphology that helps stabilize the concept of this uncommon species.

Fulton (1915), after comparing *S. asperrimus* and *S. linguafelis* in the BMNH, accepted both as valid. He stated, “The *linguafelis* is a heavier shell, of darker color and different form.” Indeed, both species may have a similar cat-tongue sculpture, with sharp, short, prickly scales. But *S. linguafelis* is markedly heavier and the spines more solid. Whereas *S. asperrimus* (Figure 10) is usually less than 100 mm in size, *S. linguafelis* attains more than 100 mm. All *S. linguafelis* seen have the same uniform dark color, whereas *S. asperrimus* is usually found in variations of white. In shape, *S. linguafelis* is somewhat more regular and pectiniform, with the upper valve less inflated.

Most importantly for this paper, the species from Hawaii or Panamic offshore islands usually referred to “*S. linguafelis*” does not fit Sowerby’s original description. Hawaiian specimens are more fragile than *asperrimus* and much lighter than *linguafelis*. Instead of a strong, short cat-tongue sculpture with thick prickles, a multitude of needle-like spines is present. A uniform dark brown color is not reported for the Hawaiian species, but rather orange, yellow, white, purple, and red are known. The strongly marked, brown internal border is also not present in Hawaiian and Panamic specimens. Consequently, Dall, Bartsch & Rehder (1938) considered the Hawaiian species as new and described it as *S. gloriosus* from Oahu (Figure 11). This is the valid name for this famous species, mainly known from Hawaii (Keen, 1971: 96) but it has also been reported as *S. linguafelis* from the offshore islands of the Panamic Province by Kaiser & Bryce (2001) from Isla Malpelo, Isla del Coco, Islas Galápagos and Islas Revillagigedo and from Île Clipperton by Kaiser (2007). However, Keen (1971) had it right, but unfortunately provided no illustration.

Kay (1979) added *S. kauaiensis* Dall, Bartsch & Rehder, 1938, as a synonym of *S. gloriosus*. However, I do not agree with the additional synonym *S. mimus* Dall, Bartsch & Rehder, 1938. *Spondylus mimus* is regarded here as an uncommon, rather small, but valid species, as depicted by Severns (2000: 236) under “*S. nicobaricus*” from Hawaii.

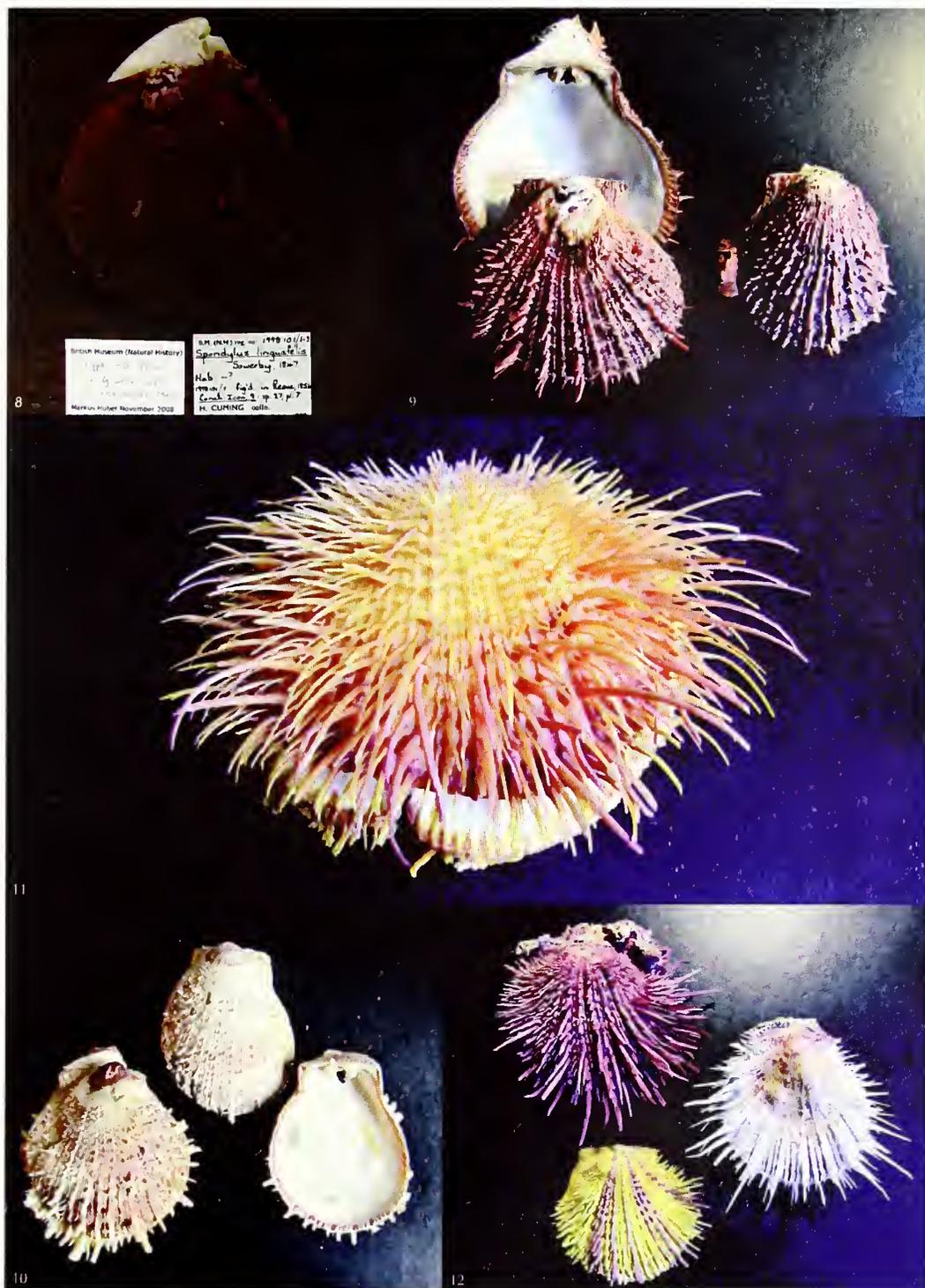
Longer spined, smaller Philippine, Okinawan or Solomon specimens often labeled as “*linguafelis*” are referable to *S. swinnyi* Lamprell, Stanicic & Clarkson, 2001, as well depicted by Lamprell (2006: pl. 33) (Figure 12).

Acknowledgments

Thanks are due to Kathie Way and Amelia MacLellan, The Natural History Museum, London, for the opportunity to study the BMNH bivalve types and for reconfirmation of the BMNH type numbers; the conditions of having a type collection so close to the rich general collection and adjacent to a marvelous library were perceived as a role model. Thanks are also due to Yves Finet, MHNG, for the opportunity to study the Lamarck types and for the loan of his *S. crassisquama* type photos and to Eugene V. Coan of Palo Alto, California, for insights into the Panamic bivalve fauna, encouragement to publish this article in *The Festivus*, and editorial assistance.

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Figures 8-12. (8) *Spondylus linguafelis*, no locality, BMNH, 120 mm (9) *Spondylus linguafelis*, coll. author, Philippines, 90 & 127 mm (10) *Spondylus asperrimus*, coll. author, Cebu, Philippines, 81 & 92 mm (11) *Spondylus gloriosus*, coll. author, Hawaii, Oahu, 90 mm (12) *Spondylus swinnyi*, coll. author, N. Borneo, 67 mm, Philippines, 90 & 100 mm.

BOOK REVIEW

HANS BERTSCH*

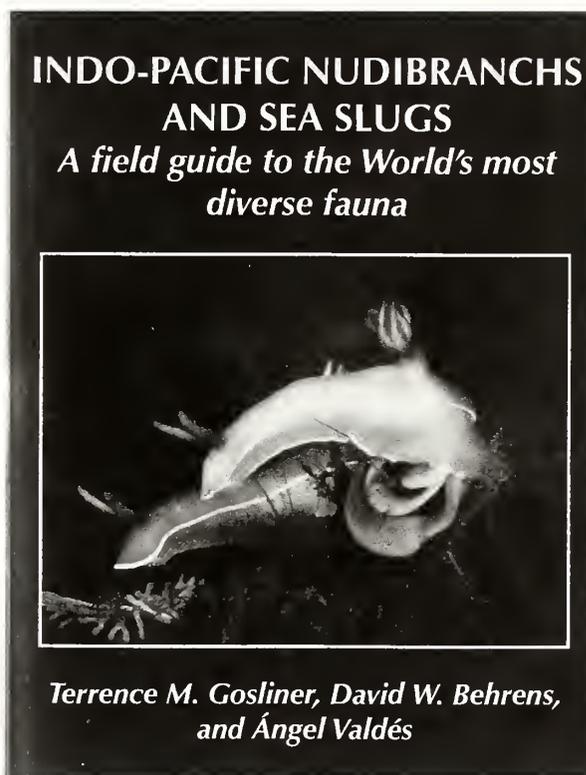
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Indo-Pacific Nudibranchs and Sea Slugs, A Field Guide to the World's Most Diverse Fauna
 By Gosliner, Terrence M., David W. Behrens, & Ángel Valdés. 2008. ISBN 978-0-9700574-3-3
 Sea Challengers Natural History Books and California
 Academy of Sciences. 426 pp. Price: \$79.95 US
 plus \$10 shipping and handling.
 Available from Sea Challengers Natural History Books
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The first photo-illustrated field guide to Indo-Pacific opisthobranchs (Bertsch & Johnson, 1981) emphasized *in situ* pictures of these marvelously colored marine invertebrates. Since this pioneering work, full-color, photo-illustrated guides to multiple areas within this region (e.g., Australia, Bali, Indonesia, Japan, and Korea) are now available. In the past decade, publication of nudibranch field guides has not been parsimonious! The standard is now set by the publication of Gosliner, Behrens & Valdés (2008). In writing this review, I must clearly state that the authors of this book are my friends and colleagues, whom I have known for many years.

This truly magnificent book is the most comprehensive and scientifically accurate field guide to Indo-Pacific (IP) sea slugs. It is the best reference available for the opisthobranch fauna of that vast tropical zoogeographic region. It illustrates and describes 1387 species. The book probably covers 60-70% of the known diversity, and about half of the total shallow water Opisthobranchia *s.l.* diversity of the IP. This latter percentage is similar to that found in the Sea of Cortez, eastern Pacific with 4877 known macroinvertebrate species. Hendrickx, Brusca & Findley (2005) "estimate that less than half of its invertebrate fauna has been described." What Steinbeck & Ricketts (1941: 168) wrote about the Sea of Cortez, is still true for most of the oceans: "The shores of the Gulf, so rich for the collector, must still be fairly untouched."

Despite the plethora of IP research, there were inherent limitations in these authors' ability to include



all the known species. The book is particularly short in Cephalaspidea *s.l.* There are many more species illustrated only from shells, but photographs of living animals are not available. There are 360 described species of Chromodorididae, but they only include 252. The other 108 are names of organisms that haven't been rediscovered since their original descriptions, many could be synonyms, or lack photos. Their decision not to include these species which require further research to properly identify is further testament to the scientific accuracy of this book.

This book is the culmination of an 11-year research project, involving numerous field trips by the authors and

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their colleagues. They are to be congratulated for their brilliant synthesis, which called upon the vast worldwide community of “branchers” in its writing. They incorporated the knowledge and experiences of many researchers, photographers, and authors of other sea slug guides. The authors considered over 20,000 photos in making their selections for the book. Most are excellent portrait-style “tub shots,” although there are a fair number of superb *in situ* photographs that illustrate aspects of the natural history. I personally would have included more of these types of photographs, because of the additional visual biological information they provide, but it's their book—and they chose their pictures very well! John and Ed would have been pleased: “We wished to take photographs of many of the animals....However, none of us was expert in photography and we had a very mediocre success” (Steinbeck & Ricketts, 1941: 46-47). Over 65 years later, the photos in this book are very successful.

The book consists of 2 parts: Introduction and Species Descriptions. The Introduction emphasizes biogeography, phylogeny, evolution, and coral reef conservation.

The authors define the IP as stretching latitudinally from the Indian Ocean coast of southern Africa to the central Pacific of the Hawai'ian, Easter and Marquesas Islands. The area is isolated from the coasts of west America by the Eastern Pacific barrier, although there is a “leak” (their word) of a few species that occur in both E–W extremes of the tropical Pacific. There is no sharp boundary for the IP, neither E–W nor N–S, and they describe a continuum of change between adjacent faunal provinces. This is similar to the ecotonal regions of faunal provinces along the Pacific coast of the Baja California peninsula (Bertsch, 1993). I especially appreciate, respect and concur with their wake-up call for emergency action to save coral reefs, in the face of mass extinction. This extends, and forms part of a continuum to, the Conservation Ethic published 29 years ago by Bertsch & Johnson (1981: 108).

Each species description includes the species name, authorship and year; comments on Identification, Natural History, Size and Distribution (with precise known occurrence sites); and at least one photograph of the living animal. The species descriptions (pp. 13-409) are phylogenetically arranged within eight major groups: Acteonoidea, Cephalaspidea (which two comprise Cephalaspidea *s.l.*), Acochliadia, Anaspidea, Sacoglossa, Umbraculoidea, Pleurobranchioidea (these latter two comprise Notaspidea *s.l.*), and Nudibranchia. The smallest group is the Acochliadia (4 spp.), whereas Nudibranchia (1077 spp.) comprise the majority of the 1387 species described. Some speciose genera are

arranged by shared morphological features. For instance, species of *Chromodoris* are grouped among the flat egg-mass clade, the *C. tinctoria* group, species that raise and lower the anterior portion of the head, mantle raising and lowering, etc. The 252 species of Chromodorididae represent 18.2% of the total fauna that the authors describe.

Diversity distribution (represented as total numbers of species) varies greatly throughout the IP. For instance, they list 258 known species from Tanzania, 717 from the Philippines, and 430 from the Hawai'ian Islands. These figures reflect the highest biodiversity levels occurring in the Coral Triangle. It would be extremely enlightening to analyze the taxonomic biogeography and biodiversity within and between the various IP regions.

The new data of the authors in this book show changes in species' percentages representation among the higher taxa from those presented nearly two decades ago by Gosliner (1992: 704, Table 2). The cephalaspideans show a decreased percent occurrence in the IP (17.9% to 10.7%), but as previously discussed, numerous cephalaspideans were not included in this book. Nudibranchs show an increased percentage (61.9% to 77.6%); dorids show an increase (42.3% to 50.4% of total opisthobranch fauna), but aeolids show no percentage change in composition (15.2% vs. 15.9%).

This book provides an important, useful watershed of biodiversity and biogeographic data. It also reminds us that there is still much to be learned about opisthobranchs in the IP and elsewhere worldwide.

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THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

August 13, 2009

Number:8

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 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

'Branches and Bubbles in Mission Bay

Paul Tuskes will be talking about opisthobranchs in Mission Bay. This presentation will include underwater photos of the nudibranchs and their relatives and he will

also discuss his two year study on the Bubble Snail, *Bulla gouldiana*, with new information on its life history and predators.

Mini-auction of Books

Meeting date: August 20, 2009

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting July 16, 2009

The meeting was called to order by Carole Hertz at 7:45 pm. The previous minutes were accepted as published in *The Festivus*. The treasurer was absent so there was not a report. Business prior to the speaker was light. The September party will be held at Larry and Debbie Catarius' home on Saturday, September 12th, so save the date. More details later.

Benjamin Pister introduced the speaker Dr. Tonya Huff who discussed her research on the effects of foot pressure and sand movement on intertidal invertebrates. The research spanned three years and generated many interesting findings. The movement of sand in the rocky intertidal zone influences diversity. Within one day sand dwelling species quickly move into the new environment and dominate the composition. These are typically mobile species that can take advantage of the disturbance. Some pre-existing species are adapted to these intrusions, while others move to more favorable habitats when the sand arrives.

So just how many critters are out there? Sampling showed that 290,000 to 1.6 million critters to m² could be present. Foot pressure from visitors in the rocky intertidal was also examined. The truly small organisms may not be crushed, but macro plants and animals are at risk. Most damage is to the top of rocks. The destruction of the algae changes the complexity of the habitat and species diversity and numbers sharply decreased. The good news is that after approximately nine months of protection, both the algae and animal community recovered and were comparable to pre-test levels.

Paul Tuskes

Too Late for the Roster

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The Club's Annual September Party September 12, 2009

Once again we are so fortunate that Debbie and Larry Catarius have offered their garden for the Club's most enjoyable annual September party. It will be held on Saturday afternoon September 12th beginning at 4 pm. The address is 4173 Galt St., San Diego, 92117. (You will notice the map enclosed with this issue.)

A sign up sheet for this potluck will be passed at the August meeting for either a salad, main dish or dessert to serve 12 and the Club will provide coffee, soft drinks, water, wine and beer.

If you are unable to attend the August meeting and would like to attend the party, contact Carole Hertz (858-277-6259) to sign up for your potluck contribution.

It's always a fun, relaxed get-together. Plan to come!

A Generous Donation to the Club

Member George Metz of Novato, California, has sent a generous donation of shells to be used for the Club's next auction. Some very interesting specimens like a freak Stombus and urchins with parasitic mollusks will be terrific additions to the auction. Our appreciation to George for thinking of our Club.

A Mini-auction of Books

As is customary with our meetings, we occasionally have mini-auctions and offer some books and/or periodicals to those in attendance.

This one will include: Newbert's 1984, hardcoverd, *Within the Rainbow Sea*, with his fantastic photography; Gosliner's 1987 (signed) *Nudibranchs of Southern Africa* and Springsteen & Leobrera's 1986, hardcoverd, *Shells of the Philippines*.

REPORT OF THE WSM MEETING - 2009

JULES HERTZ

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The 42nd annual meeting of the Western Society of Malacologists (WSM) was held June 23-27, 2009, at the California State University, Fullerton (CSUF), California. The meeting was organized and ably run by WSM President Michael Vendrasco. There were approximately 59 attendees, some from as far as Alaska and La Paz, México. Many of the presenters and attendees were students which bodes well for WSM and for the future of malacology. The meeting was held in the Kinesiology & Health Science auditorium which was spacious and had good projection equipment.

The first day's program consisted of registration, a micromollusk workshop and an evening reception. The Micromollusk Workshop was an all-day event presented by Daniel Geiger of the Santa Barbara Museum of Natural History. There were 12 attendees who were introduced to the main techniques of working with micromollusks. The workshop covered the topics of collecting, sorting, storage, photography, z-stacking, preparation of animals, radula and shells for scanning electron microscopy (SEM), and exposing selected specimens prepared during the workshop to SEM. Those who attended spoke highly of the workshop. The evening reception was hosted by the Pacific Conchological Club. There was wine, beer and soft drinks as well as a goodly amount of snacks. In addition, the local Club members provided a number of interesting shell displays. Shawn Wiedrick, President of the Pacific Conchological Club, gave a PowerPoint presentation detailing the 102 year history of the Club along with the many name changes during that time. He showed the current officers as well as significant members in the past and described the Club's activities. It was a very enjoyable social event.

The presentation of papers started on the 24th. Opening remarks were given by WSM President Michael Vendrasco and the meeting was officially opened by the blowing of a conch shell (see Figure 1). The day was devoted to opisthobranch papers with the morning session moderated by Ángel Valdés and the afternoon session by Patrick Krug. Most of the papers

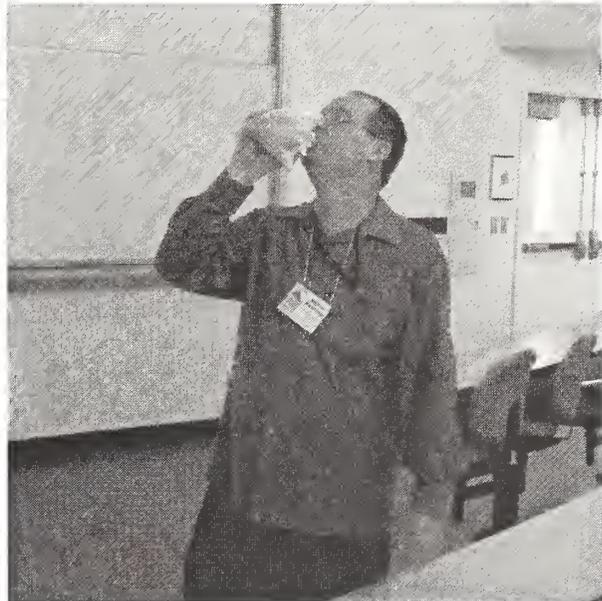


Figure 1. President Michael Vendrasco opening the presentation of papers at the 2009 WSM meeting.

were presented by students. The paper I enjoyed the most was presented by Dominique Gordon and was entitled "Environmental effects on larval development of the sea slug *Alderia willowi*." She explained how *Alderia willowi* seasonally switch developmental mode of their offspring between larger non-feeding lecithotrophic larvae in the summer and smaller feeding planktotrophic larvae in the winter. She ran multi-generation selection experiments in the laboratory to evaluate whether temperature, seawater salinity or growth rate control the development mode. Her results suggest that it was growth rate rather than environmental cues. In addition to the verbal presentations in the afternoon, there were five very interesting posters hung for viewing. The two of most interest to me were Jann Elizabeth Vendetti's "A method for replicating gastropod protoconchs for morphological analysis" and Wendy Enright Storms' "Deep water mollusk communities in the Southern

California Bight.”

On the morning of the 25th there was a Bivalve Workshop presented by Paul Valentich-Scott of the Santa Barbara Museum of Natural History. There were 22 attendees and I would have attended had I not done so twice before. He always does a marvelous job and it is always very entertaining besides being very educational. Even gastropod lovers leave his workshop with a new appreciation for “clams.” The afternoon session was moderated by Douglas Eernisse. Many of



Figure 2. Coffee break.. L-R Nora Foster, Paul Valentich-Scott, Kelvin Barwick, Chuck Powell, Jim McLean, Carlos Cáceres Martínez.

the papers were on limpets and were presented by his students. To me the most interesting paper of the day was Michael Vendrasco's entitled “Homology between shells of brachiopods and early molluscs.” He showed superb photographs of the microstructure of many Cambrian fossils. This microstructure known as calcitic semi-nacre shows a striking similarity between early mollusks and modern brachiopods. There are some distinct differences between the shells of brachiopods and mollusks such as the predominance of aragonite in mollusks versus calcite and calcium phosphate in brachiopods, however the overall similarity suggests a relatively high degree of homology.

On the evening of the 25th we had the traditional WSM reprint sale and auction. Beverages were provided by WSM to get the audience in the mood for a fun affair. The reprint sale was run by George Kennedy and was very successful. The auction which followed had a lot of good books, photographs and shells for sale. Carole Hertz was the auctioneer and she had the

audience laughing and bidding on items which they might not want. It was all for a good cause - the WSM Student Grant fund. The reprint sale and auction brought in more than \$700 (Figures 2, 3).



Figure 2. Scanning the auction table. L-R. Rosa del Compay Villalobos, Jules Hertz, Chris Kitting, Constance Gramlich, Omar Mendoza Porras, Paul Valentich-Scott, Carlos Cáceres Martínez, Kelvin Barwick, Doug Eernisse.



Figure 3. Auctioneer Carole Hertz at work.

The papers continued on the 26th with a symposium convened by Hans Bertsch entitled “The Interface of Human and Molluscan Ecology.” Most of the papers were presented by our Mexican members. I was most interested in a paper by Carlos Cáceres Martínez and A. Medina Bustamante entitled “Hermaphroditism in *Pinna rugosa* at San Ignacio Lagoon.” The pen shell *Pinna rugosa* has become a commercial fishery in Baja California Sur, México, despite the lack of basic

biological knowledge of its reproductive cycle. The authors determined that the pen shell is a protandric hermaphrodite with reproduction at the end of spring and early summer. A catered lunch was provided after the morning session and this was followed by taking of the group photograph with multiple cameras provided by the attendees (see Figure 4).

The WSM Business Meeting was held in the afternoon. The next meeting of WSM is tentatively scheduled to be a joint meeting with the American Malacological Society (AMS) in San Diego on June 27-29, 2010. It will be held at San Diego State University and will be co-hosted by WSM President George

Kennedy and AMS President Douglas Eernisse. The following year, WSM will meet in La Paz, México, on June 9-13, 2011. It will be a joint meeting with the National Mexican Malacological Association. The winner of the best student poster award was Jann Elizabeth Vendetti and she was also recognized as having given a superb paper. The winner of the student paper award was Dominique Gordon.

The final event of the 2009 meeting was a field trip to Santa Catalina Island. There were 23 who attended and it was reported as great fun. The visibility was superb, so many went snorkeling and there were a lot of "critters" in the dredged rocks.



Figure 4. Group Photo at the 2009 Annual Meeting of the Western Society of Malacologists

- Row 1, l-r: Deborah Roman, Elysse Gatdula, Jann Vendetti, Wendy Enright Storms, Laney Whitlow, Carlos Cáceres Martínez, Chrystal Johnson, Rosa del Carmen Compay Villalobos.
 Row 2, l-r: Omar Mendoza Porras, Miguel Ángel del Río-Portilla, Christine Fernandez, Celia K.C.Churchill, Miguel Agustín Téllez Duarte, Carlos Figueroa Beltrán, Ángel Valdés.
 Row 3, l-r: Carole Hertz, Nora Foster, Constance Gramlich, James McLean, Jackson Lam, Rebecca Kowallis.
 Row 4, l-r: Douglas Eernisse, Jules Hertz, Roger Seapy, Michael Vendrasco, Hans Bertsch, Christopher Kitting, Kelvin Barwick, George Kennedy, Patrick LaFollette, Robert Moore, Brenton Ferguson, Charles Powell.

A NOTE ON THE OPISTHOBRANCH MOLLUSKS OF ROCAS ALIJOS

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Rocas Alijos are the wave-worn remnants of a small volcano arising from deep water off Baja California Sur, México, and lie in a transitional region between the temperate Californian and the tropical Panamic provinces. Located at 24°57'36"N, 115°45'54"W, Rocas Alijos is 185 nautical miles due west of Cabo San Lázaro and Bahía Magdalena (Schmieder, 1996).

In the book *Rocas Alijos* (1996) edited by R.W. Schmieder, McLean and Coan compiled an extensive list of the marine mollusks collected at Rocas Alijos during the multi-faceted, scientific Cordell Expedition of October-November 1990. The molluscan fauna showed greater affinity to the Californian Province. The total number of mollusk species reported by McLean and Coan (1996), was 165; the only opisthobranch reported was *Tyrodina fungina* Gabb, 1865.

In the 1993 expedition, as reported by Schmieder (1996), two more species were observed: *Berthellina ilisima* Marcus & Marcus, 1967 (as *Berthellina engeli*) and *Hypselodoris californiensis* (Bergh, 1879) (as *Hypselodoris californica*).

During her three dives of the 2004 expedition, Kaiser (2006) reported one more opisthobranch, *Elysia hedgpethi* Marcus, 1961.

Seven dives were done in October of 2008. Because the area does not present a variety of habitats, with few sessile invertebrates seen, only a few more opistho-

branches were observed.

In this note, three additional opisthobranch species are reported: *Navanax aenigmaticus* (Bergh, 1893) in several color variations (Figures 1, 2), *Pleurobranchus aerolatus* (Mörch, 1863) (Figure 3) and *Eubranchnus cucullus* Behrens, 1985. Numerous specimens of *Hypselodoris californiensis* (Figure 4) and *Berthellina ilisima* (Figure 5) were also observed and photographed at this time.

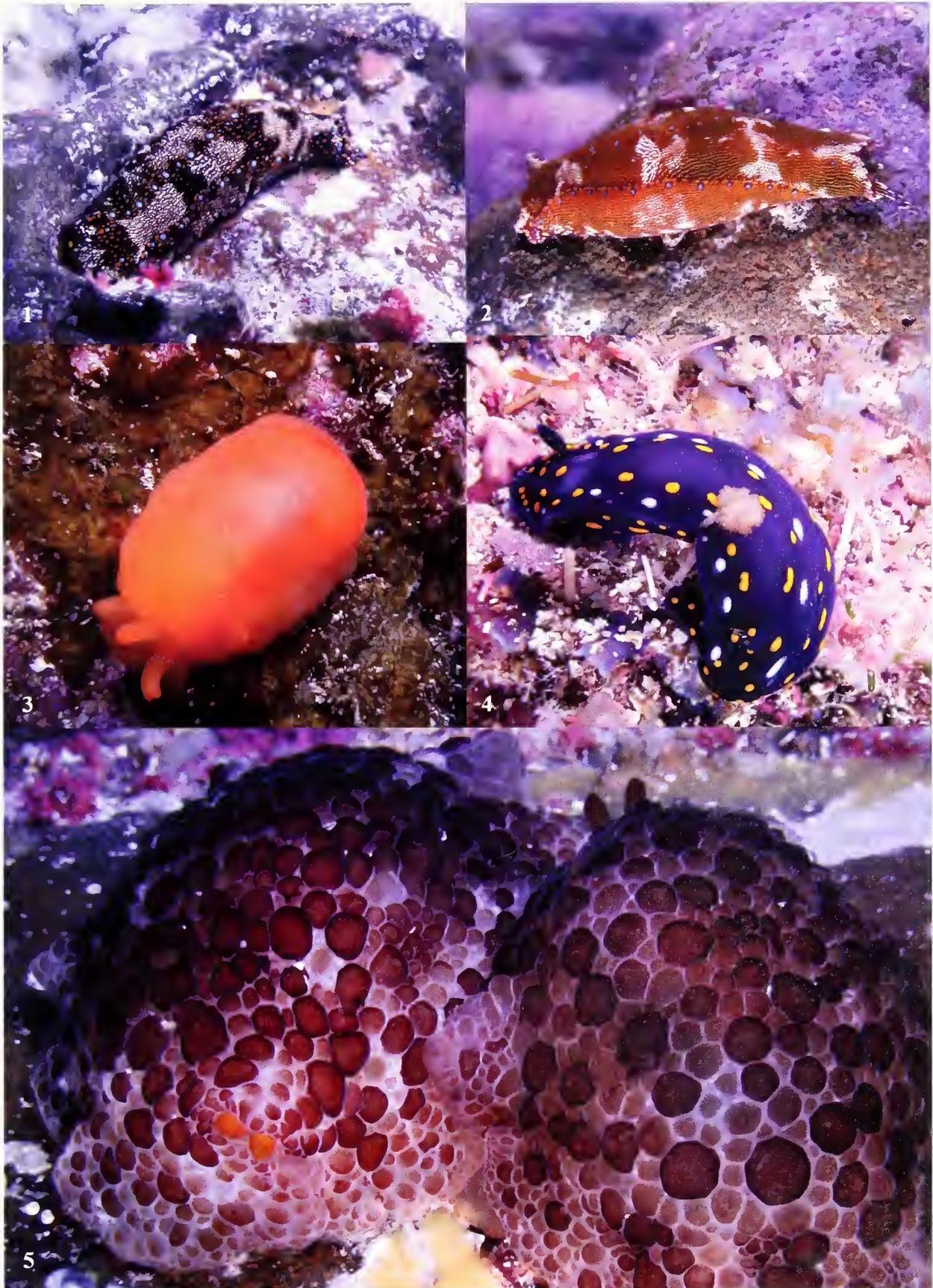
ACKNOWLEDGMENTS

Many thanks to Roberto Chavez and Kirstie Kaiser, Captain Mike and the crew of MV Nautilus Explorer.

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Figures 1-5. (1, 2) *Navanax aenigmaticus* (Bergh, 1893), two color forms ± 45 mm (3) *Pleurobranchus aerolatus* (Mörch, 1863) ± 100 mm (4) *Hypselodoris californiensis* (Bergh, 1879) ± 60 mm (5) *Berthellina ilisima* Marcus & Marcus, 1967 ± 60 mm. →



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THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

September 10, 2009

Number:9

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Annual dues are payable to San Diego Shell Club.
Membership (includes family). Domestic \$20.00;
Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc., c/o
3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
The publication date appears on the masthead above.
Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
Room 104, Casa Del Prado, Balboa Park, San Diego

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PROGRAM

THE SEPTEMBER PARTY
There is no regular meeting this month.

Party date: September 12, 2009

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting 20 August 2009

The meeting was called to order at 7:40 pm by President Carole Hertz. The previous meeting minutes were accepted as published in *The Festivus*. Silvana Vollero gave the treasurer's report. Carole discussed the September part at Larry and Debbie Catarius' house and passed around a sign-up sheet for food.

The Club auctioned off a number of shell books and as a result some of us took home some new treasures for our personal libraries. Wes Farmer talked briefly about his trip to Castro Camp and visit with a commercial abalone grower. Kelvin Barwick announced a meeting on mollusk taxonomy to be held on the 19th of October at the offices of the Orange County Sanitation District. For details, see below.

The presentation was on the opisthobranchs of Mission Bay. Lots of underwater photos that illustrated 21 species and their typical habitats was presented. Paul Tuskes also reviewed many species that are reported to be "common" but as yet have not turned up in the collecting effort or in some cases only one specimen has been found so far.

The speaker then presented his research on the life history of the bubble snail, *Bulla gouldiana*, with information on growth rates, longevity, reproduction, recruitment into the population, predation, and behavior.

Wes Farmer won the door prize, and refreshments were supplied by Silvana Vollero, and Paul and Ann Tuskes.

The meeting was adjourned at 9:05 pm.

Paul Tuskes

SCAMIT Talks Mollusks

The regular monthly meeting of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) will be hosted by the Orange County Sanitation District at their laboratory facilities on October 19. It will be a workshop on selected mollusk groups. Topics under discussion will include local species of the bivalve genus *Tellina* and the deepwater species

Nuculana leonina. *Boreotrophon* (Family Muricidae) will also be up for discussion. As participants of a recent Bight-wide survey, a number of attendees will, no doubt, have new and interesting mollusk discoveries to share. For information and directions, please contact Kelvin Barwick at 714-593-747 or <mailto:kbarwick@ocsd.com>. For information about SCAMIT the organization go the web site at <http://www.scamit.org> or www.scamit.org.

Correction to Hermosillo (2009)

The editor regrets transposing the figure captions for Figures 3 and 5 in Alicia Hermosillo's *A Note on the Opisthobranch Mollusks of Rocas Alijos*, pp. 118 and 119 in the August issue of *The Festivus*.

The captions should read: Figure 3. *Berthellina ilisima* Marcus & Marcus, 1967 and Figure 5. *Pleurobranchus aerolatus* (Mörch, 1863).

We apologize for the error.

The Club's Annual September Party September 12, 2009

As reported on the front page, there will be no regular meeting this month since the Club's most enjoyable annual September party will be held on Saturday afternoon September 12th beginning at 4 pm. at the Catarius' home at 4173 Galt St., San Diego, 92117.

If you hadn't heard and would still like to attend the party, just come ahead and bring a potluck contribution to serve 12. It's always a fun, relaxed get-together.

Save the Date for the Christmas Party

The Club's Christmas Dinner Party date has been reserved and it will be on the first Saturday evening in December – the fifth. It will again be held – by popular demand – at The Butcher Shop Steak House in Kearny Mesa.

Save the date – it's always a great party.

DIVING AND SHELL COLLECTING IN NEW ZEALAND'S MARLBOROUGH SOUND

KATHY KALOHI

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One week in February of 2008 my husband Joe and I had an opportunity to join another couple on a scuba diving trip to New Zealand. The other couple, Cathy and Don, had never been to New Zealand and this would be our second dive trip. We had done some diving and collecting on the North Island a few years before but always wanted to try the South Island.

We stayed on Arapawa Island, which is located on the northeast end of the South Island (Figure 1). We rented a house that overlooked the entrance to Tory Channel at Whakenui Bay. On clear days we could see across Cook Strait and the South end of the North Island. Arapawa Island was famous as a base for the

acres and is mainly forests, small family farms, retirement homes, and fish farms that raise salmon, mussels, and abalone.

When we arrived at the Arapawa homestead (Figure 2) our host Mike Radon greeted us. He and his wife Antonia purchased the homestead in 1993 from the heirs of the Perano whaling family. Antonia home-schools their three children and runs the rental opera-

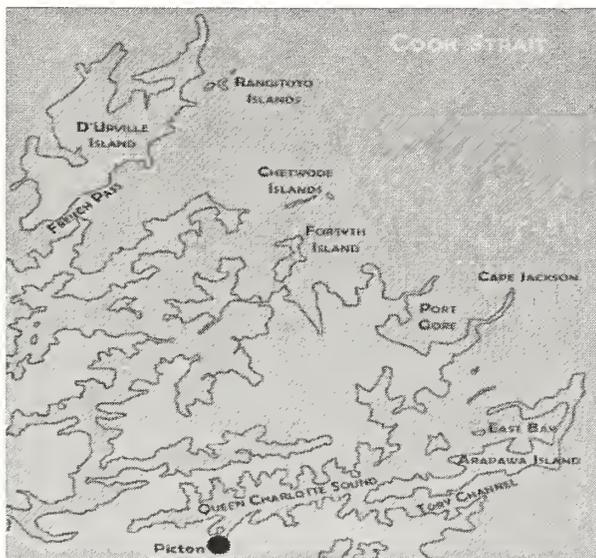


Figure 1. Map of Marlborough Sound.

whaling industry which was in full operation from the late 1820s to the mid 1960s. We had to take a water taxi from the town of Picton to reach Whakenui Bay, which was about an hour run. Arapawa Island is about 18,500



Figure 2. Road down to the homestead.

tions of the homestead while Mike oversees the rest of the farm. Besides having an abalone farm on the property, Mike is also a commercial fisherman and an avid diver since he was age 12. He and his Dad were commercial divers together in the earlier years when they lived in Santa Barbara, California.

After touring the farm and getting a general idea of where we would be diving we headed on up to the house. We used an ATV with a trailer that was included in our rental agreement. This ATV was our only means of transportation for the week. We hauled our diving gear using the trailer down to the next bay where Mike would pick us up every morning for the day's dives. Usually his guests would launch from their personal

wharf but it was being repaired while we were there. This bay we launched from for the week is called Fisherman's Bay and has remnants of one of the whaling stations. It is now a historic landmark with signs and pictures explaining the history of the whaling industry on the island and the families involved with it. It also explains how the whale carcasses were processed there at the station. Mike later showed us several whale rib bones he has in his yard from one of the whaling stations in the Channel.

Our main diving locations were inside the Tory Channel and outside the entrance of the Channel. I had planned on taking underwater pictures on each dive but that plan fell through when I learned that Mike had absolutely no problem with my collecting living specimens. While collecting became my priority, Joe, Cathy and Don's plan was to hunt for dinner each day. With the water temperature an average of 57 degrees F and the strong tidal exchange going in and out of Tory Channel, our diving plan became more of quality dives rather than quantity. Either way we all would be happy divers!

The Sunday afternoon we arrived, while Cathy was picking salad fixings from the Radon garden, the hunt for dinner also began. There are wild stock *Haliotis iris* (Gmelin, 1791) living around Mike's wharf. New Zealand law says abalone diving is by snorkel only so Joe and Don collected several legal size abalones for our dinner that evening. I snorkeled in about two feet of water along the rocky edges by the wharf and was finding usual lower tidal specimens. I collected Nacellidae: one worn *Cellana ornata* (Dillwyn, 1817), *C. radians* (Gmelin, 1791), *C. stellifera* (Gmelin, 1791), *C. redimiculum* (Reeve, 1854) and *C. denticulata* (Martyn, 1784). I also found *Maoricrypta monoxyla* (Lesson, 1831), *Venerupis largillierti* (Philippi, 1849), *Littorina antipodum* (Philippi, 1847), *L. cincta* Quoy & Gaimard, 1833, *Diloma nigerrima* (Gmelin, 1791), a worn *Austrofuscus glans* (Röding, 1798), a worn *Amalda australis* (Sowerby, 1830), and a dead *Cookia sulcata* (Gmelin, 1791). I also found many chitons including *Amaurochiton glaucus* (Gray, 1828) (Figure 7) and *Sypharochiton pelliserpentis* (Quoy & Gaimard, 1835) (Figure 6). And of course there were dead *Haliotis iris* Gmelin, 1791, and a few dead *H. australis* Gmelin, 1791 (Figure 12). Outside of the rock area it changed to a gradual sloping sand bottom. I did not explore this area of the bay which now I wish I had.

The next five days we dived locations where we could find crays (lobsters), fish, mussels, old bottles (yes, bottles), and a shipwreck I had personally

requested. The cray diving was the priority game that we enjoyed eating almost every evening (Figure 3).

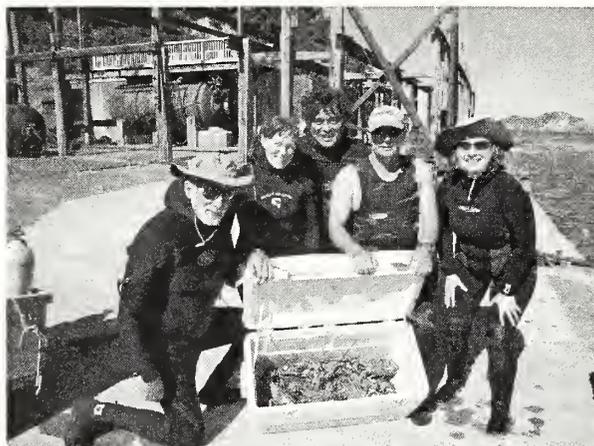


Figure 3. The catch of the day with l-r: Don Mueller, Kathy & Joe Kalohi, Mike Raddon (our host), and Cathy Mueller

The mussel collecting was done by snorkel only. Mike received permission from the mussel farm owners to let us collect only what we would eat for several meals. The mussel farm was very pretty with several types of algae along with the common *Macrocystis* kelp. The primary mussel that we collected is the *Perna*



Figure 4. Looking south down Tory Channel.

canaliculus (Gmelin, 1790) but I also took a few *Mytilus galloprovincialis* (Lamarck, 1819) and a single specimen of *Aulacomya maoriana* (Iredale, 1915). I saw one or two smaller unidentified nudibranchs crawling on the kelp blades too.

Inside Tory Channel (Figure 4) we dived several

bays with the names of Blackwood Bay and Bay of Many Coves. Cathy and I dived for bottles in most of these spots (Figure 5) and also in areas closer to the town of Picton. In the Queen Charlotte Sound, which is



Figure 5. Finding bottles and Chitons inside Tory Channel

northwest of Arapawa Island, we did one dive looking for bottles at Cook's Landing. All of these dive sites were not as affected from the tidal exchange and could be accessed most of the day. The typical bottom features of these areas could be medium-sized boulders and/or small rocky outcrops from the low tide zone out to a 25 foot depth and then become a sandy bottom sloping off to the middle of the deeper channel. The ferry boats run every half hour during the summer going back and forth between Picton and the North Island. Because of the boat traffic we restricted our deepest depth to around 80 feet or less. At Cook's Landing it was basically a cobblestone bottom to about a 20 foot depth and then again a sandy sloping bottom. We were again looking for bottles but did not find a single one. However, looking at the bottom topography, I could understand why Captain Cook used this landing several times for repairing his ships during his years exploring this part of the world.

In these back bays and coves in the shallower water among the rocky areas the most common species was *Maoricolpus roseus* (Quoy & Gaimard, 1834). Also among the rocks I found dead specimens of *Struthiolaria papulosa* (Martyn, 1784), a live *Ranella australasia* (Perry, 1811) on a deeper rocky ledge, a dead *Struthiolaria vermis vermis* (Martyn, 1784), live *Trochus tiaratus* Quoy & Gaimard, 1834, in the rubble areas, and a live *Trochus viridis* Gmelin, 1791. In the sloping area from 25 feet on down to 80 feet were live

and dead specimens of *Pecten novaezelandiae* Reeve, 1853. These are a free-swimming bivalve and they were fun to watch swell up with water and take off like a pair of false teeth. We could not take live specimens for food because the season had closed a few weeks prior to our stay. However, there were plenty of dead complete specimens to be found. Also in these sandy areas were live *Atrina zelandica* (Gray, 1835) embedded in the sand. Other bivalves were *Modiolarca impacta* (Hermann, 1782), *Gari stangeri* (Gray, 1843), *G. lineolata* (Gray, 1835), *Tellina gaimardi* Iredale, 1915, *Soletellina siliqua* Reeve, 1857, *Venerupis largillierti* (Philippi, 1849), *Dosinia zelandica* (Gray, 1835), *Venericardia purpurata* (Deshayes, 1854), and *Nemocardium pulchellum* (Gray, 1843). I found one large, heavy, dead specimen of *Glycymeris laticostata* (Quoy & Gaimard, 1835).

On the bottles we picked up I found many chitons. Besides the specimens I listed from Mike's wharf I also found *Ischnochiton maorianus* Iredale, 1914, (Figure 8) and one *Cryptoconchus porosus* (Burrow, 1815) that was nestled inside of a dead bivalve. This specimen was a deep orange when found live but turned to a dark brown after being preserved. Also living on the bottles were *Anomia trigonopsis* (Hutton, 1877) and *Maoricrypta monoxyla* (Lesson, 1831) among other shells (Figure 11). Most of the bottles we were looking for were embossed liquor bottles, water bottles etc. that were from the 1940s to the 1960s. Cathy proved to be an excellent bottle hunter besides a great lobster diver.

The shipwreck I was hoping to see was the Mikhail Lermontov, a Russian passenger liner that sank in 1986. She struck some rocks off of Cape Jackson and drifted to her deep grave in Pt. Gore. She lies on her side in 120 feet of water with her diving depth starting at 45 feet. Mike arranged to go out to the wreck on a friend's boat. It was at least a two hour run into the wind and chill but we enjoyed looking at the Marlborough Sound scenery. Every now and then we would pass a section of island that still had original old growth forest down to the tide zone. When we finally jumped into the water and touched the wreck we encountered very low visibility, perhaps 10 feet with a green plankton bloom haze around us. The wreck was covered with tunicates, small fish, small algae, starfish, hydroids, tube worms, anemones, and fine silt which stirred up easily. I did pick up a few specimens on the wreck and took some pictures too. The specimens I found were *Ostrea chilensis* (Philippi, 1844) which is a non-native oyster and a nice yellow form of *Chlamys zealandiae* (Gray, 1843). Also to my surprise I found a dead *Haliothis*

virginea Gmelin, 1791. With the visibility being so poor we decided to skip another dive on the wreck.

Diving the entrance to Tory Channel and the outside of the channel proved to be more advanced due to higher tidal exchanges and surge. Because of these conditions the variety of marine life was much more abundant and colorful than inside the channel. Along the north wall of the entrance to the channel Cathy and I drifted in an incoming current. Larger boulders provided an eddy where I could collect some shells while she looked for crays. On the outside of the channel we made several dives heading north at Perona Head and East Head and one dive South of the channel entrance. On the South side dive I found a specimen I had hoped to see and collect. It was a Noble Chiton, *Eudoxochiton nobilis* (Gray, 1843). I knew I would be collecting some chitons and I had a hard time finding enough isopropyl alcohol in Picton before our trip. After purchasing the only two small bottles in the pharmacy in town I quickly found the package liquor store. One pint bottle of vodka was enough to preserve the chitons until I could get them back home.

Other specimens I picked up outside of the channel were: *Notirus reflexa* (Gray, 1843), *Barbatia novaezelandiae* (E.A. Smith, 1915) (Figure 9), a dead *Maurea tigris* (Gmelin, 1791), *Turbo granosus* (Martyn, 1784), a dead *Maurea punctulatum* (Martyn, 1784), *Sigapatella novaezelandiae* (Lesson, 1831), *Argobuccinum tumidum* (Dunker, 1862), *Penion sulcatus* (Lamarck, 1816), *Astraea heliotropium* (Martyn, 1784) (Figure 10), and brachiopods *Notosaria*

nigricans (Sowerby, 1846) and *Calloria inconspicua* (Sowerby, 1846). I found one nudibranch that I did photograph and when I returned home it was identified as a different color form of *Aphelodoris luctuosa* (Cheeseman, 1882).

After five days of diving we decided to go touring with Mike on the ATVs and sightsee the northern portion from his farm. I had mentioned to the others that I would love to take a picture of a *Paryphanta* land snail. No large land snails were to be found but we did enjoy the scenery. We stopped by a stream on the way back and I was able to pick up several varieties of Caddis fly egg casings. Mike and his daughter Sarah gave us a tour of the abalone farm and patiently answered our many questions. Our farewell gift from Sarah to Cathy and me was a growth series of the abalone from the farm. Mike brought out a box of *Argonauta nodosa* (Lightfoot, 1786), the Paper Nautilus specimens that float up onto his beach every so often. He kindly gave Cathy and me each a perfect specimen. We gratefully accepted these gifts from the Radon family.

As the week drew to a close we bid goodbye to our new friends and the water taxi took us back to Picton. We still had time for a quick look in the Picton museum before we had to board the ferry and saw many artifacts from the whaling industry, a few items from the Mikhail Lermontov shipwreck, and of course the *Paryphanta* land snails which I'd hoped to have seen. Needless to say it was a wonderful vacation and we are looking forward to returning again one day.

Figures 6-12. (6) *Sypharochiton pelliserpentis* (Quoy & Gaimard, 1835) (7) *Amaurochiton glaucus* (Gray, 1828) (8) *Ischnochiton maorianus* Iredale, 1914 (9) *Barbatia novaezelandiae* (E.A. Smith, 1915) with brachiopod (10) view of base of *Astraea heliotropium* (Martyn, 1784) with bivalves in the umbilicus (11) assortment of shells collected from bottles (12) *Halotis australis* Gmelin, 1791. →



6



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8



10



9



11



12



ERRATA

Stebbins, T. D., and D. J. Eernisse. 2009. Chitons (Mollusca: Polyplacophora) known from benthic monitoring programs in the Southern California Bight. *The Festivus*, (Special Issue) 41(6): 53-100.

1. **Cover photo caption (facing page 53):** The chiton depicted in the cover photo is *Lepidozona* sp. C (not *Lepidozona* sp. A). The correct legend should be:

Live specimen of *Lepidozona* sp. C occurring on a piece of metal debris collected off San Diego, southern California at a depth of 90 m. Photo provided courtesy of R. Rowe.

2. **Page 56:** The symbol [†] next to "Sources" at the top right of Table 1 on this page should be changed to a [‡] to match the footnote at the bottom of the page (i.e., Sources [‡]).
3. **Page 58:** In the footnote at the bottom of the page, *Leptochiton* cf. *belknapi* should be spelled with a period after the "cf" instead of a comma.
4. **Page 80:** In the caption for Figure 2, the sample depth listed for the chiton depicted in Figure 2a should be 88 m instead of 18 m. The correct legend should be:

Figure 2. *Hanleyella oldroydi* (Bartsch MS, Dall, 1919). (a) Dorsal view of specimen, 4 mm length, collected west of Mission Bay, San Diego County, California at a depth of 88 m; (b) Lateral view of live specimen, ~ 5 mm length, collected southwest of Point Loma, San Diego County, California at a depth of 90 m.

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

October 8, 2009

Number:10

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 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM.
 Room 104, Casa Del Prado, Balboa Park, San Diego

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PROGRAM

OF SEAS AND SHELLS: MOLLUSKS IN THE SERI WORLD

Cathy Moser Marlett will present a program on the Seri people, now numbering around one thousand, who for millennia lived on the eastern shore of the Gulf of California. Their language and rich culture, threatened by increased contact with the outside world, provide a unique glimpse at how past Gulf peoples used the region's rich resources.

The study details the Seri knowledge and use of mollusks. More than 150 species have been identified; most are presented with their Seri names (more than 250) and ethnographic details. This presentation, a sampling of both shelled and unshelled mollusks, includes photographs, graphic illustrations and ethnographic information.

Meeting date: October 15, 2009

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CLUB NEWS

From the September Party 12 September 2009

As always, the September parties at the home of Debbie and Larry Catarius have been special and this one was no exception. This time, with a group of 25 (four of whom were children who had a blast in the Catarius' play area) the wine, beer and soft drinks were plentiful, the delicious food never ran out, the conversations never lagged and the laughter could be heard throughout the afternoon and early evening. People were definitely not in a hurry to leave.

Our grateful thanks to Debbie (whose birthday it was – what a way to celebrate?) and to Larry for once again making everything perfect for this annual September event.

SCAMIT Talks Mollusks

The regular monthly meeting of the Southern California Association of Marine Invertebrate Taxonomists (SCAMIT) will be hosted by the Orange County Sanitation District at their laboratory facilities on October 19. It will be a workshop on selected mollusk groups. Topics under discussion will include local species of the bivalve genus *Tellina* and the deepwater species *Nuculana leonina*. *Boreotrophon* (Family Muricidae) will also be up for discussion. As participants of a recent Bight-wide survey, a number of attendees will, no doubt, have new and interesting mollusk discoveries to share. For information and directions, please contact Kelvin Barwick at 714-593-747 or mailto: <kbarwick@ocsd.com>. For information about SCAMIT the organization go the web site at <<http://www.scamit.org>>or <www.scamit.org>.

The WSM Now Has a Blog

The Western Society of Malacology (WSM) announces it now is online with a blog. To check it out, go to: <http://westernmalacologists.blogspot.com/>
Check it out !

New Mollusk Book Announced

Marine Mollusks of Bermuda: Checklist and Bibliography

By: Russell H. Jensen & Timothy A. Pearce (2009)
Published by: Delaware Museum of Natural History
Price: \$30, plus \$10 domestic shipping or \$20 for international shipping.

This book "catalogues more than 900 mollusk species, including more than 100 never before reported and 66 found only in Bermuda. The book is compiled from more than 750 literature sources and previously unpublished museum records."

"The list of mollusks, comprising the bulk of the book, is arranged systematically in six classes: Solenogastres (aplacophora, or worm mollusks), Polyplacophora (chitons), Gastropoda (snails and sea slugs), Cephalopoda (octopods and squids), Scaphopoda (tusk shells), and Bivalvia (clams and scallops). Photographs include a number of endemic species in Bermuda that have never before been illustrated in color, and the list of endemic species will be of use to conservation workers."

To order, contact Delaware Museum of Natural History, P.O. Box 3937, Wilmington, DE 19807. Domestic orders can be made online at <http://www.delmnh.org/CandRBermudaMarineMollusks.php>

Save the Date for the Christmas Party

The Club's Christmas Dinner Party date has been reserved and it will be on the first Saturday evening in December – the fifth. It will again be held– by popular demand – at The Butcher Shop Steak House in Kearny Mesa. The menu will be announced at the October meeting and reservations will be accepted. Since the party is early in December – all reservations (checks) will have to be received by the end of November.

Save the date – it's always a great party.

MISSION BAY SURVEY UPDATE

PAUL TUSKES

3808 Sioux Avenue, San Diego, California 92117, USA

E-mail: tuskes@aol.com

Since the previous report in *The Festivus* dated January 2009, thirteen additional species have been added to the Mission Bay list. Two species that I was particularly pleased to find were *Bursa californica* (Hinds, 1843) (Figure 1) and *Latiaxis oldroydi* (I. Oldroyd, 1929) (Figure 2). The *Bursa* were in the sand at 30 feet on the edge of the channel, and the *Latiaxis* was at 24 feet on a rocky structure. The most stunning addition is the bright yellow *Tylodina fuugiua* Gabb, 1865 (Figure 3). The first specimen was quite large and traveling over red algae. Close examination of yellow sponges turned up many more individuals. A unique characteristic of this species is the limpet-like circular shell on its back.



Figure 1. *Bursa californica* in sand at 30 feet in Mission Bay.

Surprisingly, many intertidal and shallow water species reported to be common in the literature have not yet been found during the survey. Your efforts allowed us to compile a list of 136 species the first year. We have huge blind spots with sand/mud dwelling species, plus limpets and chitons in the rocky areas.

Only one specimen of *Rictaxis punctocaelatus*



Figure 2. *Latiaxis oldroydi* on rock at 24 feet in Mission Bay.



Figure 3. *Tylodina fuugiua* moving on red algae in Mission Bay.

(Carpenter, 1864) (by John LaGrange in Santa Clara Cove) and one *Acteocina culcitella* (Gould, 1853) (by

John Bishop in South Cove) have been found. There are still many opportunities to turn up additional species, especially among the smaller shells. Your help in tracking down species is critical to the success of this effort. It's always exciting to find the odd or the rare, but data on species at each location is no less or more valuable regardless of the rarity.

When sampling, please use the on-line data sheet for recording your information. List all collectors so

that they can be acknowledged. It is up to you to call some friends to get together for a field trip. Most locations have restrooms nearby, and some have tables, fire rings, and BBQs, so think about a picnic before or after the tide. It is probably best to be at your site 45 minutes before the low tide. Please send completed data sheets to Paul Tuskes, by e-mail, post, or bring them to a meeting. Remember, a fishing license is needed if picking up live critters. Have fun.

Most Recent Finds

Entodesma navicula (A. Adams & Reeve, 1850)
Modiolus neglectus Soot-Ryen, 1955
Rictaxis punctocaelatus (Carpenter, 1864)
Assimineea californica Tryon, 1865
Bursa californica (Hinds, 1843)
Cerithiopsis ?carpenteri Bartsch, 1911

Crepipatella lingulata (Gould, 1846)
Latiaxis oldroydi (I. Oldroyd, 1929)
Turbonilla tenuicula (Gould, 1853)
Baptodoris mimetica Gosliner, 1991
Doris montereyensis (Cooper, 1862)
Flabellina trilineata (O'Donoghue, 1921)
Tylodina fungina Gabb, 1865.

Remaining Mission Bay Tides for 2009

<i>Date</i>	<i>Time</i>	<i>Tide</i>	<i>Location</i>
Sept 19 Sat	4:20p	-0.1	Anza Cove area
Oct 17 Sat	3:28p	-0.5	West Crown Pt
Oct 18 Sun	4:09p	-0.6	South Cove
Oct 31 Sat	2:34p	0.2	Your Favorite
Nov 2 Sun	2:10p	-0.3	Ventura Cove
Nov 14 Sat	1:43p	-0.5	Anza Cove area
Nov 15 Sun	2:23p	-0.8	West Crown
Nov 16 Mon	3:02p	-0.9	Your Favorite
Dec 29 Sun	1:21p	-0.2	Fiesta Island
Dec 30 Mon	2:00p	-0.8	Your Favorite

IN MEMORIAM

James Willard Nybakken (1936-2009)

James Willard Nybakken (Figure 1) was born in 1936, in Warren, Minnesota, son of Clarence and Effie Nybakken. He attended St. Olaf College and received his B.A. degree (summa cum laude) in biology in 1958. While there, he met another biology student, Bette Halvorsen, whom he married in 1960. He attended the University of Wisconsin, and in 1961 earned his M.A. in zoology, and in 1965 he earned his Ph.D. in zoology. After receiving his Ph.D., he joined the faculty of California State University, Hayward. In 1966 he became a founding faculty member of Moss Landing Marine Laboratories (MLML) which had recently been created by a consortium of California State Colleges (Hayward, Fresno, Sacramento, San Jose, San Francisco; later joined by Stanislaus & Monterey Bay). Jim served twice as acting director of MLML.

His research interests were ecology and systematics of predatory neogastropods, primarily the genus *Conus*; ecology and systematics of nudibranch mollusks; and ecology and life cycle of benthic and deep-sea invertebrates. While pursuing his research on *Conus*, he participated in two cruises on the R/V *Te Vega*: in 1963 as Junior Scientist on the "International Indian Ocean Expedition" and in 1967 as Chief Scientist on the Stanford University "Biological Oceanographic Studies of the Gulf of California". During the late 1960s and early 1970s he was also a Research Associate in the Department of Zoology at the University of Washington, where he continued his research on *Conus* with Alan J. Kohn.

He administered several grants over the years, providing financial support to numerous graduate students and, in keeping with the hands-on, field-oriented approach of MLML, giving them valuable experience as technicians for the grant projects. He mentored many students over the years, evidenced by the 94 theses located in the MLML library. He was thesis advisor for 59 theses, and committee member for another 35.

He was a peer reviewer for several scientific journals, including: *The Veliger*, *Journal of Molluscan Studies*, *American Malacological Bulletin*, *Nautilus*, *Marine Biology*, *Malacological Review*, *Journal of Experimental Marine Biology and Ecology*, *Malacologia*, *Ecology*, *Marine Ecology Progress Series*, and *California Fish and Game*.



Figure 1. James Willard Nybakken

After 32 years of service, Dr. Nybakken retired from MLML to emeritus status in 1998. During his tenure he saw the lab grow from a small field station in a converted cannery, to a world-class institution.

In addition to his academic interests, he also cultivated orchids in greenhouses he built, and was President of the Carmel Valley Orchid Society (2003, 2004). He also was an enthusiastic wine maker. After winning a battle with prostate cancer in 1999, Jim was diagnosed with leukemia in August, 2008, and passed away in 2009.

In addition to his numerous publications in scientific and popular journals, he authored or coauthored five books on zoology or marine ecology, the best known being: "General Zoology", and "Marine Biology: An Ecological Approach".

MEMBERSHIP IN PROFESSIONAL AND EDUCATIONAL ORGANIZATIONS

Fellow of the California Academy of Sciences (elected 1978)
 Western Society of Malacologists (Vice-president 1972, 1974; President 1975)
 American Malacological Society (Vice-president 1983-84; President elect 1984-85; President 1985-86)
 California Malacozoological Society, Inc. (Vice-president 1976-80, Board of Directors 1989-2005)
 Western Society of Naturalists (President 1985-86)
 Institute of Malacology (Vice-president 1985-1989, 2001-02; President 1989-92)
 Board Member, Friends of MLML (1999-2008; Chair 2003-2008)

PUBLICATIONS OF JAMES W. NYBAKKEN:

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLI

November 12, 2009

Number: 11

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 Membership (includes family). Domestic \$20.00;
 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.

Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
 Room 104, Casa Del Prado, Balboa Park, San Diego

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PROGRAM

The Marine Life Protection Act Initiative and the Establishment of Marine Protected Areas in Southern California

Benjamin Pister will give a slide presentation explaining the current Marine Life Protection Act passed in 1999 and discussing the Act, the latest Initiative, and the process which has been going on to design the marine protected areas. Several proposals have been intro-

duced by the Blue Ribbon Task Force and their recommendation will have been made by the time of this talk. Ben will show everyone the different proposals focusing on San Diego and answer questions on why the certain areas were chosen.

Meeting date: November 19, 2009

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting 15 October 2009

President Carole Hertz called the meeting to order at 7:40 pm. The previous minutes were accepted as published. The treasurer was absent so there was no report.

The slate of officers for 2010 was presented. It is: President, Benjamin Pister; Vice President, Jules Hertz; Recording Secretary, Paul Tuskes; Corresponding Secretary, Marilyn Goldammer; Treasurer, Silvana Vollero. Elections will be held at the November meeting at which time nominations (with permission of the nominee) from the floor will be accepted. Installation of the new officers will take place at the December dinner party.

The details of the Christmas dinner party on Saturday, 5th of December were announced by Jules Hertz. The Speaker will be Bob Yin. (I know Bob from the Underwater Photographic Society and am sure his interest in shells and photography will result in a great program). For details, see column 2, this page.

Cathy Marlett gave a presentation on the Mollusks in the Seri World. Cathy grew up in the Seri community and speaks the language. The community she lived in was Desemboque, which translates to "Place of the Clams". The Seri Indians in the Gulf of California lived primarily along the coast of Sonora and in the Gulf on islands such as Tiburón. Like some tribes in México, they have retained their language and culture, but increased reliance on modern technology and communication is impacting the culture.

The Gulf provided much of the required resources and as a group they were shell collectors par excellence. Gathering was critical and mollusks were such an important part of the food supply and culture that they have specific names for approximately 150 molluscan species. Shells have either a primary name or a descriptive name based on habitat, use, shape, color or behavior. Primary names had no specific meaning, i.e. Tom's shell.

Venus and Chione clams, mussels and some snails were most commonly collected for food. The egg cockle *Lavicardium elatum* was both eaten and the shell used to make a wide range of tools including bowls, scoops, scrapers, and digging tools. Shells were used as utensils, tools, toys, adornment, and amulets to ward off spirits. The presentation included excellent line drawings made by Cathy of many shells, recordings of Seri songs/stories about the Gulf and shells. The door prize was won by Nancy Schneider. The meeting was adjourned at 9 pm.

Refreshments were provided by Debbie and Larry Catarius and Marilyn Goldammer.

Paul Tuskes

Save the Date for the Christmas Party

The Club's Christmas Dinner Party date has been reserved for Saturday evening December 5th. It will again be held – by popular demand – at The Butcher Shop at 5255 Kearny Villa Road in San Diego (off Highway 163 at Clairemont Mesa Blvd). Festivities begin at 6 pm with no host cocktails; dinner will be served promptly at 7 pm.

The dinner begins with a Mixed Greens Salad and dinner rolls and butter. The choice of entree is either Prime Rib of Beef (8 oz) or Fillet of Salmon. Vegetarian dinners are also available. All entrees will be served with garlic mashed potatoes and fresh vegetables. The dessert will be Chocolate Overload Torte and will be served with coffee or tea. As always, the Club will provide the dinner wine. As noted in the Minutes, Bob Yin, diver, photographer, author and traveler will give the evening's program. It will be terrific, as always.

Remember to bring an anonymous, gift-wrapped shell or shell-related gift with only very general locality on the outside i.e. Atlantic, S. Pacific for the Club's traditional gift exchange. You can only choose one, if you bring one!

The cost of the entire evening including tax and tip will be \$30 per person. Reservations (checks) will only be accepted through November 31st since the party is so early in December. Please put your entree choice(s) on your check. And if you wish, you can include your membership for 2010, still \$20, on the check.

Dues are Due

Dues for the year 2010 are now due. The rates remain the same as for 2009 – Domestic \$20.00; overseas (air mail) \$50.00; Mexico/Canada \$30.00. Please mail your checks to the address on the masthead.

The Fourteenth Annual Scum Meeting

The 14th annual meeting of the Southern California Unified Malacologists (SCUM) will be held at the City of San Diego's Environmental Monitoring Laboratory on Saturday, January 23, 2010. Details to come later.

A NEW LOOK AT *CYMATIUM (TURRITRITON) GIBBOSUM* (BRODERIP, 1833)

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Abstract: This study of 273 specimens previously identified as *Cymatium gibbosum* encompasses its variability and its distribution from southern California, USA, to Panamá and the Islas Galápagos. Examination of photographs of the syntypes of the Broderip species *C. gibbosum* described from Panamá presented a different aspect than that of the “northern” specimens classified as *C. gibbosum*. Specimens previously identified as *C. adairense* in the collections studied were determined to be *C. gibbosum* based on examination of the photos of the type of *C. adairense*. No adult specimens conspecific with the type of *C. adairense* were found.

Introduction

In our ongoing work on the mollusk collection at the San Diego Natural History Museum (SDNHM), while curating the family Ranellidae, we observed differences in *Cymatium gibbosum* (Broderip, 1833), between specimens from Panamá and those from more northerly areas. We examined specimens from as far north as San Pedro, California, USA (Figure 1), down the outer coast of Baja California (Figure 2) into the Golfo de California, México, and south to Panamá and the Galápagos. *Cymatium (Turritriton) gibbosum*, the type of the subgenus *Turritriton* Dall, 1904, is a rather common species in the Gulf (Figure 3), and much to our surprise, we learned that the species had been described from Panamá, the area in which specimen differences caused us to examine whether or not there was one variable species or two species.

Our previous understanding of *C. gibbosum* was that of “northern” specimens as figured in Abbott & Dance (1982:121, 2 figs); Catarius (1988:10, figs. 1,2) and Henning & Hemmen (1993, pl. 22, fig. 6). After examining specimens in the SDNHM from Panamá we saw specimens identified as *C. gibbosum* which looked quite different. This started our study.

Broderip (1833) in his brief description, without illustration, gave the type locality for *C. gibbosum* as Panamá. For illustration of the species we looked in Reeve (1844, pl. 11, fig. 38, pl. 14, figs. 38b,c) (Figure 4). We realized that if this is the true *C. gibbosum*, it is quite different from specimens from

western México. In 1904 Dall described the subgenus (as section) *Turritriton* with *C. gibbosum* as the type for “forms with short canal and longer spire, heavy varices and flat-topped turriculate whorls.” At this point we decided that we needed to study the type material of *C. gibbosum* and we requested photos from the Natural History Museum, London (BMNH) (Figure 5 a-f syntypes).

Later Dall (1910) described (without illustration) *Cymatium adairense* from Bahía Adair, Sonora, México, stating “it most nearly recalls” Broderip’s *gibbosum* which is a “much heavier, larger, proportionately wider and more clumsy shell.” Dall illustrated the species in 1925, pl. 35, fig. 1 (Figure 6 herein). At that time he did not place his species in the subgenus *Turritriton*. Dall’s type of *C. adairense* from the National Museum of Natural History (USNM) is shown here in Figure 7.

Keen (1971) stated of *C. adairense* “it may qualify as a subspecies that is smaller with coarse sculpture confined to the northern part of the Gulf of California. Whether it is validly different remains to be determined.” Her illustration of *C. gibbosum* (Keen, 1971, fig. 961) from La Libertad, Sonora, resembles the type of *C. adairense* (Figure 7). Beu & Knudsen (1987) listed *C. adairense* in their synonymy of *C. gibbosum* but stated that “beach shells from Adair Bay ... have shorter spires and wider shells than the form known as *C. adairense* and are exactly comparable with beach

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Figures 1a-3b. *Cymatium gibbosum* Broderip, 1833. (1a,b) SDNHM 34009, 51.5 mm L, apertural and dorsal views, East San Pedro, California, USA, leg. Captain Luke, ex Herbert N. Lowe Collection (2a, b) SDNHM 34006, 50.1 mm L, apertural and dorsal views, Scammon's Lagoon, Baja California, México, leg. Captain Porter (3a, b) SDNHM 34014, 43.5 mm L, apertural and dorsal views, Pta. Libertad, Sonora, México, intertidal, leg. H.N. Lowe, 1935.



Figure 4. *Cymatium gibbosum* Broderip, 1833. Three syntypes, after Reeve (1844, pl. 11, sp. 38; pl. 14 sp. 38 b,c) "Panama and Monte Christi, West Columbia ... coarse sand at the depth of seven fathoms."



Figures 5a-f. *Cymatium gibbosum* Broderip, 1833. BMNH 1968527. syntypes (a,b) 36.8 x 21.0 mm (c,d) 38.2 x 22.5 mm (e,f) 34.6 x 19.4 mm. Panamá. Photos: Amelia Maclellan.

shells from Panama and other southern localities.” Henning & Hemmen (1993) consider “*adairensis* ... a slender, less tabulated deep-water variety of *C. gibbosum gibbosum*.”

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Figure 6. *Cymatium adairensis*, type drawing after Dall (1925, pl. 35, fig. 1), “10 fathoms, sand off Adair Bay.”

Material Studied

We have now examined 105 lots of 273 specimens of *C. gibbosum* (which include photographs of the three syntypes of *C. gibbosum* and the holotype of *C. adairensis*): 31 lots of 100 specimens from the Santa Barbara Museum of Natural History (SBMNH); 48 lots of 115 specimens from the SDNHM, 11 lots of 34 specimens from the Carol Skoglund Collection (CS), 10 lots of 13 specimens from the Hertz Collection (CJH), 2 lots of 6 specimens from the Myers Collection (MC) and one lot of one specimen from the Larry Catarius Collection (LC) (Table 1).

In the 31 lots in the SBMNH, we examined 8 lots of 23 specimens from Panamá that resembled Figure 38a in Reeve, 1844, and 23 lots of 77 “northern” (including some intergrade) specimens from Scammon’s Lagoon (SDNHM 34006) and Bahía Magdalena (SBMNH 366143) on the outer coast of Baja California, through the Golfo de California and south to Nayarit and Jalisco, México and El Salvador, Nicaragua and Costa Rica and one specimen from the Islas Galápagos. The SDNHM Collection contains 13 lots of 32 specimens from Panamá and 35 lots with 83 specimens extending from California to Nicaragua, El Salvador and Costa Rica.

From this survey, we noted that of the 8 small specimens from Nicaragua, 2 were Panamá look-alikes and the remainder were too immature to classify (SDNHM 34012). The two specimens from El Salvador, one a juvenile (SBMNH 423171) and the other an adult



Figure 7. *Cymatium adairensis* Dall, 1910. USNM 214103, holotype, 33.0 x 17.0 mm, 3 views. “10 fms. Gulf, off Adair Bay.” Photos: Jerry Harasewych.

(SDNHM 34013) were “northern” in appearance. Of the 29 specimens from Costa Rica, 4 appeared “northern”, 10 appeared Panamá-like, 2 were intergrades (SBMNH 24582 & 366224) and 13 juveniles were too small to classify.

A broad 40.0 mm specimen from the Islas Galápagos (SBMNH 423169) had features of both “northern” and Panamá specimens with a tall turreted spire, a downward curving apertural varix, humped on the dorsum of the body whorl and no anal sulcus. From the northern localities to Manzanillo, Colima, México, we observed specimens which were Panamá-like or mixed lots of “northern” and Panamá-like specimens or intergrade lots (SDNHM 59007 [Baja California Sur], 34007 [Jalisco]; and SBMNH 423176 [Colima]). For example, in the Skoglund Collection of 12 lots of 35 subadult to adult specimens plus 50 small juveniles, we found in 3 lots of 12 specimens from Nayarit, one lot of 7 specimens that appeared “northern”, a second lot of one specimen was an intergrade and the third lot was mixed -- of the largest specimens, one was northern and one was Panamá-like. It appeared to us that more species intergradation was evident from Nayarit south (see Table 1).

Discussion

In total we have studied 273 specimens identified as *Cymatium gibbosum*. We observed that in the Panamá specimens most were small, reaching ± 33 mm. However, one 60.7 mm specimen from Panamá was reported by Beu & Knudsen (1987) from the Academy of Natural Sciences of Philadelphia Collection (ANSP) (Figure 8 herein) and resembles the “northern” speci-

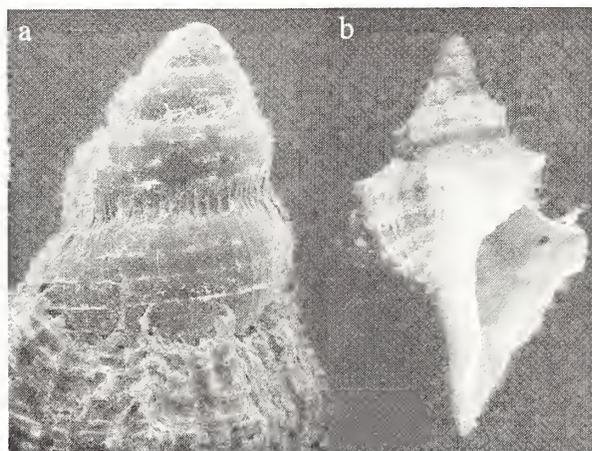


Figure 8. *Cymatium gibbosum*. ANSP 36950, 60.7 mm L, 3 views, Panamá. Photo: Amanda Lawless.

mens which can reach a maximum length of ± 60 mm. However, Draper (1987) listed the maximum size of a specimen, measured from Santa Rosalia, Baja California, as 71 x 32 mm. This specimen is in the collection of the SBMNH (423179).

The Panamá specimens have $3\frac{1}{2}$ -4 subangulate weakly noded whorls, are low spired, moderately tabulate with weakly impressed suture and a downward curving apertural varix, whereas the "northern" specimens have $3\frac{1}{2}$ -5 elongately turreted whorls concave from periphery to deeply indented suture forming a flattened subsutural ramp, and an upwardly pointed apertural varix at the periphery. Most Panamá specimens have a deep, narrow, anal sulcus bracketed by two nodes while most more-northern specimens either have no anal sulcus or a broad shallow one. Very few of the Panamá specimens studied (40+) had periostracum on the beaded teleoconch while most of the "northern" specimens were covered with periostracum, some obscuring the beading. All specimens, both "northern" and from Panamá, have trifid, beaded spiral cords on the entire teleoconch and a body whorl with the two posterior spiral cords merging into one deeply-grooved cord at the periphery (Table 2). The color of the Panamá-like specimens tend to be a grayish-brown and the "northern" specimens tan to cream to brown. The protoconchs of all the specimens have 4-5 clear to cream, round, conical whorls, often with brown bands near the suture. For the nucleus of a Panamá specimen see Figure 5f [syntype] and for the nucleus of a "northern" specimen see Figure 9a,b [SBMNH 423141]. The opercula of all the specimens were the same - corneous, ovate with anterior nucleus (Figure 5c [syntype] and Figure 10 [SBMNH 423157]). However, we did observe that the periostracum on the protoconchs

while mostly dark brown is occasionally a mustard color and often with raised, fringed spiral lines (Figure 9a,b). The radula has not yet been described for *C. gibbosum* (Beu, 1998).



Figures 9 a,b. *Cymatium gibbosum*. SBMNH 4233141, SEM of protoconch and apertural view of complete 17.5 mm L juvenile shell, Bahía de los Angeles, Golfo de California, México, leg. Roy Poorman, 1/1975. Photos: Daniel L. Geiger.

Beu & Knudsen (1987) in their in-depth report on the Ranellidae, studied the syntypes of *C. gibbosum* and comparative material in the New Zealand Geological Survey (NZGS), the Natural History Museum of Los Angeles County (LACM) and the Academy of Natural Sciences, Philadelphia (ANSP). However, they did not report on specimens from the most northern of the range at East San Pedro (Figure 1) and at La Jolla (SDNHM 70790) both in California, as well as specimens from Scammon's Lagoon (SDNHM 34006) and Bahía Magdalena (SBMNH 366143) which were examined by us and listed in Table 1. These specimens all showed the shape and overall characters of the "northern" specimens.

Of the 28 specimens in the SDNHM examined that had been previously identified as *C. adairense*, comparisons with Dall's type as illustrated in Dall (1910) and the photos of the 33 mm type from the USNM (Figure 7), we conclude that although previously identified as *C. adairense* (either as a species or a subspecies) those specimens are conspecific with the "northern" *C. gibbosum*. Four lots were intertidal but no depths were given for the rest. We could find only three immature, dredged specimens from the Skoglund Collection (CS) at Bahía Concepción, Baja California Sur, and one immature intertidal specimen from the

Golfo de California (SDNHM 64739) that could possibly resemble juveniles of Dall's *C. adairense*. However, *C. adairense* was described from an apparently mature specimen (Figure 7) taken from 18 m. These immature specimens have a more fusoid shape with strongly noded spire and are often covered with a golden-tan periostracum, sometimes fringed along the axials down the length of the specimen including the long canal.

Emerson & Old (1963:25-26) stated, based on specimens of *C. gibbosum* studied from the Puritan-American Expedition, that "Dall's taxon [*adairense*] would appear to be a form of *C. gibbosum*, as "typical" specimens of the present species also occur in the Gulf of California, as well as in the southern part of the Panamic Province as far south as Manzanillo, Mexico." We have not studied those specimens.

Beu & Knudsen's *C. adairense* (p. 81, fig. 24) seems to us to be a typical mature "northern" specimen of *C. gibbosum*, not resembling the type of *C. adairense*. The type of *C. adairense* (Figure 7) has angulate spire whorls and strongly pointed nodes overhanging the deep suture and protruding over part of the succeeding whorls, whereas the specimen in Beu & Knudsen has a deeply turreted spire with prominent nodes, deep suture and tabulate shoulder with a flattened ramp. The canal in the Beu & Knudsen figure is open, short and straight, the canal of the type of *C. adairense* is open, long and considerably dorsally recurved.

Conclusion

Beu & Knudsen (1987: 82) stated that "the species is extremely variable ..." however, we could not make their distinction in the difference in shape between deeper-water and intertidal shells. We found that the Panamá specimens look like the Broderip syntypes, small with weakly noded, subangulate whorls and weakly impressed suture while the "northern" ones are generally larger, higher spired, turreted with concave whorls and deeply indented suture (Figures 1-3) and lacking periostracum on the entire shell (Figure 10). Some lots seemed to be intergrades between the "northern" and Panamá shells (Figure 11). Those lots had specimens with features of both, mostly evident beginning at Nayarit and continuing south. We also discovered specimens from the Golfo de California and Nicaragua that resembled Panamá specimens and shells from Panamá and El Salvador that looked like "northern" shells (Table 1). In the matter of *C. adairense* (Figure 7), we do believe that based on the type photos, it is not a form or subspecies of *Cymatium*

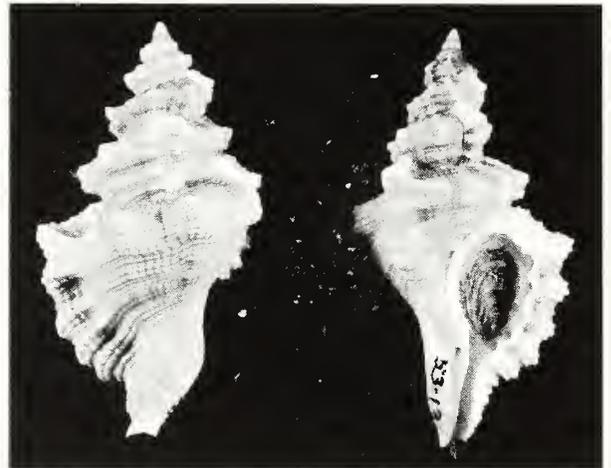


Figure 10. *Cymatium gibbosum*. SBMNH 423157, 2 specimens 43.1 and 43.3 mm L. Guaymas, Sonora, México, leg. Laura Shy. Specimens show trifold spirals and beaded sculpture visible when periostracum is missing. See ovate operculum with anterior nucleus.

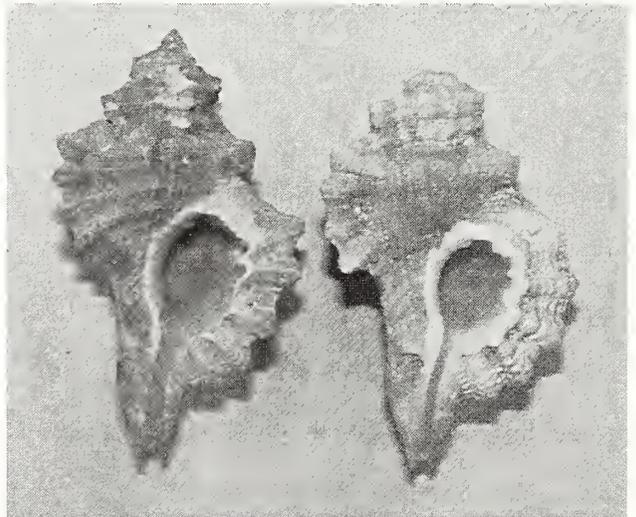


Figure 11. *Cymatium gibbosum*. SDNHM 53037, intergrade lot of 2 specimens: 32.1 mm (left) "northern," 30.0 mm (right) Panamá-like. Bahía Cuastecomate, Jalisco, México, in 14-20 m, on and under stones, leg. George Radwin, 10/17/1968.

gibbosum. We found no adult specimens resembling *C. adairense* in any specimens examined in this study.

The more "northern" specimens in this study differ from those from Panamá in their size, overall shell shape including spire height, turreted versus subangulate whorls, suture depth, apertural varix shape, presence or absence of anal sulcus and canal length. The protoconch, operculum and periostracum are the same on all specimens

as is the sculpture and number of beaded trifold spiral cords (Table 2).

At present we consider *C. gibbosum* to be one variable species. Its distribution was listed by Dall (1921) as from San Pedro and San Diego, California, to Panamá; Grant & Gale (1931), citing Arnold (1903), noted rare Pleistocene occurrences in upper San Pedro, Los Angeles County; Keen (1971) gave the distribution of *C. gibbosum* from "Sonora, Mexico to the Galápagos Islands and Peru on and under rocks at low tide" and added that *C. adaireuse* (Keen, fig. 961) may qualify as a subspecies ... confined to the northern part of the Gulf of California." Beu & Knudsen (1987) listed the species north to Isla Cedros off the west coast of Baja California, México, intertidal to 50 m; Catarius (1988), with his live-collected specimen, gave a recent finding at Palos Verdes, California; Henning & Hemmen (1993) suggested that the species ranges from Panamic western America (Baja California to Perú, and the Galápagos Islands). Material in the SDNHM Collection also confirms the distribution to East San Pedro, southern California and specimens from the SBMNH and SDNHM collections add the northern and central Pacific coast of Baja California to the range.

It is known that species with large protoconchs, in this case of 4+ whorls, indicate a longer time in the plankton, therefore, a greater opportunity for dispersal. This could account for the intergradation we found. To finally be certain if we are truly dealing with one variable or two distinct species, anatomical studies and DNA research are probably necessary, but this is beyond the scope of this study.

Acknowledgments

The SDNHM provided facilities for our research in the Marine Invertebrate Department. Michael Wall, Director of the Biodiversity Research Center of the Californias (BRCC) and Entomology Chair, and Jim Berrian, Collection Manager, with whom we share work space, were both most considerate and helpful. Scientific Librarian Margaret Dykens made the library's important research collection available to us.

At the SBMNH, Director of Collections and Research, Henry W. Chaney provided difficult to locate literature; Paul Valentich-Scott, Curator of Malacology, made the mollusk collection available, gave us work space in the Department of Invertebrate Zoology and helped in locating material; Daniel L. Geiger, Research Curator of Electron Microscopy, took the SEM and entire shell photos for Figure 9a,b and Patricia Sadeghian, Associate Curator of Invertebrate Zoology,

photographed specimens and provided accession numbers for some of the lots of *C. gibbosum*.

Amelia MacLellan, Curator of Higher Invertebrates, and Kathie Way, Collection Manager of Higher Invertebrates, BMNH, sent photographs of the syntypes of *C. gibbosum* and Jerry Harasewych and Ellen Strong, Research Zoologists at the USNM sent photographs of the type material of *C. adaireuse*. Gary Rosenberg, Chair of Malacology and Research Assistant Amanda Lawless at ANSP sent photographs of a 60.7 mm specimen of *C. gibbosum* reported from Panamá and Carol Skoglund of Phoenix, Arizona, gave us a long-term loan of specimens of *C. gibbosum* in her collection.

Jules Hertz assisted with research at SBMNH, proof-read drafts of the manuscript, helped with computer problems and made many helpful suggestions. We thank them all and are grateful for their considerable help.

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TABLE 1: COMPARATIVE MATERIAL STUDIED

Lots arranged in geographical order from north to south. I=intergrade N=northern, P=Panamá.
BC = Baja California, BCS = Baja California Sur, CA = California, USA, Mex = México

Museum number/Collection	Number of specimens and sizes	Locality, Collector and Date Found	Condition and Sculptural Features	Depth	"Form" and Remarks
SDNHM 34009	1 specimen, 51.5 mm	East San Pedro, CA, Capt. Luke 2/1/1909 ex H.N. Lowe Colln.	no operculum; turreted; smooth shoulders to deep suture; up-pointed varix; no anal sulcus	unknown	N labeled " <i>gibbosum adairense</i> "
Catarius Colln	1 specimen, 42.6 mm	off Palos Verdes, CA L. Catarius, 6/11/83	live; turreted; smooth shoulders to deep suture; up-pointed varix; no anal sulcus	diving in 13.7 m, on sand near rocks	N
SDNHM 70790	1 specimen, 21.5 mm	La Jolla, CA J. Bailly	spire squat, turreted; up-pointed varix; possible shallow anal sulcus	intertidal	N
SBMNH 366143	1 specimen, 41 mm	Bahía Magdalena, BC, Mex., 24°38'00"N, 112°09'00"W, B. Rerrstrell, 11/73	live, with operculum; protoconch broken, 1½ whorls remaining; apertural varix up-curved; no anal sulcus; humped on dorsum; short canal open, broken?; covered with golden-tan periostracum	5-6 m, under large rock	N
SDNHM 34006	5 specimens, 29.1-54.5 mm	Scammon's Lagoon, BC, Mex., Captain Porter	live; 2 remaining protoconch whorls; teleoconch with up-curved varix; anal sulcus in 31.6 mm shell, others none	unknown	N
Hertz Colln	1 specimen, 45 mm	Miramar Beach, San Felipe, BC, Mex., J. Hertz, 2/27/71	live; turreted, 2½ remaining protoconch whorls; 5 teleoconch whorls; smooth shoulders to deep suture; up-pointed varix; no anal sulcus	intertidal on rocks, night low tide	N
Hertz Colln	1 specimen, 36.8 mm	Ensenada Blanca, San Felipe, BC, Mex., S. Hertz, 3/9/70	live; turreted; 4+ protoconch whorls; 4+ teleoconch whorls; up-pointed varix	intertidal	N
Hertz Colln	1 specimen, 30.5 mm	17 miles N of Puertecitos at Coloradito, BC, Mex. J. Hertz, 3/16/69	live; turreted; 5 teleoconch whorls; up-pointed varix; no anal sulcus; 4 strong nodes dorsally on body whorl, humped.	intertidal, low tide high on rock	N
Hertz Colln.	1 immature specimen, 17.1 mm	Bahía Willard, San Luis Gonzaga, BC, Mex., J. Gemmell, 4/67	live; fusiform; totally covered with golden-tan periostracum; 2½ teleoconch whorls; apertural varix incomplete but up-pointed; no anal sulcus; canal long, open; 4 strong nodes on dorsum	intertidal on reef	N
Hertz Colln	1 specimen, 40.0 mm	Pta. Pelican, Pto. Peñasco, Sonora, Mex., J. Hertz, 6/2/69	live; turreted; spire tall; 5 teleoconch whorls; shoulder tabulate, smooth to suture; 4 varices, up-curved; no anal sulcus	intertidal on rock at low tide	N
SDNHM 34028	6 specimens, 14.1-32.1mm	Pto. Peñasco, Sonora, Mex., H.N. Lowe, 2/1934	turreted; beaded throughout; up-pointed apertural varix; no anal sulcus; dorsal nodes strong, humped	intertidal	N labeled " <i>adairense</i> "

SDNHM 77149	1 specimen, 26.7 mm	Pto. Peñasco, Sonora, Mex., H. Bertsch	dead; slender, turreted; up-pointed apertural varix; no anal sulcus; dorsal nodes strong, humped	unknown depth	N
Myers Colln	1 specimen, 31.5 mm	Pto. Peñasco, Sonora, Mex., B. Myers, 3/71	live; triangulate; covered with coralline algae and sponge; 5 teleoconch whorls, tabulate on body whorl; 3 varices, one per whorl, discontinuous; apertural varix up-curved; broad anal sulcus	intertidal	N
SBMNH 10906	1 specimen, 42 mm	Cholla Cove, Pto. Peñasco, Sonora, Mex., F. Howard	fat, squatly; apertural varix curving downward; no anal sulcus; humped dorsum; short open canal	depth not given	N labeled " <i>gibbosum</i> <i>adairensis</i> "
SBMNH 51093	4 specimens, 29.0-42.2 mm	Norse Beach, Bahía la Cholla, Sonora, Mex., J. Wilkins, 1959	dead; lgst more slender	intertidal	N labeled "subsp. <i>adairensis</i> "
SBMNH 29357	2 specimens, 32.0 & 32.9 mm	Norse Beach, Bahía la Cholla, Sonora, Mex., G. Sphon, 2/10/57	live; typical "northern" sculpture	intertidal	N
SBMNH 14821	3 specimens, lgst. 34.8 mm	Bahía la Cholla, Sonora, Mex., F. Howard 1/58	dead; typical "northern" sculpture	intertidal	N labeled " <i>adairensis</i> "
SBMNH 423164	2 specimens, 33.5 & 47.0 mm	Guaymas, Sonora, Mex., 27°56'00"N, 110°54'00"W J. Bailey, ex Koch Colln.	dead; smaller one "squattier" outer lip and varix, white and brown; apertural varix curving downward; deep anal sulcus	depth not given	N labeled " <i>gibbosum</i> <i>adairensis</i> "
SBMNH	6 specimens, 24.8-44.0 mm	Guaymas, Sonora, Mex., M. Cunningham	several with curved, open canal	depth not given	N
SBMNH 366144	1 specimen, 50.6 mm.	Bahía la Cholla, Sonora, Mex., 31°20'00"N, 113°37'00"W, R. Koch, 3/26/90	live; turreted; varices white with brown tinges; up-pointed apertural varix; 4 nodes dorsally, humped; canal straight, distally curved	amid rocks at low tide	N
SBMNH 117223	1 specimen, 43.6 mm	Bahía Adair, Cholla Cove, Sonora, Mex., M. Long, 4/10/52	turreted; complete protoconch covered with periostracum; no periostracum on rest of shell, evenly beaded sculpture with light band on dorsum; apertural varix curving downward; dorsally humped; no anal sulcus	outer reefs, no depth given	N
SDNHM 34014	8 specimens, 24.9-43.6 mm	Pta. Libertad, Sonora, Mex., H.N. Lowe, 1935	large, mature, turreted; 4½ smooth, rounded conical protoconch with dark brown periostracum; up-pointed apertural varix; no anal sulcus; large nodes on dorsum, humped; grayish- white under tan periostracum	intertidal	N labeled "var. <i>adairensis</i> "
SDNHM 52977	3 specimens, 30.2-36.8 mm	La Libertad, Sonora, Mex.	1 live, turreted, slender; up-pointed apertural varix; humped dorsally on body whorl	intertidal	N labeled " <i>adairensis</i> "

Skoglund Colln.	4 specimens, 58.5-60.0 mm	Black Mt., Bahía la Cholla, Sonora, Mex., C. Skoglund, 6/30/65	live; 60 mm shell with 4¾ smooth, round, protoconch, conical, no spiral fringes to teleoconch, brown band posteriorly on all but 1 st protoconch whorl; 5¾ teleoconch whorls; 6 discontinuous varices, one per whorl; aperturalvarix up-pointed; aperture with slightly raised node posteriorly, possibly forming sulcus	intertidal at -0.30 m tide, sand covered rock, on eggs	N
Skoglund Colln.	2 specimens, 41.7 & 44.4 mm	Bahía la Cholla, Sonora, Mex., C. & P. Skoglund, 9/7/71	live; protoconch 4+ whorls; 5-5+ teleoconch whorls; apertural varix up-pointed; no anal sulcus; beaded sculpture throughout; 3-4 strong nodes on dorsum, humpbacked appearance	intertidal at -1.2 m tide on sand over rock	N
Skoglund Colln.	1 immature specimen, 22.0 mm	N of Punta Chueca, Sonora, Mex., C. Skoglund, 4/76	live; fusiform; 4+ rounded, brown protoconch whorls; 3½ teleoconch whorls curved downward; not tabulate; one up-pointed varix on body whorl; no anal sulcus; teleoconch covered by golden-tan periostracum.	intertidal in sand at low tide	N
SDNHM 70728	1 specimen, 43.2 mm	Guaymas, Sonora, Mex.	dead; eroded, tabulate; no protoconch; 5 teleoconch whorls, 5 varices, deeply indented suture; apertural varix up-pointed; no anal sulcus; light band on dorsum	depth unknown	N
SDNHM 82047	1 specimen, 55.0 mm	near Guaymas, Sonora, Mex., N shore of Bahía San Francisco, 1982	?dead; smooth shoulder with deep suture; shallow anal sulcus; 4 strong nodes on dorsum, humped	0.91-1.8 m	N
SDNHM 51916	2 specimens, 21.5 & 30.8 mm	Pta. Lobos, Bahía Saladita, Guaymas, Sonora, Mex., D.R. Shasky	spire short; up-pointed broken apertural varix; no anal sulcus; big nodes on dorsum of body whorl, humped	7.6 -18.2 m	N
SBMNH 423158	1 specimen, 35.0 mm	Bahía Saladita, Guaymas, Sonora, Mex., 27°55'00"N, 110°58'00"W, D.R. Shasky, 9/23/89	live; brown shell with white tinged with brown on up-pointed apertural varix; possible shallow anal sulcus.	under rock 5-10 m	N
SBMNH 423157	2 specimens, 43.1 & 43.3 mm	near Empalme Bridge, Guaymas, Sonora, Mex., 27°58'00"N, 110°49'00"W L. Shy, 9/1962	live; complete protoconchs, 4 teleoconch whorls, upturned apertural varix, white tinged with brown; no anal sulcus, canal open, distally curved	old fish dump, low tide	N
SDNHM 52537	1 immature specimen, 18.0 mm	Isla Catalina, Golfo de California, Mex., F. Wollson	dead; immature lip completely covered with golden-tan periostracum; 3 nodes on dorsum of final whorl	28.0-36.2 m	N
SDNHM 59077	2 immature specimens, 24.9-25.0 mm	Golfo de California, Mex., H.N. Lowe	small, very eroded; one specimen with anal sulcus; downward curving apertural varix; 4 strong dorsal nodes, humped on final whorl; other differing in having upturned apertural varix, no anal sulcus	unknown depth	P/N
SDNHM 34011	3 specimens, 28.1-30.5 mm	Isla Tiburón, Golfo de California, Mex., H.N. Lowe, 1932	2 live; turreted, smooth shoulders to deep suture; apertural varix up-pointed; smallest specimen with anal sulcus; 3-4 strong nodes dorsally, humped	depth unknown	N

SBMNH 423179	1 specimen, 71.0 mm, record size	Santa Rosalia, BCS, Mex., 27°25'40"N, 112°18'44"W F. Howard, 1971	dead; apertural varix up-pointed; light brown band on dorsum, 4 nodes dorsally, humped; no anal sulcus	depth unknown	N
SDNHM 64739	1 immature specimen, 26.8 mm	Isla Partida, Golfo de California, Mex., D.R. Shasky	spire squat, subangulate; penultimate whorl noded at edge; deep suture; up-pointed apertural varix; no anal sulcus; strong dorsal nodes	4.6 -7.6 m	N could possibly resemble juvenile of <i>adairensis</i>
SDNHM 56379	5 specimens, 15.5-37.5 mm	Bahía Escondido, BCS, Mex.	dead; smooth, flat ramp, deep suture; up-pointed apertural varix; no anal sulcus; big nodes on dorsum of body whorl	intertidal in 0.15 m	N
SBMNH 423159	1 specimen, 63.3 mm	Danzante Channel, BCS, Mex., 25°45'52"N, 111°16'00"W L. Poorman, 2/1978	live; complete protoconch; complete shell covered with periostracum, open canal curved distally	intertidal, under rock	N
Hertz Colln	3 specimens 12.6-21.5 mm	S of Isla Danzante, BCS, Mex.	all dead; lgt. turreted, tabulate; rest fusiform, 4 teleoconch whorls on all 3, spire whorls noded; 3 flattened discontinuous varices, varices up- pointed; no anal sulcus; all shells mostly covered by golden-tan periostracum	dredged, 30.5-45.7 m	N
SDNHM 44618	1 specimen, 26.5 mm	Isla Danzante, BCS, Mex., Vermillion Sea Expedition, W.K. Emerson	dead; squat spire, subangulate; tabulate; upturned apertural varix, no anal sulcus	dredged	N
SBMNH 366140	1 specimen, 45.5 mm	Isla San José, BCS, Mex., 25°00'00"N, 110°37'00"W B. Merstrell, 5/73	live, encrusted; sculpture obscured	SCUBA	N
Myers Colln	5 specimens, 23.1-32.0 mm	Bahía de los Angeles, Golfo de California, Mex., D. Myers, 1/82	live taken; turreted, tabulate at shoulders with deep sutures; no anal sulcus; largest with 4+ whorls and 3 discontinuous varices, one per whorl; 3 nodes on dorsum forming hump	diving	N
SBMNH 423141	11 specimens, 8.5-35.0 mm	Bahía de los Angeles, Golfo de California, Mex., 28°56'00"N, 113°31'00"W R. Poorman, 1/75	SEM of 17.5 mm specimen; shell covered with periostracum; 4+ proto- conch whorls, 3-4 raised spirals; 2+ teleoconch whorls, immature aperture	10-25 m	N SEM of protoconch & shell
Skoglund Colln	3 specimens, 18.0-34.8 mm	off Requeson, Bahía Concepción, BCS, Mex., P&C Skoglund, 11/90	dead; entire shells covered with golden- tan periostracum, fringed on axials running down length of body whorl, on apertural varix and continuing on side of canal; axials crossing over spirals	dredged, 8-20 m	N possibly resembles juvenile of <i>adairensis</i>
Skoglund Colln	5 specimens, 15.9-31.8 mm	off Pta. la Gringa, Bahía de los Angeles, Golfo de California, Mex. C. Skoglund, 5/76	3 lgt live; 2 specimens, 19.4 & 25.2 mm grayish-brown to cream & brown; apertural varix cream with brown finges and up-pointed; other specimens com- pletely covered by golden-tan perios- tracum; no anal sulcus; body whorl with strong nodes on dorsum, humped	intertidal	N

SDNHM 44587	1 specimen, 36.0 mm	Isla Monserrate, B.C., Mex., Vermillion Sea Expedition	dead; spire squat and broken; smooth shoulder deep to suture; up-pointed apertural varix; no anal sulcus; dorsal nodes on body whorl	depth unknown	N
SDNHM 44441	1 specimen, 19.5 mm	Isla San Lorenzo, B.C., Mex., Vermillion Sea Expedition	dead; eroded; squat spire, small shell but looks mature; apertural varix up- pointed; anal sulcus present; dorsum with nodes on body whorl, humped	depth unknown	N
SDNHM 52931	1 specimen, 23.2 mm	Pto. Refugio, Ángel de la Guarda, Golfo de California, Mex.	dead, turreted, tabulate; upturned apertural varix; dorsum noded, slight hump, possible anal sulcus forming	intertidal	N
SDNHM 34019	1 specimen, 33.9 mm	La Paz, B.C.S. Mex., H.N. Lowe, 2/29	dead; shoulder ramp deep; apertural varix curving downward; deep anal sulcus; strong nodes on dorsum, humped	depth unknown	N
SDNHM 84793	1 specimen, 34.3 mm	La Paz, B.C.S. Mex., E. Swoboda	squat spire, tabulate; deeply indented suture; eroded but beaded sculpture remaining	depth unknown	N
SDNHM 34007	9 specimens, 7 adults, 17.9-30.5 mm	Mazatlán, Sinaloa, Mex., H.N. Lowe, 1929	dead; spire short; 3-4 teleoconch whorls, varices begin on 1 st or 2 nd whorls; anal sulcus in aperture of 6 adults; apertural varix curving downward in all; body whorl dorsum humped on some	intertidal	I
Skoglund Colln	7 specimens, 8.1-29.2 mm	La Cruz de Huanacastle, Bahía Banderas, Nayarit, Mex., C. Skoglund, 1/22/67-2/83	1gst. live, elongate, turreted; 3½ teleoconch whorls, tabulate at shoulder, deep suture; 3 varices discontinuous; apertural varix up-pointed; shallow anal sulcus; 4 strong dorsal nodes, humped	intertidal	N
Skoglund Colln	1 specimen, 35.6 mm	40 mi. N of San Blas, Nayarit, off Isla Isabella, Mex., B. Baker, 2/67	dead; spire, squat, eroded; tabulate at shoulder, deep suture; entire shell beaded; 3½ teleoconch whorls; 4 varices discontinuous; apertural varix curving downward; anal sulcus present, no periostracum	6.1-9.1 m, diving	I
Skoglund Colln	4 specimens, 7 mm-32.4 mm	Chacala, Nayarit, Mex., C. Skoglund, 12/70	tiny one may be live; ±8.8 mm speci- men with 5 fringed spirals on rounded, conical protoconch whorls, dark brown bands near suture on all but 1 st whorl, 2 1gst (32.2 & 32.0 mm) live; apertural varix almost up-pointed on 32.4 mm, up-turned on penultimate whorl; shallow anal sulcus; 32.0 specimen with apertural varix curved downward, reaching to periphery of previous whorl; deep anal sulcus.	intertidal on large boulders, snorkeling near dock	2 1gst: one N, one P Interesting because two largest were in same place but look different.
SDNHM 34010	4 specimens, 28.1-34.1 mm	Islas Tres Marias, Nayarit, Mex., H.N. Lowe, 4/1930	dead; eroded spire; apertural varix up- turned; 2 with anal sulcus; dorsum humped	no depth given	N
Hertz Colln	1 specimen, 35.5 mm	Sayulita, Nayarit, Mex., C&J Hertz, 2/9/97	dead; 4 teleoconch whorls, turreted at shoulder; deep suture; 3 varices, one per whorl; apertural varix curving down- ward, thick, flattened abaperturally; anal sulcus present; strong nodes dorsally forming hump	intertidal, on rocks and sand	N

SDNHM 51528	2 specimens, 23.0-33.5 mm	Pto. Vallarta, Jalisco, Mex., H.N.Lowe, 1/12/66	dead; tabulate; shells eroded; shallow anal sulcus present	intertidal	I
SDNHM 89653	1 specimen, 36.6 mm	S side of Bahía Cuastecomate, Jalisco, Mex., G. Radwin & L. Bibbey, 12/3/73	dead; tabulate, ramp flat with deep suture; periostracum on penultimate and body whorl; apertural varix curving downward; deep anal sulcus	3.0-19.8 m, diving on hookah	N
SDNHM 51292	1 specimen, 44.4 mm	Bahía Cuastecomate, Jalisco, Mex., L. Thomas, 1969	dead; spire tall, turreted; tabulate with deeply indented suture; 5 teleoconch whorls; apertural varix slightly up- turned; shallow anal sulcus; dorsum deeply humped	no depth given	N
SDNHM 53037	2 specimens, 30.1 mm = immature & 32.0 mm = mature	Bahía Cuastecomate, Jalisco, Mex., G. Radwin 10/17/68	dead; 30.1 mm: squat spire whorls, subangulate, noded; apertural varix curved downward; no anal sulcus; 32.0 mm specimen: with up-pointed apertural varix; immature lip; strong anal sulcus	14-20 m, on and under stones	I
SDNHM 52478	1 immature specimen, 29.0 mm	Bahía Espiritú Santo, Jalisco, Mex., G. Radwin	3 teleoconch whorls, no varices, 1 st & 3 rd whorls noded at periphery; apertural lip unformed	0.9-1.5 m	unable to classify
SDNHM 63027	2 specimens, 32.4 mm live, 29.5 mm dead	Bahía Cuastecomate, Jalisco, Mex., 1/3/74	32.4 mm; turreted; apertural varix up- pointed; anal sulcus present; 29.5 mm: spire eroded; apertural varix curved downward, anal sulcus present	diving on hookah, 12- 20 m	mixed lot, 32.4 = N 29.5 = P
SDNHM 89518	2 specimens, 9.4 & 37.8 mm	S side of Bahía Cuastecomate, Jalisco, G.Radwin & L.Bibbey, 1/3/74	dead; 3 whorls of cream, smooth proto- conch remaining with no periostracum; short spire, tabulate, deep suture; 1 st teleoconch whorl with rounded spirals; apertural varix curved downward; shallow anal sulcus, golden periostracum	12.2-19.8 m, diving on hookah	large = intergrade; 9.4 mm, too immature to classify
SDNHM 49367	1 immature specimen, 18.1 mm	Bahía Cuastecomate, Jalisco, Mex., D.R. Shasky, 10/13-20/68	dead; subangulate spire, 2 teleoconch whorls; apertural varix up-pointed, lip immature but forming sulcus	10.7-18.2 m	N
Skoglund Colln	1 specimen, 39.0 x 23.0 mm	Bahía Cuastecomate, Jalisco, Mex., C. Skoglund, 12/28/72	live; spire squatty, eroded; 3½ teleoconch whorls; 3 varices; apertural varix up-pointed; anal sulcus present	snorkeling in 2 m, on rock	N
SDNHM 52246	1 specimen, 38.9 mm	Tamarindo Cove Bahía Tenacatita, Jalisco, Mex., D.R.Shasky	live; 4 teleoconch whorls; 5 varices, apertural varix curved downward; anal sulcus present	7.6-9.1 m	I
SBMNH 17021	1 specimen, 38.7 mm	Tenacatita, Jalisco, Mex., 2 nd Curea Expedition, F. Howard & G. Sphon, 2/5-8/63	dead; protoconch missing; turreted, smooth ramp; apertural varix up- pointed, humped on dorsum; no anal sulcus; beaded sculpture, golden-tan periostracum	no depth given	N
SBMNH 423173	4 specimens, 17.5-44.1 mm	Bahía Carrizal, Manzanillo, Colima, Mex., 19°05'35"N, 104°26'09"W, L. Shy, 1967	lgst one live; white with brown on varices, apertural varix curving downward; no anal sulcus	15-17 m	N

SBMNH 423176	8 specimens, 27.9 & 32.7 mm+5 juv.	Bahía Carrizal, Manzanillo, Colima, Mex., 19°05'35"N, 104°26'09"W, C. Shy, 1967	live with operculum; lge: squatty spire, noded at edge, body whorl turreted at shoulder; mature lip; downward curving apertural varix; varices tan; anal sulcus present; humped on dorsum; other smaller with immature lip, varix upturned, no anal sulcus,	25-30 m	lgst = P sm = N, rest too small to classify
SDNHM 34012	8 specimens, 6.7-30.1 mm	San Juan del Sur, Nicaragua, H.N. Lowe, 1931	all dead; sculpture as in Panamá specimens; apertural varix curving downward, anal sulcus present; tabulate shoulder on body whorl; big nodes, periostracum covering entire specimens	no depth given	2 adults = P juveniles too immature to classify
Hertz Colln	1 specimen, 37.4 mm	Playas del Coco, Costa Rica, C.M. Hertz, 4/1/86	dead; turreted; 4½ teleoconch whorls strongly tabulate at sutures; 4 varices, one per whorl; apertural varix curving downward, others up-pointed; shallow anal sulcus; strong node on dorsum of body whorl, humped, entire shell covered with periostracum	intertidal	N
Hertz Colln	2 specimens, 10.2 & 10.9 mm	Playas del Coco, Costa Rica, C.&P. Skoglund, 4/86	live; fusiform; complete protoconchs, shells completely covered with perio- stracum; lgst with 2½ whorls & 3 varices up-turned apertural varix; no anal sulcus	9.1-18.3 m dredged, mud bottom	N
SBMNH 366145	13 juv. specimens	Playas del Coco, Guanacaste, Costa Rica, 4/12/82	live, anal sulcus shallow	17.4-18.3 m coarse sand and mud	too immature to classify
SBMNH 366224	3 specimens, 19.0-37.5 mm	Playa Tamarindo, Guanacaste, Costa Rica, 10°18'00"N, 085°50'00"W R. Koch	lgst: tabulate; downward curving apertural varix; anal sulcus present; large hump on dorsum; aperture with dorsal band showing through; other two with typical P characters	low tide, among rocks, volcanic substrate	I=lgst P=others
Skoglund Colln	1 specimen, 19.5 mm	Playas del Coco, Guanacaste, Costa Rica, C&P Skoglund, 4/86	live; protoconch white, no periostracum, no dark bands; 3 teleoconch whorls; 5 varices; immature lip, downward curved apertural varix covered with periostracum; no anal sulcus	dredged, 24-37 m	N
SDNHM 34025	1 specimen, 34.9 mm	Pta. Arenas, Guanacaste, Costa Rica	dead; no periostracum; short spire, moderately turreted; angled penultimate whorl; tabulate; anal sulcus present; downward curved apertural varix	no depth given	P
SBMNH 24582	8 specimens, 24.9-39.6 mm	Bahía de Culebra, Guanacaste, Costa Rica, 10°37'00"N, 085°40'00"W T. Dranga, 1953	all with anal sulcus, but lgst with features of both P & N-- turreted, smooth ramp; covered with periostracum; downward curving axial varix; humped, others Panamá-like	no depth given	lgst = I rest = P
SDNHM 34013	1 specimen, 34.5 mm	La Union, Golfo de Fonseca, El Salvador	dead; turreted, eroded spire broken; 5 whorls; 5 varices; no periostracum; light tan color; apertural varix damaged, others up-pointed; no anal sulcus; no dorsal hump	no depth given	N

SBMNH 423171	1 juv., 18.5 mm	Golfo de Fonseca, El Salvador, 13°11'00"N, 087°48'00"W, X. Mendoza, 10/608/60	live; apertural varix up-turned; shallow anal sulcus present	64-128 m	N
Skoglund Colln	5 specimens, 19.6-31.2 mm	Playa Venado, Canal Zone, Panamá, C. Skoglund, 3/74	4 live; shell subangulate; teleoconch whorls 3½ sm to 4¼; 5 varices on sm, 4 on lgst.; apertural varix curving downward; anal sulcus present; beaded sculpture of raised spirals and axial grooves; no periostracum; 3-4 nodes on dorsum, somewhat humped	-0.76 m, night low tide	P
Hertz Colln	1 juv. specimen, 6.9 mm	Isla Venado, Panamá, D.R. Shasky, 4/4/81	live; 4+ whorls all covered with periostracum; teleoconch whorl showing that sculpture continues from protoconch	no depth given	too immature to classify
SDNHM 63188	2 specimens, 33.0 mm	Palo Seco, Panamá, D.R. Shasky	live; 5 whorls; 5 varices; shell sloping rather than tabulate; anal sulcus present; less pronounced nodes; dark grayish	no depth given	P
SDNHM 62280	1 specimen, 28.1 mm	Canal Zone, Panamá	shell grayish, less tabulate; 4 teleoconch whorls, 5 varices flattened; downward curving axial varix; anal sulcus present; less pronounced nodes dorsally	no depth given	P
SDNHM 58346	1 specimen, 28.1 mm	Vera Cruz, Panamá, D.R. Shasky	dead; spire eroded; 4 teleoconch whorls; 4 varices somewhat flattened; anal sulcus present; dorsal nodes not humped	no depth given	P
SDNHM 91726	2 specimens, 23.6 & 30.2	Panamá, M. Burkenroad	grayish color; lg.: protoconch sculpture with dark brown periostracum; 4 teleoconch whorls, 5 varices; sm.: no periostracum on light brown protoconch with brown bands; teleoconch with 3½ whorls, 4 varices; no periostracum on teleoconch; on both: apertural varix curved downward, anal sulcus present	no depth given	P
SDNHM 63290	1 specimen, 28.9 mm	Isla Venado, Panamá	grayish with cream varices; 4 whorls; 5 varices; apertural varix downward curving, cream with brown tinges; anal sulcus present	no depth given	P
SDNHM 83656	1 specimen, 31.2 mm	Canal Zone, Panamá, M. Levine	tabulate; almost 4 whorls; 5 varices; apertural varix cream with brown edges; anal sulcus present; node from dorsal periphery slightly raised on shoulder	intertidal, underside of rock, low tide	P
SDNHM 64231	8 specimens, 2.0-26.4 mm	Isla Venado, Panamá, D.R. Shasky	3 live; sloping not as tabulate, 4 whorls, 5 varices; anal sulcus present; small nodes dorsally, slightly swollen	intertidal	P
SDNHM 58310	3 specimens, 26.2-28.5	Isla Venado, Panamá, D.R. Shasky, 3/1971	dark colored; tabulate; 3½ whorls; 4 varices; apertural varix flattened, cream with brown tinges; anal sulcus present	no depth given	P
SDNHM 76908	1 immature specimen, 20.0 mm	Isla Contadora, Islas Perlas, Golfo de Panamá, D.R. Shasky	3 whorls; 4 varices; covered with periostracum; immature apertural lip, varix upturned; no anal sulcus	intertidal to 3.0 m	I

SDNHM 77004	1 specimen, 31.6 mm	San Carlos, Panamá, D.R. Shasky	dead; tabulate at shoulder; apertural varix upturned; no anal sulcus; strong nodes on dorsum, humped	no depth given	N
SDNHM 84791	1 specimen, 31.4 mm	Isla Venado, Panamá, E. Swoboda	3½ whorls; 5 varices; apertural varix curved downward, cream with brown edges; anal sulcus present	low tide, on rocks	P
SBMNH 01361	2 specimens, 33.0 & 32.8 mm	Balhoa, Canal Zone, Panamá, A. Martí, 7/1962	dead; somewhat flattened; grayish- brown; apertural varix downward curved; anal sulcus present; dorsally humped	no depth given	P
SBMNH 23127	1 specimen, 31.0 mm	Balboa, Canal Zone, Panamá, H. King	dead; grayish shell with cream & brown apertural varix, downward curving; anal sulcus present	no depth given	P
SBMNH 423180	3 specimens,	Balboa, Canal Zone Panamá, 08°57'00"N, 079°34'00"W, H. Dawson, 4/1960	downward curving apertural varix; anal sulcus present	no depth given	P
SBMNH 423165	2 specimens, 32.0 & 32.9 mm	Isla Gobernadora, Veraguas, Panamá, 07°34'44"N, 081°12'30"W V. Upton	live; one grayish, one golden; no periostracum; short spire; downward curving varix, white with brown; big humps on dorsum; anal sulcus present	intertidal, under rocks at low tide	P
SBMNH 423170	9 specimens, 23.5-31.0 mm	Isla Venado, Panamá, 08°53'06"N, 079°35'48"W, D.Shasky, 12/2/67	4 live; without periostracum; grayish; downward curving axial varix; dorsal spiral band reflected in aperture; all with anal sulcus	intertidal, under rocks	P
SBMNH	2 specimens, 24.4 & 28.3 mm	Isla Venado, Panamá, R. Koch	grayish to grayish brown shells, small and no periostracum	low tide, on sand and gravel	P
SBMNH 423177	1 specimen, 29.2 mm,	Isla Venado, Panamá, 08°53'06"N, 079°35'48"W E. Swoboda,	dead; short spire, some-what flattened, grayish under periostracum; cream & white apertural varix downward curving; dorsal band reflected in aperture	intertidal, rocks	P
SBMNH 423180	3 specimens	Balboa, Canal Zone, Panamá, 08°57'00"N, 079°34'00"W, H.P. Dawson, 4/1960	dead; varix curved downward; anal sulcus present	no depth given	P
SDNHM 64231	8 specimens, 20.7-26.3 mm	Isla Venado, Panamá, D.R Shasky	live taken; small adults; short spire, not tabulate; apertural varix curving downward; 7 with anal sulcus	no depth given	P
SDNHM 63152	2 specimens, 24.9 & 26.8 mm	Isla Venado, Panamá, D.R. Shasky	live; higher spire with periostracum; downward curved apertural varix; anal sulcus present	no depth given	P
SBMNH 423169	1 specimen, 40.0 mm	Pto. Nuñez, Isla S Santa Cruz, Islas Galápagos, 00°45'00"S, 090°14'50"W Leg. Angermeyer	dead; broad specimen; tall spire; down- ward curving apertural varix; penul- timate varix up-pointed; hump on dorsum; anal sulcus present	no depth given	N



TABLE 2: DEFINING CHARACTERS IN *CYMATIUM GIBBOSUM* FROM PANAMÁ ENVIRONS AND NORTH OF PANAMÁ

Character	Panamá & Environs	North of Panamá
Size	largest ± 33 mm length	largest ± 60 mm length
Shell shape	subtrigonal, flattened ventrally; spire low, moderately tabulate; subangulate whorls weakly noded at periphery; apertural varix curved downward, anal sulcus present	elongately turreted, ventrally flattened; strongly tabulate; whorls concave from periphery to deeply indented suture forming flattened ramp; body whorl with 3-4 strong dorsal nodes giving shell a humpback appearance; apertural varix up-pointed sharply
Protoconch	4-5 clear to cream-colored, round, smooth, conical whorls, often with brown band near suture when not covered by periostracum	4-5 clear to cream-colored, round, smooth, conical whorls, often brown banded near suture when not covered with periostracum
Color	teleoconch grayish-brown to light brown and cream; apertural varix cream with brown at edges without periostracum; peristome white, interior of aperture white often reflecting light spiral band on dorsum	teleoconch light brown with shades of tan or cream; peristome white, interior of aperture white often reflecting light yellowish spiral band on dorsum
Periostracum	periostracum on protoconch missing on most specimens, if present brown or occasionally mustard color, with 3-4 spiral threads, fringed on many specimens; most without periostracum covering teleoconch	periostracum on protoconch brown or tan, occasionally mustard color with 3-4 spiral threads, many fringed; teleoconch of many specimens with tan periostracum obscuring beaded sculpture
Whorls	3½-4 subangulate teleoconch whorls; suture weakly impressed; body whorl moderately tabulate; dorsum of body whorl with weak nodes	3½-5 turreted whorls, concave from periphery to deeply indented suture, ramp almost horizontal; dorsum of body whorl with 3-4 strong nodes, "humped"
Spire	moderately low spire, conical with raised axial ribs; 1 st teleoconch whorl with 10-12 raised axial nodes at periphery, 2 nd with 4-5 raised axial nodes with minor spirals between, 3 rd with 3-4 raised noded spirals; periphery with strong spiral, trifid-beaded cords from 2-4 per whorl	high spired, periphery with heavy trifid-beaded spirals; 1 st & 2 nd whorls with 2 heavy, noded spirals at periphery, 3 rd whorl with 3 strong trifid spirals with 3-5 nodes between varices; penultimate spire whorl with 4 major spiral cords with 5 nodes and minor spirals between varices
Varices	4-5 discontinuous varices; apertural varix downwardly curved, thick, flattened, crenulate at aperture, continuing spire sculpture of whorl	4-5 discontinuous varices, apertural varix thick, flattened, up-pointed, ribbed and continuing to beyond suture of previous whorl; crenulate at aperture continuing spire sculpture of whorl
Sculpture	teleoconch with trifid spiral sculpture, 5 strong spiral cords on the body whorl, the 2 posterior merging at periphery, deeply grooved between; 3 strong trifid final cords, grooved between; body whorl with 3 small nodes on apertural side and 4 slightly stronger nodes on dorsum, some with light band between; axial grooves combine with spirals forming strong beaded appearance on entire teleoconch	teleoconch with trifid spiral sculpture; body whorl with 5 strong trifid spiral cords with deeply grooved interstitials; posterior 2 cords merging on dorsum to one thickened cord with slight groove between, 3 final cords cross dorsum of body whorl with interstitial cords between; 3 nodes on apertural side of body whorl, 3-4 strong spiral nodes dorsally on body whorl giving a humped appearance; fine incised axial grooves with raised spirals creating headed look on entire teleoconch.
Aperture	apertural varix flattened, cream with brown edges; erect white peristome with many raised pustules; interior reflecting exterior sculpture of dorsal bands; deep, narrow anal sulcus bracketed by a well-developed node on each side; 4-5 denticles on interior of outer lip, columellar lip with 7-8 heads continuing as raised lirae into aperture; anal sulcus on most specimens; operculum corneus, ovate with anterior nucleus	apertural varix flattened, tan, rarely cream with brown edges; erect white peristome; only occasional specimens with anal sulcus and bracketing nodes in aperture; 5-6 denticles on interior of crenulate outer lip, central one often bifid; columellar lip sometimes with small denticles forming lirae continuing into aperture, interior of aperture reflecting exterior dorsal spiral bands; operculum corneus, ovate with anterior nucleus
Canal	open, rather short, straight, slightly recurved distally	open, straight, medium length, recurved at distal end

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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLII

January 14, 2010

Number: 1

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 Membership (includes family). Domestic \$20.00;
 Overseas (air mail):\$40.00; Mexico/Canada (air mail):\$30.00.
 Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

Pteropods and Heteropods and the Danger of Ocean Acidification Due to Increasing Carbon Dioxide

Dr. Victoria Fabry, a biological oceanographer at the University of California Santa Barbara, has been focusing her research on the sensitivity of calcareous organisms, such as the planktonic molluscan pteropods and heteropods, and marine ecosystems to elevated carbon dioxide and ocean acidification.

Meeting date: January 21, 2010

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting November 19, 2009

The meeting was called to order at 7:45 p.m. by Carole Hertz. The minutes from the previous meeting were approved and the treasurer's report was given by Silvana Vollero. The librarian's report by Marilyn Goldammer, reminded everyone to fill out the book's library card when checking out a book and to place the card in the small file box. Material can only be checked out for one month at a time and should be returned promptly (crossing out the card and replacing it in the book), so that others will have access to them.

Wes Farmer has reserved our meeting room through 2011. Plans for the Christmas party were reviewed. Next month's speaker will be Victoria Fabry. She will be talking about pteropods and heteropods.

Carole reviewed the slate of officers for 2010, and then called for nominations from the floor. There were none and the slate was elected by acclamation: President Benjamin Pister, Vice President Jules Hertz, Corresponding Secretary Marilyn Goldammer, Recording Secretary Paul Tuskes and Treasurer Silvana Vollero.

The speaker was Benjamin Pister. Ben recently completed his Ph.D. at Scripps Institution of Oceanography and is the National Park Service representative to the Marine Life Protection Act initiative (MLPA). The MLPA was signed into law in 1999 and is a program designed to protect marine ecosystems rather than specific species. There has been a great deal of anxiety over the MLPA and after 10 years an implementation plan has been proposed for southern California and will be reviewed by the California Fish & Game Commission in early December 2009.

The goals of the MLPA are to: protect diversity and ecosystems, reduce harm to the environment, provide educational and scientific opportunities, and ensure effective management. State Marine Reserves are "No Take" areas, State Marine Parks may allow some species to be taken by sport fishermen. State Marine Conservation Areas may allow sport and commercial fishing for specific species. The actual permitted activities will be site specific. The proposals and maps are available on the internet – search on MLPS.

After the informative program, members gathered and enjoyed the social time and refreshments provided by Wes Farmer and Marty Schuler.

Paul Tuskes

A new member joins *The Festivus* Scientific Review Board

As you may have noticed on our front page, we have a new member on our editorial review board. We are delighted to welcome Dr. Emilio Fabián García of the University of Louisiana at Fayette. Dr. García has had a long and distinguished career at the U. of Louisiana and has traveled and published extensively on mollusks, of the Atlantic coast in particular. He is also on the editorial board of *American Conchologist*.

The Club's Annual Christmas Dinner Party – 2009

As always, the Club's Christmas Party was a delight. It is wonderful to observe how much our members enjoy being together and sharing the holiday season.

The 26 members in attendance filled the cozy room and were welcomed by MC Carole Hertz. Amid stories/jokes Carole reminded us that our Club has been continuously active since 1961 and *The Festivus* has been publishing since 1970 – and as a peer-reviewed publication since 1985. The dinner was excellent and the program by Bob Yin terrific – filled with videos of marvelous underwater life and greatly enjoyed by all.

Many participated in the traditional gift exchange – with oohs and aahs for gifts received. Members lingered to socialize a bit more – not really ready to leave this favorite event.

Dues are Due

Dues for the year 2010 are now due. The rates remain the same as for 2009 – domestic \$20.00; overseas (air mail) \$50.00; Mexico/Canada \$30.00.

Please mail your checks to the address on the masthead. For those whose dues are not paid, this will be your last issue.

The Fourteenth Annual Scum Meeting

The 14th annual meeting of the Southern California Unified Malacologists (SCUM) will be held on Saturday, January 23, 2010, beginning about 9:30, at the City of San Diego's Environmental Monitoring Laboratory, 2392 Kincaid Rd., San Diego. RSVP: Wendy Enright 619-758-2378 or e-mail: wenright@sandiego.gov

**NEW INSIGHT ON GALEOMMATID BIVALVES
(BIVALVIA, GALEOMMATOIDEA, LASAEIDAE)
DESCRIBED BY OLSSON, 1961, FROM THE PANAMIC PROVINCE**

PAUL VALENTICH-SCOTT

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Abstract: The type specimens of three species from Olsson's (1961) book on the Panamic Bivalvia - *Oorbitella margarita*, *O. peruviana*, and *O. zorrilla* - were incorrectly figured in the original publication. New images of the types and original labels are provided here and for the first time associated with their correct names. Descriptions and synonymies of these species are given.

Introduction

Axel Olsson's *Mollusks of the Tropical Eastern Pacific* (1961) provides one of the few comprehensive reviews of the marine bivalves in the southern portion of the Panamic Province. In this tome, Olsson described and illustrated dozens of new bivalve species.

During examination of Olsson's type specimens at the Academy of Natural Sciences, Philadelphia, it was discovered that three holotypes were incorrectly figured in the original publication. The original descriptions in Olsson (1961) applied to the type specimens, not the incorrect illustrations found in his Plate 35. Keen (1971) reiterated the errors by using Olsson's original photographs and mis-attributed names in her book.

Provided herein are new images of the holotype specimens, along with synonymies, new descriptions, and distributions for *Oorbitella margarita*, *O. peruviana*, and *O. zorrilla* (all Olsson, 1961). Olsson's original illustrations and captions are shown in Figures 1 and 2.

The following abbreviations are used in the text.

ANSP - Academy of Natural Sciences, Philadelphia, Pennsylvania, USA

SBMNH - Santa Barbara Museum of Natural History, Santa Barbara, California, USA

Systematic Account

Galeommatoidea Gray, 1840

Lasaeidae Gray, 1842

Oorbitella Chavan, 1959

***Oorbitella margarita* Olsson, 1961** (Figure 3)

Oorbitella margarita Olsson, 1961: 237.

Description: Shell subovate, inflated; inequilateral, anterior much longer; sculpture of irregular, commarginal striae and growth checks; periostracum adherent, translucent, silky; hinge line narrow; left valve with single heavy anterior cardinal tooth, and minute tubercle posterior to it; right valve dentition unknown; ligament unknown, resilifer trigonal, narrow, short. Length to 12 mm.

Distribution: San Miguel, Isla del Rey, Archipiélago de las Perlas, Panamá (8.5°N) [ANSP], to Punta Piedras Verdes, Manabí, Ecuador (1.5°S) [SBMNH 84929].

Holotype: ANSP 218884; 1 left valve; length - 11.77 mm, height - 7.30 mm; type locality, on the beach at San Miguel, Isla del Rey, Archipiélago de las Perlas, Panamá (approximately 8.4563°N, 78.9367°W).

Remarks: This species was not figured in Olsson (1961). The author was unable to determine which species is illustrated in Plate 35, figure 2, which is labeled as the holotype of *O. margarita*.

Literature: Keen (1974: 142).

***Oorbitella peruviana* Olsson, 1961** (Figure 4)

Oorbitella peruviana Olsson, 1961: 237.

Description: Shell subovate, inflated; inequilateral, anterior much longer; anterior end broadly rounded, posterior end narrowly rounded; sculpture of irregular, commarginal striae, ribs, and growth checks, surface rough; periostracum thin, adherent, translucent, silky to shiny; hinge plate broad anteriorly, very narrow posteriorly; right valve with a single projecting cardinal tooth; left valve dentition unknown; ligament very narrow, oblique; resilifer long, very narrow. Length to 8 mm.

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Figure 1. Figure legend for Plate 35 from Olsson (1961). Note that legends for figures 2, 3, and 7 are incorrect. Reproduced with permission from the Paleontological Research Institution.

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OLSSON, PLATE 35



Figure 2. Original Plate 35 from Olsson (1961). Reproduced with permission from the Paleontological Research Institution.

Distribution: Playa Jacue, Darién, Panamá (7.5°N) [SBMMH 148223] to Bocapan, Tumbes, Perú (3.7°S) [ANSP]; intertidal zone to 20 m. Also in the Pliocene of Ecuador (Olsson, 1961).

Holotype: ANSP 218882; 1 right valve; length – 8.47 mm, height – 6.03 mm. Type locality: Bocapan, Tumbes, Perú (approximately 3.7068°S, 80.7225°W).

Remarks: An external view of the holotype of this species was figured in Olsson (1961) on Plate 35, figure 3. It was mislabeled as the holotype of *O. zorrita*. *Orobitella zorrita* is illustrated in Plate 35, figure 7, which is labeled as the holotype of *O. peruviana*. The record of this species by Paredes et al. (1998) from Callao, Lima, Perú proves to be *O. sechura* Olsson, 1961, with strong radial sculpture.

Literature: Keen, (1971: 142), Paredes et al. (1998).

Orobitella zorrita Olsson, 1961 (Figure 5)

Orobitella zorrita Olsson, 1961: 236.

Description: Shell subovate-elongate, moderately inflated; inequilateral, anterior much longer; sculpture of irregular commarginal striae, ribs and growth checks, with very fine irregular radial striae; periostracum unknown; hinge plate relatively broad; left valve with one large, long, oblique cardinal tooth, with narrow pit anterior to it, also with minute tubercle directly below beaks; ligament oblique, large; resilifer very large, oblique, wide. Length to 8 mm.

Distribution: Only known from the type locality at Zorritos, Tumbes, Perú (3.6°S) [ANSP]; intertidal zone.

Holotype: ANSP 218887; 1 left valve; length – 13.87 mm, height – 11.05 mm. Type locality: Zorritos, Tumbes, Perú (approximately 3.670°S, 80.660°W).

Remarks: This species was figured in Olsson (1961) on Plate 35, figure 7. It was mislabeled as *O. peruviana*. *Orobitella peruviana* is illustrated in Plate 35, figure 3, which is labeled as the holotype of *O. zorrita*. Poorman & Poorman (1968) and Skoglund (1991) cite a specimen of *O. zorrita* from off Bahía San Carlos, Sonora, México. Examination of this lot, now in the Santa Barbara Museum [SBMNH 84931], shows that it is actually *Amerycina cultrata* (Keen, 1971).

Literature: Keen (1971: 144).

Discussion

Galeommatoidean bivalves are often difficult to identify

due to their small size, variable shell morphology, and commensal lifestyle. The error initiated by Olsson (1961) and inadvertently carried on by Keen (1971) has further complicated the identifications of several species of *Orobitella* in the Panamic Province. It is likely that most museum collections have the above species misidentified, as well as any reports from the region. The lesson learned: it is imperative to make direct observations of type specimens when writing monographic works, and never to rely solely on original descriptions or illustrations.

Acknowledgments

I am grateful for access to the type collections at the Academy of Natural Sciences, Philadelphia, provided by Paul Callomon and Gary Rosenberg. Eugene V. Coan provided useful comments on the manuscript. Patricia Sadeghian assisted with digital cleanup of the type images. Paula Mikkelsen provided Paleontological Research Institute copyright information and permission on Olsson (1961).

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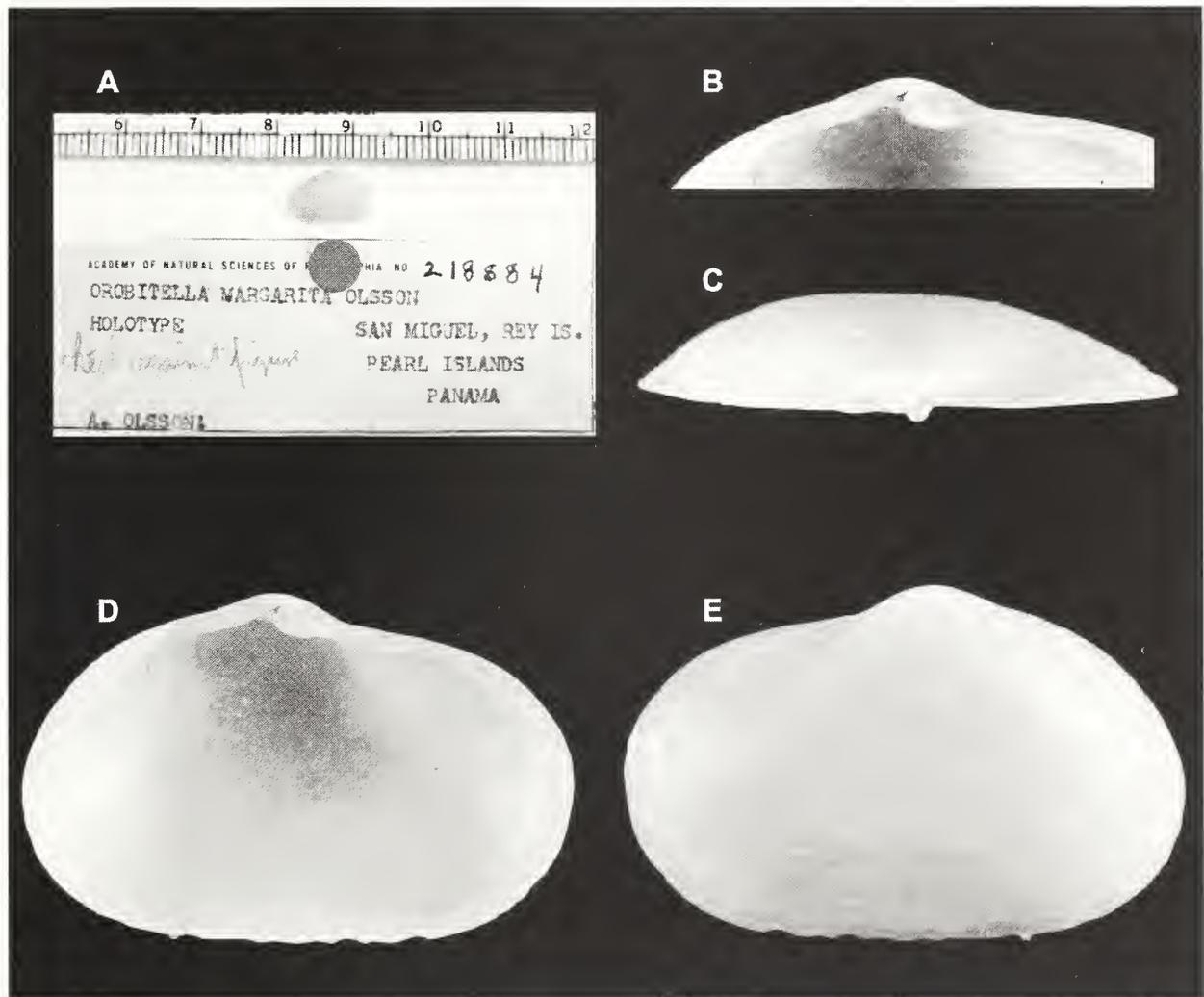


Figure 3. *Orobittella margarita* Olsson, 1961, holotype, ANSP 218884, Panamá, Islas Perlas, Isla del Rey, San Miguel, shell length= 11.77 mm; shell height 7.30 mm; A, original label and holotype specimen; B, detail of left hinge; C, dorsal view; D, internal left valve; E, external left valve.

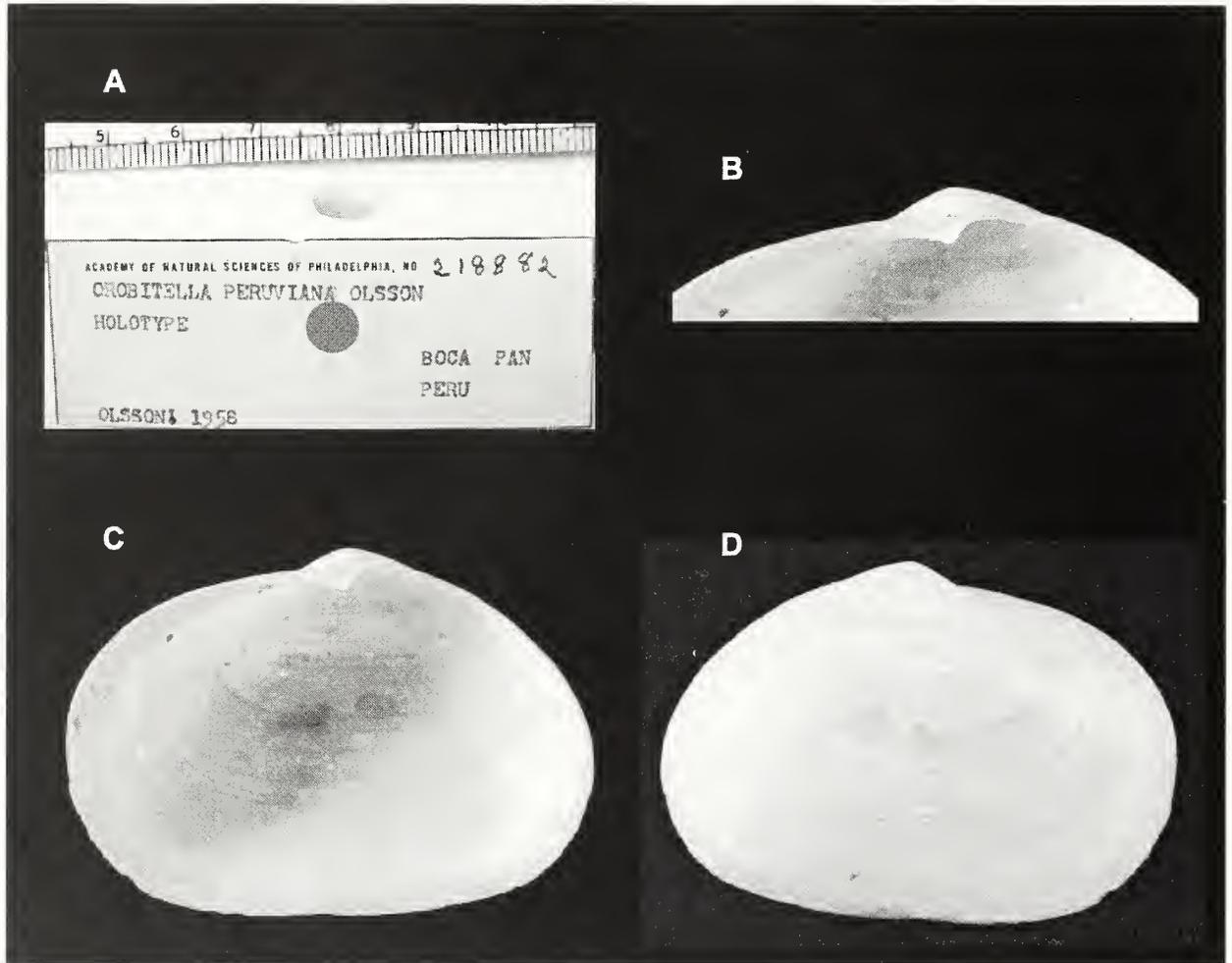


Figure 4. *Orobittella peruviana* Olsson, 1961, holotype. ANSP 218882, Perú, Bocapan, shell length = 8.47 mm; shell height = 6.03 mm; A, original label and holotype specimen; B, detail of right hinge; C, internal right valve; E, external right valve.

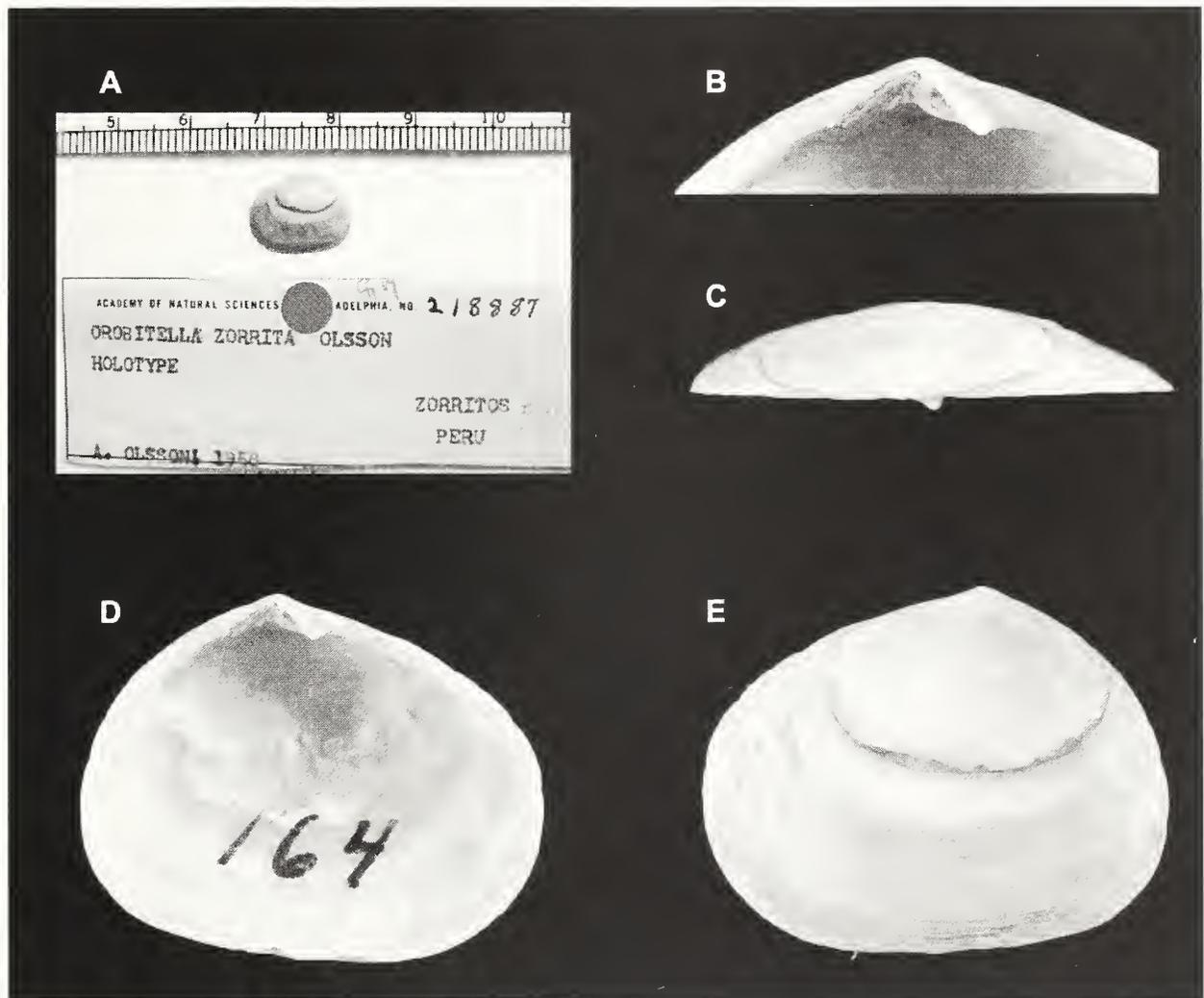


Figure 5. *Orobittella zorruta* Olsson, 1961, holotype, ANSP 218887, Perú, Zorritos, shell length = 13.87 mm; shell height = 11.05 mm; A, original label and holotype specimen; B, detail of left hinge; C, dorsal view; D, internal left valve; E, external left valve.

JOHN D. JACKSON 1941 – 2009

The final weeks came to be and life ended peacefully for John Davies Jackson at his home in El Cajon, California. In his final days, he was comforted and surrounded by his loving family and by the good friends he tended to draw about him.

Born John Davies Jackson, Jr., son of John and Frances Jackson, his life began on December 10, 1941 in the farming community of El Centro, California. There, John grew up the older brother of Chrisman (Chris) and his sister Sara. He attended local schools and graduated from El Centro High in 1959 and went on to earn a business degree from Tulane University then serving a stint in the U.S. Coast Guard. In 1978 he decided to study law, receiving his law degree from Cal Western College of Law in Point Loma, California.

Even after moving his home base to San Diego, where he worked and played during his adult life, John kept and maintained his farming community contacts, both social and business, in El Centro. Those contacts were an important part of his life.

John Jackson had a perpetual zest for adventure and the appreciation of fine food and wine, becoming a gourmet cook. As a hunter, avid fisherman, scuba diver, and shell collector, John traveled and explored the world. Having a great passion for natural things he involved himself with the oceans he enjoyed by serving on the board of Hubbs Research Institute, establishing Odyssey Publishing as an endeavor to offer quality books on ocean-related subjects and as an active and generous supporter since 1988 of The San Diego Shell Club.

John led a full life and relished everything the world had to offer. He was a giving man, generous with family and friends, earning the love and respect of all that knew him. Over the years, John accumulated a growing number of friends worldwide – traveling companions, associates, and people who crossed paths with him. He will be dearly missed by all.



A joyous John with a grouper he speared on a diving trip.

He is survived by his brother Chris, his son Andrew, and daughter Adrienne, mother of his three grandchildren – Tyler, Nevin and Annabelle.

A fund to benefit coral reef research and preservation has been established at California Bank & Trust of El Cajon in John Jackson's memory.

Larry Buck

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LOW TIDES FOR 2010 AT SAN FELIPE, BAJA CALIFORNIA, MÉXICO

The entries below show periods of low tides of -3.90 feet and below. The times of low tides are given in Pacific Standard Time, except those dates marked with an asterisk which are in Pacific Daylight Time. To cor-

rect for Puerto Peñasco add one hour to listed times when they are in Pacific Standard Time. Tides below the midriff of the Gulf cannot be estimated using these entries. All entries are approximate times and tides.

Jan. 1	8:50 p.m.	-5.40 ft	Apr. 27	8:25 a.m.*	-4.22 ft	Sep. 9	9:40 a.m.*	-4.67 ft
Jan. 2	9:34 p.m.	-4.63 ft	Apr. 28	8:59 a.m.*	-4.34 ft	Sep. 9	9:59 p.m.*	-4.52 ft
Feb. 26	7:08 p.m.	-4.69 ft	Jun. 13	9:36 a.m.*	-4.09 ft	Oct. 6	8:04 a.m.*	-3.94 ft
Feb. 27	7:48 p.m.	-5.56 ft	July 11	8:48 a.m.*	-4.57 ft	Oct. 6	8:22 p.m.*	-4.72 ft
Feb. 28	8:16 a.m.	-3.93 ft	July 12	9:30 a.m.*	-5.03 ft	Oct. 7	8:43 a.m.*	-3.95 ft
Feb. 28	8:27 p.m.	-5.51 ft	July 13	10:13a.m.*	-4.76 ft	Oct. 7	8:57 p.m.*	-5.24 ft
Mar. 1	8:51 a.m.	-4.36 ft	Aug. 8	7:55 a.m.*	-3.93 ft	Oct. 8	9:32 p.m.*	-4.99 ft
Mar.1	9:04 p.m.	-4.55 ft	Aug. 9	8:37 a.m.*	-5.19 ft	Oct. 9	10:06 pm*	-4.01 ft
Mar. 2	9:25 a.m.	-4.07 ft	Aug 10	9:18 a.m.*	-5.65 ft	Nov.4	7:00 p.m.	-4.59 ft
Mar.28	7:31 p.m.	-4.17 ft	Aug. 11	9:58 a.m.*	-5.21 ft	Nov. 5	7:36 p.m.	-4.94 ft
Mar.29	7:51 a.m.	-4.52 ft	Sep. 6	7:40 a.m.*	-3.97 ft	Nov 6	7:11 p.m.	-4.63 ft
Mar. 29	8:09 p.m.	-3.94 ft	Sep. 7	8:21 a.m.*	-5.10 ft	Dec.4	7:24 p.m.	-3.97 ft
Mar. 30	8:24 a.m.	-4.80 ft	Sep. 8	9:01 a.m.*	-5.34 ft	Dec. 21	8:18 p.m.	-4.03 ft
Mar. 31	8:56 a.m.	-4.37 ft	Sep. 8	9:24 p.m.*	-4.57 ft	Dec. 22	8:56 p.m.	-4.01 ft

Compiled by Jules Hertz

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

February 11, 2010

Number: 2

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 Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The **Festivus** is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

Communities Deep and Shallow in San Diego

Wendy Enright received her Masters in Oceanography from Scripps Institution of Oceanography and has been at the City of San Diego since 2001; first in the Ocean

Operations field group and in the Taxonomy group since 2008. She will present her talk on these deep-water mollusks, highlighted with slides of these creatures.

Meeting date: February 18, 2010

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CLUB NEWS

The January 21, 2010, San Diego Shell Club Meeting

Hopefully, you all received the e-mail notifying members of the cancellation of the January meeting as a result of the strong storms. We regret that it had to be canceled and assure you that the speaker will give her

program on pteropods and heteropods at the March meeting instead. If you aren't on the list of Club members that received the notice, please let us know by e-mail and we will correct that error.

TO ALL OUR SHELLING FRIENDS

YOU ARE CORDIALLY INVITED TO ATTEND SAN DIEGO SHELL CLUB'S ANNUAL AUCTION/POTLUCK ON SATURDAY EVENING, APRIL 17TH

Bring Family and Friends — Have we got shells for you!!!

The San Diego Shell Club's annual auction/potluck will be held on Saturday evening April 17th in the community room of Wes Farmer's condo at 3591 Ruffin Rd., San Diego, CA 92123. [Maps will be provided if you don't know how to get to the auction.] The festivities will begin at 5 p.m. with "Dave's Punch", wine, and soft drinks while you view the auction tables. Dinner will be at 6 p.m. sharp and the voice auction will begin promptly at 7 p.m.

Among some of the very special items for auction are a number of excellent books and many beautiful shells. Among them are *Strombus taurus* and *helli*; many great cowries like *Cypraea leucodon*, *aurantium*, *decipiens*, *thersites*, *rashleighana*, *nigropunctata* and a melanistic *Cypraea eglantina*; outstanding cones such as *Conus gloriamaris*, *bullatus*, *thomae* and *aurisiacus*; muricids such as *Austrorophon catalinensis*, *Pteropurpura centrifuga*, *Trophon ithitoma*, *Murex bednalli* and *Cinclidotyphis myrae*. Besides the voice auction, there will be a huge and wonderful silent auction and an enormous \$1 table.

If you are unable to attend the auction and want to be a part of it, you can request an auction list by e-mailing jhertz@san.rr.com and a list will be sent to you. Should you then wish to bid on any items, an attending Club member will bid for you following your instructions.

This is the Club's only fundraiser and its biggest social event of the year. Your help is needed to make it a success. The annual auction provides the Club with the funds necessary to support its many activities such as *The Festivus*, Club library purchases, donations toward student grants and other scientific efforts and its continued participation in the Greater San Diego Science Fair as well as the Club's social functions. It also helps to keep the membership dues low – as you've probably noticed.

If you plan to attend the auction/potluck, please contact Carole or Jules Hertz at (858) 277-6259 or at the e-mail address above. For the potluck bring a dish to serve 12 – either a main course, salad, or dessert. Shell donations will be appreciated and some may be held for the 2011 auction since the list for this auction may already have been completed.

Hope You Can Attend - We Miss Seeing You!!!

**CIRSOTREMA TOGATUM HERTLEIN & STRONG, 1951
(GASTROPODA: EPITONIIDAE), A VARIABLE SPECIES
OR THREE DISTINCT SPECIES? A PRELIMINARY STUDY**

CAROL SKOGLUND* & CAROLE M. HERTZ

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2559 Puesta del Sol Road, Santa Barbara, CA 93105-2936, USA

Introduction

In working with Panamic epitoniids we noted that there was considerable variability in specimens identified as *Cirsotrema togatum* Hertlein & Strong, 1951. This prompted our study of the type species of *C. togatum* as well as specimens of this species in several museums and private collections. We question whether specimens considered to be *C. togatum* are, in fact, one species or three.

Materials Studied

We checked the collections of five museums and six private collections and found the following material: the California Academy of Sciences (CAS), holotype and one paratype of *C. togatum* as well as a voucher specimen; the San Diego Natural History Museum (SDNHM) no specimens; the Natural History Museum of Los Angeles County (LACM), 3 specimens; the Santa Barbara Museum of Natural History (SBMNH), 40 specimens (which included shells from the DuShane, Koch, Poorman, Shasky and Shy collections); the Smithsonian Institution (USNM) no specimens of *C. togatum*, but the repository of the type material of *C. dalli* and *C. arcella* both of Rehder, 1945, and close congeners of *C. togatum* from the Atlantic; the Skoglund Collection, 25 specimens; the Hertz Collection, 2 specimens; Kaiser Collection, 1 specimen; and photos of the specimens in the Metz and García Collections (1 specimen from the Metz Collection and 2 specimens from the García Collection). We have now studied a total of 76 specimens from institutions and private collections (Table 1).

Discussion

Specimens commonly considered to be *Cirsotrema togatum* species were separated into two additional "forms" or species using simple descriptive names to

help in sorting: "buttress," a relatively slender, sloping shell with axial ribs connected from whorl to whorl and "wedding cake," a small, tiered specimen with tabulate shoulder area. Each "form" or species has several other differentiating characters. We found no intergrading in the 76 specimens studied.

Cirsotrema togatum

Cirsotrema togatum Hertlein & Strong, 1951 (Figures 1-4) is a light tan shell with a slender, slightly turreted spire with rounded whorls, moderately deep sutures, fine spiral threads and axial ribs. The ribs on the first few postnuclear whorls are made up of single sharp, raised lamellae. The number of lamellae increases as the shell grows until the ribs on the body whorl of a 31 mm specimen have 4 to 5 tightly packed lamellae. These ribs terminate in small points bending towards the suture of the previous whorl. Every fourth to sixth axial rib is swollen to form a strong varix. The fine spiral threads of the shell and 7 stronger spiral cords can be seen in the interspaces between the ribs (Figures 1-3). The axial ribs become slender as they reach the base of the body whorl and flatten into a thin basal cord which is made up of groups of lamellae. These lamellae reduce in size to create elongate pits before reaching the fasciole (Figure 4). The aperture is rounded, the lip slightly patulous and crenulate, thickened by the last rib. We have studied 31 specimens, 9 of which were live taken. The largest seen was 31 mm and had 9 remaining whorls.

The holotype of *C. togatum* has also been illustrated by Keen (1971, fig. 633 left), DuShane (1974, fig. 55) and Pitt (1981, fig. 3). A second specimen was also illustrated by Pitt (1981, fig. 2). Olsson's specimen (1971, fig. 77) was repeated in Keen (1971, fig. 633, right).

C. togatum, as treated in this paper, has been reported from the upper Golfo de California, México,

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to Costa Rica and the Islas Galápagos. The only record for the species from the Pacific side of Baja California is at the Ballenas Channel off Isla Ballenas. The earliest record is from fossils taken at Quebrada Camerones, Esmeralda, Ecuador, which are probably Pliocene in age (Pitt, 1981).

A close congener is the western Atlantic *C. dalli* Rehder, 1945 (Figure 5) with published distribution from North Carolina to Florida, West Indies and Brazil (Rios, 1985: 157, pl. 53, fig. 746).

Buttress

Specimens referred to as “buttress” (Figures 6-7) have a similar light tan color but differ from *C. togatum* in several ways. They have less rounded whorls and have broad axial ribs created of wavy lamellae so closely packed that they leave only small pits between the ribs. Fine spiral threads can be seen in these pits, but they lack the spiral cords of *togatum*. On the first 4 postnuclear whorls (Figure 8), the vertical ribs are each of a single lamella. These ribs are far enough apart to show the fine spirals on the whorl itself. The number of lamellae that make up a rib increases as the shell matures. Starting on about the 5th or 6th whorl these ribs become retractive and are slightly bent towards the deep suture of the previous whorl. By the 6th or 7th whorl the ribs cross the suture to join the previous whorl, giving a straight-sided look to the shell. The ribs on the body whorl narrow just before forming a wide basal cord (Figure 9), then narrow again before touching the fasciole. This narrowing creates large pits on both sides of the cord. The aperture is slightly oval and the lip patulous, crossed by fine striae that are raised at intervals to make heavier cords. The largest specimen seen had a length of 31mm and 10½ remaining postnuclear whorls. A total of 36 specimens were studied. The distribution is from Guaymas areas, Sonora, México, to Panamá.

The Hertlein and Strong (1951), voucher specimen of *C. togatum* (Figure 10) is a “buttress” specimen. The authors commented in their original description of *C. togatum* that “Two specimens, apparently the same species although varying somewhat from the type specimen ... were taken at Manzanillo.”

Specimens in Weil et al. (1999, fig. 446) and DuShane (1974, fig. 54) are also “buttress” specimens.

Wedding Cake

The highly tabulate, off-white specimens of “wedding cake” (Figures 11-12) are smaller than *C. togatum* or “buttress”. The first two or three postnuclear

whorls are slightly rounded. The remaining 6 whorls are flat-sided and tabulate with planate shoulders. The planate shoulder areas are unique in having thin, angled ribs that reach into the deep suture. The body whorl is slightly rounded. The ribs are made up of bunched lamellae like those in the “buttress” specimens, but are much more delicate and are so crowded together that very little of the shell surface is visible. In the few places where the surface can be seen it has the fine spiral threads also seen on *C. togatum* and “buttress” specimens. The axial ribs continue only to the start of the flat area that leads to the suture. The tops of these ribs (Figure 12), on good specimens, have small, slightly bent coronations. The partial nucleus and the sculpture of the early teleoconch whorls are shown in Figure 13. A heavy cord on the base of the body whorl is made up of widened axial ribs that leaves deep pits on both sides of the cord (Figure 14). They continue as much thinner ribs becoming a siphonal fasciole that reaches the base of the somewhat patulous aperture. The lip is crossed by very small ribs that are almost microscopic (Figure 12). The maximum size of the 9 specimens seen is 14 mm. The distribution is from Bahía de Los Angeles, Baja California, México, to Playas del Coco, Guanacaste, Costa Rica.

We have seen only photographs of the types of the two western Atlantic species, *Cirsotrema dalli* (Figure 5), and its recognized synonym *Cirsotrema arcella* (Figure 15) both of Rehder, 1945, and described without illustration. Based on the original descriptions and photographs of the types, the synonym *C. arcella* is “smaller ... shoulder more strongly angulate, and flattened horizontally above, giving the spire a sharply terraced outline.” For this reason, we have listed this junior synonym as the Atlantic congener closest sculpturally to the “wedding cake” specimens discussed here.

Cirsotrema togatum: one species or three?

The material studied was uncommon in collections and labeled either as *Cirsotrema togatum* or unidentified. All were dredged.

The three “forms” are similar in many ways. All have vertical axial ribs made up of wavy lamellae that stand upright, and fine spiral threads that can be seen on the body of the shell. The ribs on the first 3 or 4 postnuclear whorls are made of a single lamella, giving these vertical ribs a fragile look. As the shells mature more lamellae are added to make bundles of tightly packed retractive ribs. All have occasional varices, a strong basal cord on the body whorl and a round or very

slightly oval aperture with a paucispiral nucleus. Because none of the specimens studied had complete protoconchs (and very few had even partial protoconchs), no comments can be made about protoconch similarities or differences.

How do they differ? *Cirsotrema togatum* and “buttress” specimens have a similar light tan color. “Wedding-cake” specimens are off-white. The shapes of the shells vary from slightly rounded in *C. togatum*, almost straight sided in “buttress” and strongly tiered in “wedding cake”. The sutures are moderately deep in *C. togatum*, almost invisible in “buttress” and extremely deep, giving a tiered look in “wedding cake”. The number of body whorl ribs and varices are variable. Body whorl ribs on specimens examined were formed from 3 to 4 lamellae (*C. togatum*, 12 mm) to 12 lamellae (“buttress”, 26 mm) and 5 lamellae (“wedding cake”, 12 mm). Both the “buttress” and “wedding-cake” lamellae were difficult to count because they are so tightly packed, touching each other, and can be told apart only by the small pits between the ribs. The ribs on *C. togatum* are farther apart and can be easily counted. We could find no conclusive correlation between the size of the shell with the number of whorls in either *C. togatum* or the “buttress” and “wedding cake” specimens (see Table 1).

The lamellae differ in the number of retractive ribs as do the spaces between the ribs. The axial ribs of *C. togatum* starting with about the 4th or 5th whorl are composed of three or more lamellae. The wide spaces between the ribs on the body of the shell let the fine spiral threads and 7 spiral cords be seen. Neither “buttress” or “wedding cake” have these cords. The ribs of *C. togatum* terminate in small points bending towards the suture of the previous whorl. There are 16 ribs and 5 varices on the body whorl of a specimen examined. This basal cord is thinner than that of “buttress” or “wedding cake” when seen from the apertural view, but heaviest of the three when seen in a basal view (Figure 4). In contrast “buttress” looks more straight-sided resulting from its overlapping ribs crossing and hiding the suture. Single lamella, as in *C. togatum*, make up the ribs that are seen on the first few whorls. The number gradually increases to 6 or 7 tightly packed lamellae per rib on the body whorl, where 12 to 15 ribs are so tightly packed that they leave only very small areas where they do not touch. The basal cord is wider than that of *togatum* and has more closely packed lamellae with larger pits just above the cords.

“Wedding Cake” differs from the other two “forms” in its off-white color, strongly tiered outline and smaller

size. The basal cord (Figure 14) differs in having elongate pits before reaching the fasciole.

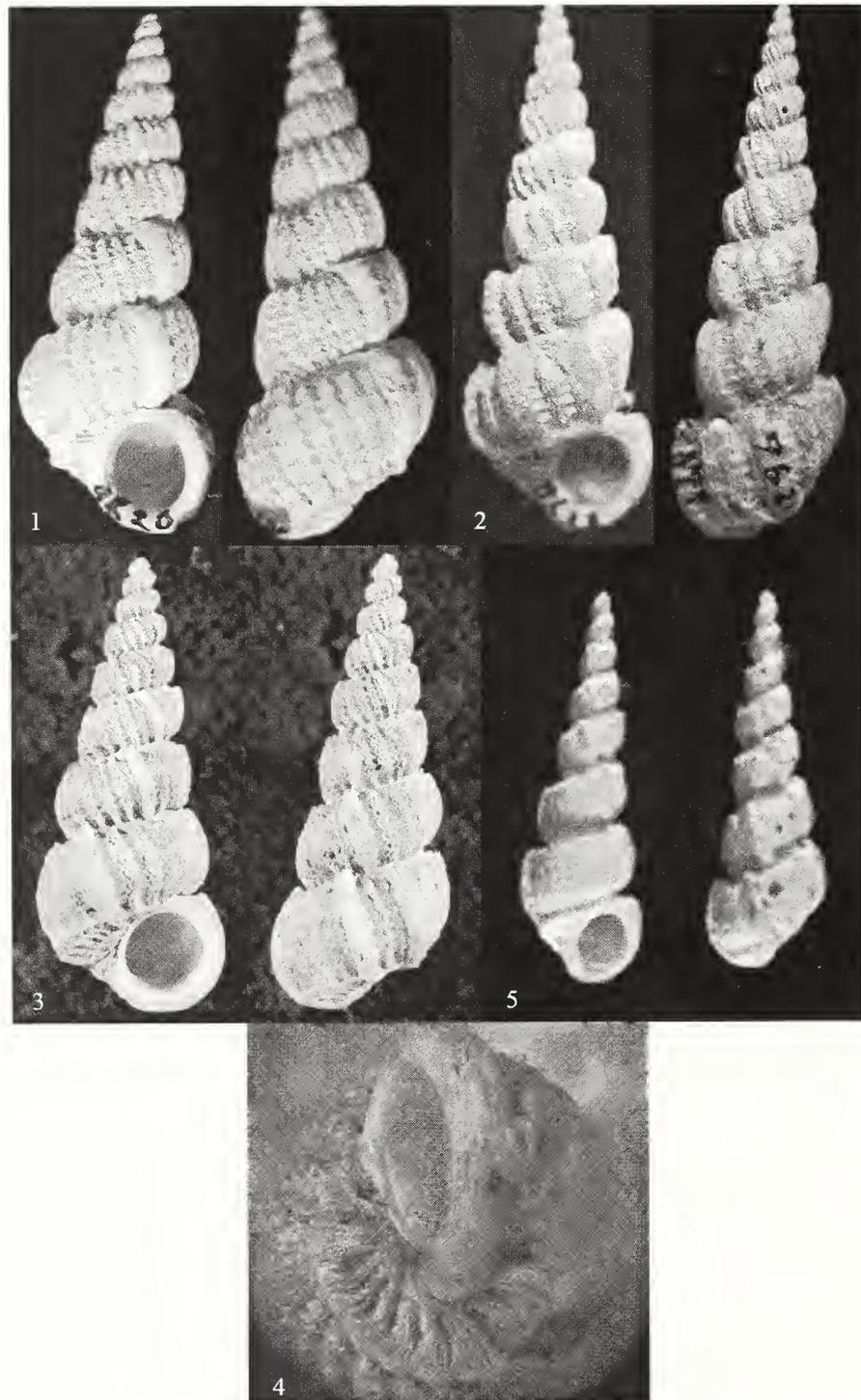
Based on our preliminary studies of the sculptural features of specimens identified as *C. togatum*, we believe that there are either three sculptural forms of *C. togatum* or two possible species waiting for new names, but this is beyond the scope of this present study.

Acknowledgments

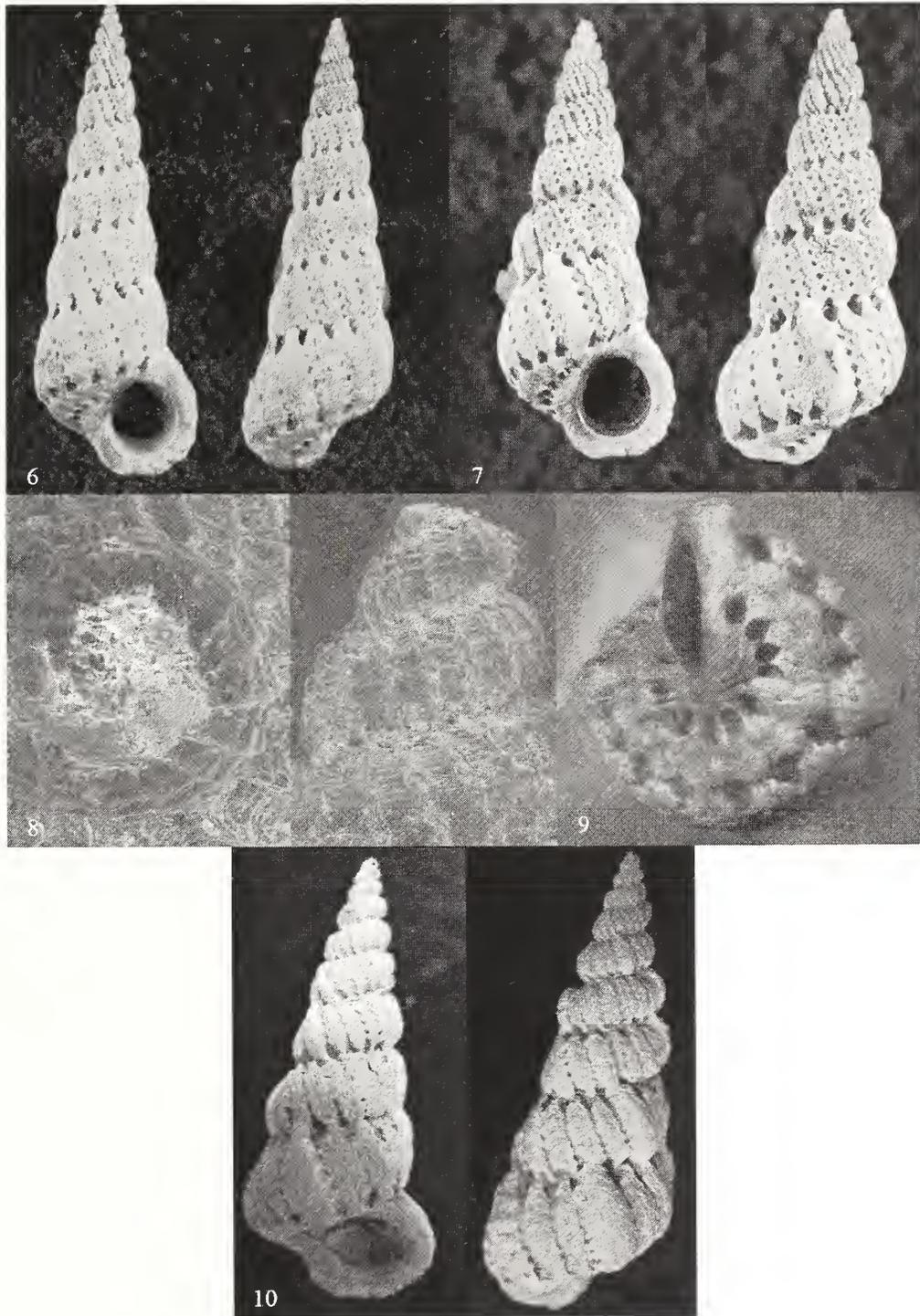
Without the help of many people this study would not have been possible. The staff of the Invertebrate Zoology Department, SBMNH, was very helpful. Paul Valentich-Scott provided work space for us during our visits there and also took photos of the *C. dalli* and *C. arcella* types at the USNM, Patricia Sadeghian photographed *Cirsotrema* specimens and Daniel Geiger did the SEM photography. The photographs of the type material and labels of *C. togatum* were taken by George Metz, Associate, Invertebrate Zoology Department at the CAS, and Lindsey Groves of the Malacology Department of the LACM provided the photos for the three specimens in its collection. Emilio García and George Metz sent photos of material in their collections and Kirstie L Kaiser kindly lent us her specimen. To them all, our deep appreciation.

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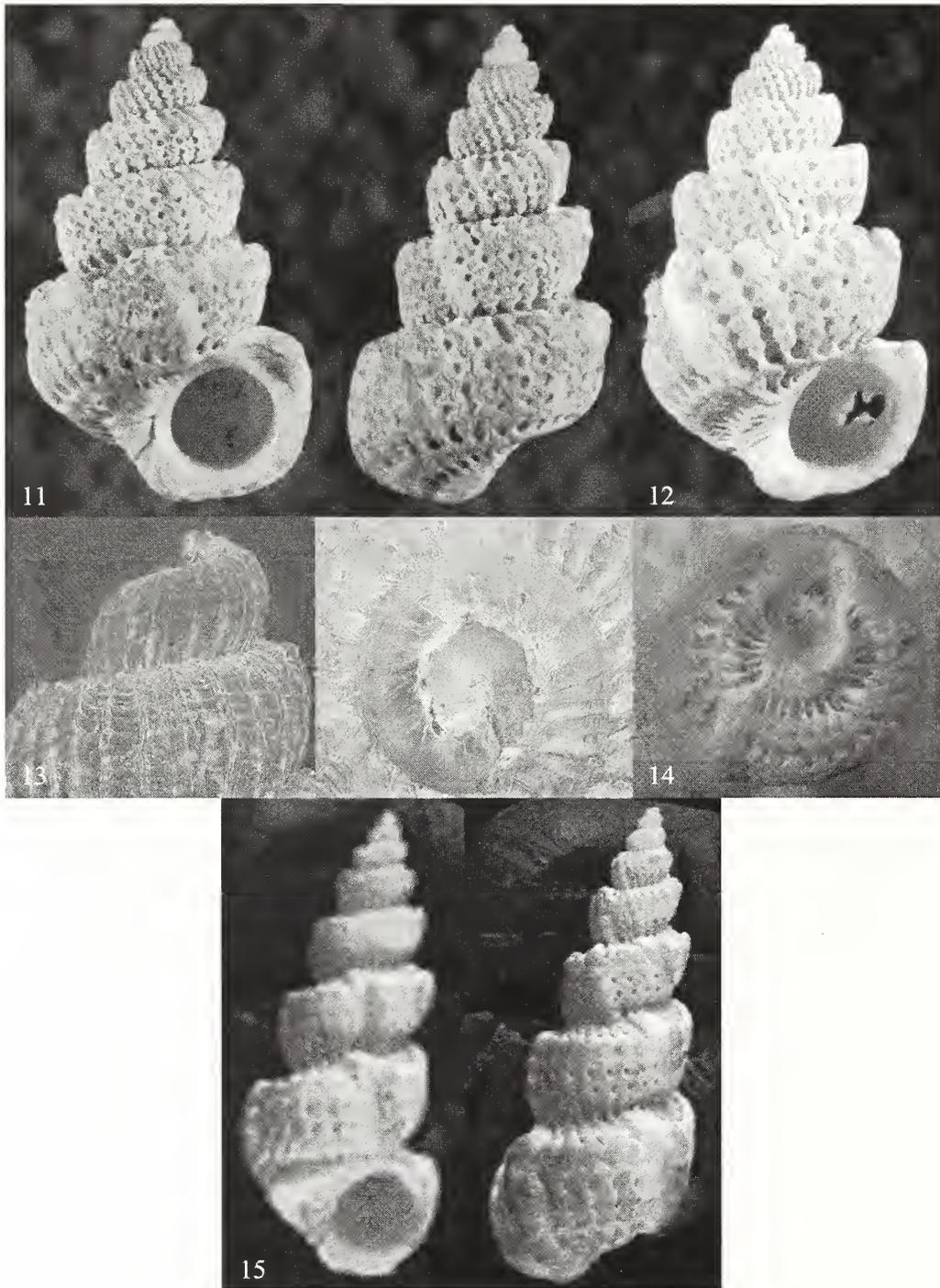
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Figures 1-.5. (1) *Cirsotrema togatum*, holotype, 37.5 mm, 2 views, Gorda Banks, Baja California Sur, México, CASIZ 065015. Photos: George Metz. (2) *C. togatum*, paratype, 33.4 mm, 2 views, SE of Pta. Judas, Costa Rica, CASIZ 065016. Photos: George Metz. (3-4) *C. togatum*, (3) 23.3 mm specimen, 2 views from SE Pta. San Antonio, Sonora, México. (4) Detail of pits on either side of basal cord, Skoglund Collection. Photos: Daniel Geiger. (5) *Cirsotrema dalli*, holotype, 41 mm, 2 views, Gulf of Mexico off Cape San Blas, USNM 515240. Photos: Paul Valentich-Scott.



Figures 6-10. (6) *Cirsorema* "butress", 26.5 mm, live taken, 2 views, off West Isla Danzante, Baja California Sur, México. Skoglund Collection. Photos: Patricia Sadeghian. (7) *C.* "butress", ±16 mm, 2 views, Bahía Santiago, off Pta. Juluapan, Colima, México, SBMNH 87386. Photos: Patricia Sadeghian. (8) Details of *C.* "butress", [SBMNH 87386], closeups of remaining protoconch [left] and spire whorls [center]. Photos: Daniel Geiger. (9) Basal view of specimen showing pits on both sides of the basal cord. Photo: Daniel Geiger. (10) *C.* "butress" specimen, 39 mm, 2 views, [CASIZ 06518, voucher specimen for *C. togatum*], Manzanillo, Colima, México. Photos: George Metz.



Figures 11-15. (11) *Cirsotrema* "Wedding Cake", 12 mm, 2 views, off Isla Danzante, Baja California Sur, México, Skoglund Collection. Photos: Patricia Sadeghian. (12-14) *C.* "Wedding Cake", (12) ± 10 mm, apertural view. Photo: Patricia Sadeghian. (13) Details of spire sculpture [left] and remaining protoconch [center], Playas del Coco, Costa Rica, SBMNH 97582, SEM photos: Daniel Geiger. (14) Basal cord showing deep pits on either side. Photo: Daniel Geiger. (15) *Cirsotrema arcella*, holotype, 16.4 mm, 2 views, SW of Cape Hatteras, North Carolina, USNM 83725. Photos: Paul Valentich-Scott.

Table I *CIRSOTREMA* SPECIMENS STUDIED
(Geographical order north to south)

Off Tetras de Cabras, Sonora = Off Punta San Antonio, Sonora. Off Ensenada San Francisco = Bahía Bacochibampo

SPECIES NAME	DREDGED LOCALITY	DEPTH IN METERS	NUMBER OF SPECIMENS AND SIZE	CONDITION [REMAINING TELEOCONCH WHORLS]	COLLECTOR AND DATE COLLECTED	PRESENT LOCATION
TOGATUM						
TYPE MATERIAL						
<i>C. togatum</i> Holotype (Fig. 1)	Gorda Banks, Golfo de California, Baja California Sur, México, 23°1'N, 109°27'30''W	91 m, sand	37.5 x 13.8 mm	9 whorls	R/V <i>Zaca</i> 3 May 1936.	CAS 065015
<i>C. togatum</i> Paratype (Fig. 2)	14 mi. SE of Pta. Judas, Costa Rica 9°19'32"N, 84°29'30''W	76.5-112 m, mud, shell, rock bottom	33.4 x 11.2 mm	10 whorls	R/V <i>Zaca</i> 1 Mar. 1938	CAS 06516
OUTER COAST OF BAJA CALIFORNIA, MÉXICO						
<i>C. togatum</i>	W Ballena Channel, 28°57'0"N, 113°22.0'W	236-362 m	1 specimen, 31 mm	live, 6+ whorls	D.L. Inman, SIO 9 April 1960	SBMNH 12029
SONORA, MÉXICO						
<i>C. togatum</i>	Bahía Bacochibampo, Isla Candelerero, 27°55'51.86"N, 110°59'36"W	18 m	1 specimen, 14.4 mm	7 whorls	C. & L. Shy	SBMNH 83658
<i>C. togatum</i> (Figs. 3, 4)	3 miles SE of Punta San Antonio, 27°56'12"N, 111°04'1" W	90 m	1 specimen, 23.3 mm	8 whorls	R. & F. Poorman Oct. 1979	Skoglund Collection
<i>C. togatum</i>	3 miles SE of Pta. San Antonio, 27°56'12"N, 11° 04'15"W	50-100 m	6 specimens, 13.5-32 mm	5 live, 32 mm, 8½ whorls	R. & F. Poorman Nov. 1971- Nov. 1977	SBMNH 87384 ex Poorman
<i>C. togatum</i>	3 miles SE of Pta. San Antonio, 27°56'12"N, 111°04'15"W	128-148 m	4 specimens, 11-38 mm	38 mm, live, 6+ whorls	C. & L. Shy May 1977	SBMNH 423139 ex Shy
<i>C. togatum</i>	Guaymas, off Punta. Colorado, 27°50'17.79"N, 110°53'08.76"W	no data	2 specimens, 11.5 & 20 mm	1 live, 11.5 mm; 20 mm, 8 whorls	C. & L. Shy Nov. 1968	SBMNH 13872 ex Shy
BAJA CALIFORNIA, MÉXICO						
<i>C. togatum</i>	Bahía de los Angeles, 28°05'00"N, 113°31'00" W	30 m	1 specimen, 15.8 mm	7+ whorls	R. & F. Poorman, May 1975	SBMNH 87371 ex Poorman

BAJA CALIFORNIA SUR, MÉXICO						
<i>C. togatum</i>	Pta. Coyote [near Puerto Escondido], 24°21'00"N, 110°16'00"W	30-45 m, sand, gravel	1 specimen, 11 mm	5 whorls	R. Koch	SBMNH 87381 ex Koch
<i>C. togatum</i>	off S Isla Danzante, 25°45'27.76"N, 111°14'35.66"W	45-75 m, shell & rubble	1 specimen, 9.5 mm	6 whorls	P. & C. Skoglund, Oct. 1981	Skoglund Collection
<i>C. togatum</i>	NE of Isla Danzante, 25°45'00"N, 111°14'00"W	91-122 m	1 specimen, ≈15 mm	7 whorls	H. & C. Norrid, 1993	SBMNH 87382 ex Norrid
<i>C. togatum</i>	S of Isla Danzante, 25°45'27.76"N, 111°14'35.66"W	30-45 m	1 specimen, 8 mm	1 partial protoconch whorl, +7 whorls	Skoglund & Hertz, 13 Oct 1991	Hertz Collection
<i>C. togatum</i>	S of Isla Danzante, 25°45'27.76"N, 111°14'35.66"W	45-75 m rubble, shell	3 specimens, 6-27 mm + 1 lg. body whorl	27 mm, 6 whorls	P. & C. Skoglund, Oct. 1981	Skoglund Collection
<i>C. togatum</i>	Los Frailes, 23°22'00"N, 109°24'00"W	46-60 m	2 specimens, 9-11.6 mm	11.6 mm, 7+ whorls	J. Bailey, 3/72-11/73	SBMNH 87383 ex Koch
JALISCO, MÉXICO						
<i>C. togatum</i>	Bahía Tenacatita, 19°17.0'N, 104°50.0'W	37-73 m	1 specimen, 11.3 mm	4½ remaining whorls	G. Willett, 18 Feb. 1938	LACM 38-7.28
COSTA RICA						
<i>C. togatum</i>	Golfo de Nicoya; S side, Isla Negros Adentro, 4°49'94"N, 84°49'22"W	12-28 m coarse sand, broken shell	1 specimen, 14 mm	6 teleoconch whorls	R. Koch, 8-9 May 1982	SBMNH 87380 ex Koch
ECUADOR						
<i>C. togatum</i>	Islas Galápagos, Isla Barrington [Isla Santa Fe], 00°49'00"S, 090°04'00"W	50 m	1 specimen, 33 mm	9 whorls	J. DeRoy, 29 Dec. 1968	SBMNH 423136 ex DuShane
<i>C. togatum</i>	Islas Galápagos, Black Beach, Charles Beach, 01°16'00"S, 090°29'00"W	18 m	1 specimen, ± 3 mm	no data	J. DeRoy	SBMNH 423140 ex DuShane
BUTTRESS SONORA, MÉXICO						
Buttress	Isla San Pedro Nolasco, 27°58.6'N, 111°22.7'W	170-496 m rock	1 specimen, 27.6 mm	8½ whorls	Velero III, 6 Feb. 1940	LACM 40-56

Buttress	3 miles SE of Pta. San Antonio, 27°56'12"N, 111°04'15"W	50-100 m	5 specimens, 11.2-29 mm	2 live: 29 mm, 8+ whorls; 11.2 mm, 7+ whorls	R & F. Poorman, Nov. 1971	SBMNH 87384 ex Poorman
Buttress	Bahía Bacochibampo, Isla Candelero, 27°55'51.86"N, 110°59'36"W	18 m	1 specimen, 19.7 mm	live, 8+ whorls	R & F. Poorman, April 1965	SBMNH 87385 ex Poorman
Buttress	Bahía Bacochibampo, Isla Candelero, 27°55'51.86"N, 110°59'36"W	18 m	2 specimens, 11.8 & 14.4 mm	2 live, smallest 11.8 mm, 7+ whorls	C. & L. Shy, Oct. 1969	SBMNH 87378 ex Shy
Buttress	Guaymas, off Pta. Colorado, 27°50'17.79"N, 110°53'08.76"W	no data	2 specimens, 11.5 & 20 mm	1 live, 11.5 mm, 1 protoconch whorl, +6 whorls. Dead, 20 mm, 7 whorls.	C. & L. Shy, Oct. 1969	Skoglund Collection
BAJA CALIFORNIA, MÉXICO						
Buttress	Bahía de Los Angeles, N of Pta. la Gringa, 29°02.5' N, 113°32.5 'W	31m, sand, gravel	1 specimen, 13.3 mm	6½ whorls	G. Sphon & D. Mulliner, 19 May 1976	LACM 76-7
BAJA CALIFORNIA SUR, MÉXICO						
Buttress (Fig. 6)	off W Isla Danzante, 25°45'33.61"N, 111°11'01"W	30-45 m, sand, shell	9 specimens, 9.5-26.9 mm	2 live; lgst. live with 10 whorls	P. & C. Skoglund, Oct. 1976 and later	Skoglund Collection
Buttress	off SE Isla Danzante, 25°45'27.76"N, 111°14'35.66"W	30 m	2 specimens, 12 & 18 mm	12mm, live, 7 whorls; 18 mm, dead, 8 whorls	J & F. Holmes, Oct. 1982	Skoglund Collection
Buttress	Isla Candeleras, [S of Isla Danzante], 25°45'27.76"N, 111°14'35.66"W	15-30 m	1 specimen	no data	G. Metz	Metz Collection
NAYARIT, MÉXICO						
Buttress	Islas Tres Marías, off Isla María Cleofas, 21°1.9'00"N, 106°13'30"W	18-36 m	1 specimen, 15 mm	7+ whorls	G. Willett, 12 Feb. 1938	SBMNH 21938 ex. Sphon
Buttress	Islas Tres Marías, off Isla María Cleofas, 21°1.9'00"N, 106°13'30"W	60-70 m sand, rock, coral rubble	1 specimen, 17.9 mm	partial protoconch whorl, +7 whorls.	K. Kaiser, 14-15 May 1996	Kaiser Collection

COLIMA, MÉXICO						
Buttress as <i>C.</i> <i>togatum</i> CAS voucher (Fig. 10)	Manzanillo, 19°04'N, 104°22'W	55 m	1 specimen, ca. 39 mm	9 whorls	R/V <i>Zaca</i> , 22 Nov. 1937	CAS 06518
Buttress	Bahía Santiago, off Pta. Juluapan, 19°04'49"N, 104°23'40" W	13 m	4 specimens, 15-25.8 mm	3 live; 25.5 mm, 10 whorls	C. & L. Shy, 6 June 1967	SBMNH 87377 ex Shy
Buttress (Figs. 7-9)	Bahía Santiago, off Punta Juluapan, 19°04'49"N, 104°23'40" W	31 m	1 specimen, ± 16mm	live, first two protoconch whorls glassy	C. & L. Shy	SBMNH 87386 ex DuShane
COSTA RICA						
Buttress	Guanacaste Province, off Playas del Coco, 10°26'30"N, 85°41'47.26"W	24-37 m mud bottom	1 specimen, 12 mm	fragment of 8 whorls, no body whorl	P. & C. Skoglund, April 1982	Skoglund Collection
PANAMÁ						
Buttress	Golfo de Chiriquí, Isla Cobita, 7°31'63"N, 81°54'36.3" W	50 m	1 specimen, 31 mm	live, 10 whorls	T. Bratcher no date	Hertz Collection
Buttress	Golfo de Chiriquí, Islas Secas, 7°55'04.72"N, 82°02'23.61"W	12-24 m sand bottom	2 specimens, 14.6 & 24.4 mm	both live; 14.6 mm, 9 whorls; 24.4 mm, 8 whorls	E. García	García Collection
WEDDING CAKE BAJA CALIFORNIA, MÉXICO						
Wedding Cake	Bahía de Los Angeles, 28°56'00"N, 113°31'00" W	30 m	1 specimen, 14 mm	7+ whorls	R & F Poorman, May 1975	SBMNH 87376 ex Poorman
Wedding Cake	Bahía de Los Angeles, 28°56'00"N, 113°31'00" W	43 m	1 specimen, 8.5 mm	live, 1+ protoconch whorls, white, smooth, glossy; 5+ whorls	J. Bailey, Oct. 1966	SBMNH 87379 ex Koch
Wedding Cake	Bahía de Los Angeles, off Punta la Gringa, 28°56'28.16"N, 113°44'54.13"W	20-40 m	1 specimen, 11.5 mm	live, 7 whorls	P. & C. Skoglund, 1975	Skoglund Collection

BAJA CALIFORNIA SUR, MÉXICO						
Wedding Cake (Fig. 11)	off S Isla Danzante, 25°45'27.76"N, 111°14'35.66"W	45-75 m shell & rubble	2 specimens, 11 & 12 mm	11 mm, live, 5 whorls; 12 mm, dead, 6 whorls	P. & C. Skoglund, Oct 1976 & later	Skoglund Collection
COSTA RICA						
Wedding Cake	Guanacaste Province, Playas del Coco, 10°26'30"N, 85°41'47.26"W	24-37 m mud	3 specimens, 6-10 mm	2 live, 6 mm, 5 whorls & 9 mm, 6 whorls; 1 dead, 10 mm, 7 whorls	P. & C. Skoglund, Apr. 1982 & later	Skoglund Collection
Wedding Cake (Figs. 12-14)	Guanacaste Province, Playas del Coco, 10°26'30"N, 85°41'47.26"W	9-24 m	1 specimen, ≈ 10 mm	6 whorls	R. Koch, 19-22 April 1983	SBMNH 97582 ex Koch
ARCELLA NORTH CAROLINA						
<i>C. arcella</i> Holotype (Fig. 15)	36 miles SW of Cape Hatteras, North Carolina	188 m	1 specimen, 16.4 mm	7.5 whorls	Bureau of Fisheries Sta. 2602	USNM 83725
DALLI FLORIDA						
<i>C. dalli</i> Holotype (Fig. 5)	Gulf of Mexico off Cape San Blas, between the Mississippi Delta and Cedar Keys	45.72 m coral	1 specimen, 41mm	7.5 whorls	Bureau of Fisheries Sta. 2373	USNM 515240

THE FOURTEENTH ANNUAL SCUM MEETING

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The fourteenth annual meeting of the Southern California Unified Malacologists (SCUM) was held on 23 January 2010 at the City of San Diego, EMTS Division Laboratory, San Diego, California. The meeting was hosted by Ron Velarde, Tim Stebbins and Wendy Enright. Refreshments were available at 9:00 a.m. and the meeting was officially convened at approximately 9:45 a.m. by Tim Stebbins who gave some brief welcoming and logistics remarks. This was followed by the traditional round of self-introductions. There were 33 attendees and this required importing many additional chairs to the over-flowing conference room.

The remainder of the meeting was led by Wendy

Enright who remarkably kept to the meeting's agenda. The first speaker was Ángel Valdés. He described opisthobranch studies that were being conducted by some of his students at Cal-Poly Pomona. The first was on isolated species of *Navanax* from the Caribbean, West Africa and the Eastern Pacific. He showed pictures of *Navanax aenigmaticus*, *N. nyanyanus* (W.A.) and *N. gemmatus* (Caribbean) which looked morphologically different. DNA studies with H3, 16S and CO1 genes indicate that the three species are the same. A second study was conducted on *Navanax inermis* and *Navanax polyalphos*. Although there are clear morphological differences it is hard to tell *aenigmaticus* apart from



Photo: Dan Ituarte

On stairs (l to r & top to bottom): Pat LaFollette, Mary Stecheson, Chuck Powell; Danielle Taranko, Jackson Lam, George Kennedy; Ángel Valdés, Doug Eernisse; Nerida Wilson, Wes Farmer (raised camera), (l to r): Jim McLean, Scott Jordan, Gina Valdez, Tim Stebbins, Carole Hertz, LouElla Saul, Lance Gilbertson, Jules Hertz, Don Cadien (between Jules & ramp; Kelvin Barwick, Bob Dees, Lindsey Groves, Carol Stadum, Scott Rugh, Terry Rutkas, Hans Teuchert: (l to r): Shawn Wiedrick, Ron Velarde, Wendy Enright, Hans Bertsch . Present at SCUM XIV but not in photo: Pat DonVito, Dan Ituarte, & Paul Tuskes.

inermis/polyalphos. An H3 tree separates *aenigmaticus* from *inermis* but shows no difference between *inermis* and *polyalphos*. There is some divergence between North and South.

Carol Stadum spoke briefly on Saddleback Valley Calcarene (limestone). She spoke of 17-million year old Deltaic Channel deposits and a wall of *Saxidomus*. This deposit had button sand dollars, Rotulidae, cones, *Turritella ocoyama*, Vermetidae, a new *Lima* species, *Crassostraea titan*, a new *Diodora* species, *Megasurcula keepi*, etc. So far over 85 taxa have been identified. Chuck Powell also described his recent and continuing work on fossils.

Terry Rutkas gave a very interesting talk on the "Use of Shell of Oceania." He tied this in to the voyages of peoples from New Guinea across the vast ocean from island to island. He spoke of how the people used various shells for ornamentation and for tools such as scrapers, chisels, fish hooks and adzes. The people could only survive if there were available resources and mollusks provided both food and the ability to make tools for daily use.

Wendy Enright presented a talk on shallow vs. deep molluscan communities in the San Diego area. Her talk was accompanied by slides showing the collecting stations and photos of some of the animals found at the different depths. There are fewer animals and a less di-

verse community at deeper stations. Bivalves are the most diverse at the lower stations followed by Scaphopoda and Aplacophora. She discussed the bivalve community structure vs. depth. The Veneroidea are most abundant at mid-range and Nuculoidea most abundant at deeper depths.

Wes Farmer related a few funny incidents and presented some short videos on Torrey Pines State Beach and squid fishing. He passed around some large dried pieces of skin from the Humboldt squid. It is amazing how pliable this skin becomes after drying. He also showed a fantastic video in which he captured the color changes of this squid.

The group then took a lunch break followed by a break for picture taking. Figure 1 shows a majority of the attendees. The afternoon proceeded with a presentation by Doug Eernisse who gave a review of the papers that he prepared during 2009 and those that are currently in press. These covered chitons, limpets, pectens and seastars. Shawn Wiedrich described his naming of *Muricopsis mcleani*, his interest in turrids and cones, and his passion for micromollusks. The last speaker on the agenda was Hans Bertsch who spoke on the "Nudibranchs of Bahía de Los Angeles. He talked of the many holotypes from the Punta la Gringa area and showed photos of the animals. The 2011 meeting will be held in Orange County-date and place to be determined.

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NOTICE OF TWO UPCOMING ANNUAL MEETINGS MARK YOUR CALENDARS

AMS & WSM – The joint 76th Annual Meeting of the AMS (American Malacological Society) and the 43rd Annual Meeting of the WSM (Western Society of Malacologists) will be held in San Diego, California and will kick off in style with a welcome reception the evening of Saturday, June 26th, 2010, at the beautiful convention center at San Diego State University with scientific sessions to be held from Sunday to noon on Wednesday, June 27-June 30, and organized excursion(s) planned on Thursday, July 1. For further information contact the meeting organizers, Doug Eernisse (deernisse@fullerton.edu) or WSM President George Kennedy (gkennedy@bfsa-ca.com).

COA – The Conchologists of America Convention, hosted by the Boston Malacological Club, will be held at the Boston Park Plaza Hotel from August 27-31, 2010 with pre-convention tours on August 26th and 27th. For further information, contact Don Robak (shellsnail@comcast.net) or Warren Graff (lowhurdler@gmail.com).

The Festivus will publish more in-depth information on these two meetings in future issues.

2010 Mission Bay Low Tides

Pick your favorite spot and call a friend. Remember if you collect live material you need a California fishing license. On your collecting form, be sure to identify the location, date, substrate if possible, and those who collected with you. Send your field notes to tuskes@aol.com, bring them to a meeting or mail them to me. Good Luck !

Paul Tuskes

Date	Time	Tide	Date	Time	Tide
Jan 28 Thu	1:38pm	-1.4	Oct 9 Sat	5:13pm	-0.7
Jan 29 Fri	2:18pm	-1.8	Oct 10 Sun	6:00pm	-0.4
Jan 30 Sat	3:22pm	-1.9	Oct 23 Sat	4:13pm	-0.1
Jan 31 Sun	4:09pm	-1.5	Nov 4 Thu	2:47pm	-0.7
Feb 12 Fri	2:24pm	-0.7	Nov 5 Fri	3:32pm	-1.1
Feb 13 Sat	3:08pm	-0.6	Nov 6 Sat	4:17pm	-1.2
Feb 14 Sun	3:31pm	-0.5	Nov 7 Sun	4:02pm	-1.1
Feb 25 Thu	1:14pm	-1.2	Nov 20 Sat	2:28pm	-0.5
Feb 26 Fri	1:51pm	-1.5	Nov 21 Sun	3:05pm	-0.7
Feb 27 Sat	2:26pm	-1.5	Nov 22 Mon	3:44pm	-0.8
Feb 28 Sun	3:00pm	-1.3	Nov 23 Tue	4:26pm	-0.8
Mar 20 Sat	2:06pm	-0.2	Dec 3 Fri	1:46pm	-1.1
Mar 25 Thu	1:00pm	-0.6	Dec 4 Sat	2:30pm	-1.3
Mar 26 Fri	1:39pm	-0.8	Dec 5 Sun	3:11pm	-1.4
Mar 27 Sat	2:16pm	-0.8	Dec 6 Mon	3:55pm	-1.3
Mar 28 Sun	2:51pm	-0.6	Dec 18 Sat	1:43pm	-0.4
Apr 3 Sat	7:24am	-0.1	Dec 19 Sun	2:20pm	-0.9
May 18 Wed	7:35am	-0.6	Dec 20 Mon	2:56pm	-1.2
Jun 16 Wed	7:00am	-0.8	Dec 21 Tue	3:33pm	-1.4
Jun 17 Thu	8:00am	-0.3	Dec 22 Wed	4:13pm	-1.3
Oct 7 Thu	3:40pm	-0.6	Dec 23 Thu	4:53pm	-1.2
Oct 8 Fri	4:24pm	-0.8	Dec 31 Fri	1:03pm	-0.7

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

March 11, 2010

Number:3

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The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

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PROGRAM

Pteropods and Heteropods and the Danger of Ocean Acidification Due to Increasing Carbon Dioxide

Dr. Victoria Fabry, a biological oceanographer at the University of California Santa Barbara, has been focusing her research on the sensitivity of calcareous

organisms, such as the planktonic molluscan pteropods and heteropods, and marine ecosystems to elevated carbon dioxide and ocean acidification.

Meeting date: March 18, 2010

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<i>Hyotissa meginyi</i> (Bivalvia, Gryphaeidae) from two islands in the Leeward Islands, Lesser Antilles, West Indies, with notes on the genus. SUSAN J. HEWITT	31
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CLUB NEWS

Minutes of the San Diego Shell Club Meeting 18 February 2010

The meeting was called to order by President Benjamin Pister at 7:40 PM. The previous minutes were accepted as published in *The Festivus* and the treasurer's report was presented. The corresponding secretary had nothing to report.

Announcements: The Club's auction is scheduled for Saturday April 17th so save that date.

George Kennedy reminded members that the WSM (Western Society of Malacologists) is having a joint meeting with the AMS (American Malacological Society) this June 26-30, 2010 in the Conference Center at San Diego State University.

Judging day for The Greater San Diego Science Fair is March 23rd and two additional volunteers are needed to help the Club judge senior division projects related to ocean life. Please contact Benjamin Pister to offer your help < benjamin.pister@gmail.com > .

Wendy Enright spoke to the Club regarding mollusk diversity off San Diego as a function of depth. The results presented are from sampling conducted by the city of San Diego. The sampling is part of the evaluation of benthic environments that may be impacted by the outfall, which discharges at a depth of 98 meters. Samples were collected from the mid shelf (30-120 m), deep shelf (120-200 m), upper slope (200-500 m) and the lower slope (>500 m). Data were generated at randomly selected points and selected based on the characteristics of the sediment. On the mid shelf bivalves were the most diverse (58 species) followed by gastropods, scaphopods and Aplacophora. Diversity and abundance decreased with depth and scaphopods and Aplacophora made up a proportionally larger percentage of the species present. On the lower slope only 16 species of bivalves were found. Wendy illustrated the commonly found species in each of the groups from the mid shelf to the lower slopes. A good presentation with excellent graphics.

The meeting was adjourned at 8:50 PM for social time and refreshments which were provided by Nancy Schneider and Wes Farmer.

An Announcement from Bob Yin

Underwater Encounters, a series of ten children's books, has just been released by the Hameray Publishing Group. "Written by author and diver Elizabeth Cook, the books are illustrated with photographs from the portfolio of underwater photographer Robert Yin. These ten entertaining and educational books are designed to bring young readers face to face with some of the most interesting ocean animals imaginable. Intriguing facts enlighten young readers about how ocean animals hide, hunt, and communicate. Appealing titles such as *Fish Tricks*, *Hide and Sneak*, and *Fish, Not Fish* entice readers to learn about fish behavior, camouflage, and what makes a fish a fish. This series is sure to inspire readers, young and old, to make a difference to the future of our oceans while educating them about the diversity of marine life."

For more information about the series of 10 books, (with about 60 color photos in each book) including how to order either call 1-866-918-6173 or Bob Yin at 858-344-2208, or check on the publisher's website at <http://www.hameraypublishing.com/underwater-encounters>

It's Almost Auction Time: April 17, 2010

Get ready for the big event – the San Diego Shell Club's annual auction/potluck!! It will be held once again at the clubhouse at Wes Farmer's condo (3591 Ruffin Road, San Diego 92123) where it has been hosted by Wes for the last 22 years. Should you need a map to the auction, please contact Carole Hertz at < jhertz@san.rr.com > .

Festivities begin at 5 PM with Dave's Punch, wine and soft drinks, giving you time to view the auction table and silent auction before the dinner which starts at 6 PM. Please remember to bring your potluck dish (main, salad, or dessert) to serve 12 (we're all big eaters). The voice auction begins promptly at 7 PM with fantastic shells. A list of the voice auction shells will be ready soon. Let us know if you wish to receive one. If you cannot attend and wish to bid, we can arrange for a bidder for you.

**HYOTISSA MCGINTYI (BIVALVIA, GRYPHEIDAE)
FROM TWO ISLANDS IN THE LEEWARD ISLANDS,
LESSER ANTILLES, WEST INDIES, WITH NOTES ON THE GENUS**

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Notes on the genus

Hyotissa mcgintyi (Harry, 1985) is a species of sessile cemented bivalve, an “oyster” in the family Gryphaeidae, the foam oysters or honeycomb oysters, so called because of the minutely foamy structure of their shells. Gryphaeidae (the foam oysters) and Ostreidae (the true oysters) are the only two families in the superfamily Ostreoidea, in the bivalve subclass Pteriomorpha.

The living species of Gryphaeidae are very few (5 or 6), and several of them are not commonly encountered, thus they are not well known to most shell collectors. However, the genera *Exogyra* and *Gryphaea* are very familiar to paleontologists because gryphaeid oysters are a major presence in the fossil record and formed a substantial part of various marine ecosystems during the Mesozoic era.

Abbott 1974 (p. 457, #5280) listed only one species in this family from the tropical Western Atlantic, *Pycnodonte hyotis* (Linnaeus, 1758), and described it as uncommon. However, Mikkelsen and Bieler (2008) list three gryphaeids, all of which they consider rare in the Florida Keys: *Hyotissa hyotis* (Linnaeus, 1758), the giant foam oyster, introduced to Florida from the Indo-Pacific; *Hyotissa mcgintyi* (Harry, 1985), the Atlantic foam oyster; and *Neopycnodonte cochlear* (Poli, 1795), the deep-water foam oyster.

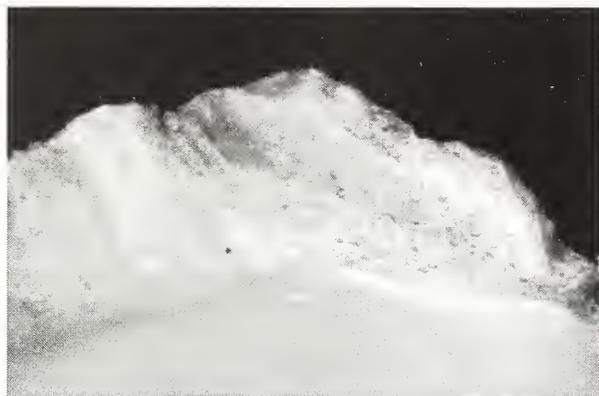
Hyotissa mcgintyi is indigenous to the Caribbean faunal zone. Lee (2009) records this species (as *Parahyotissa mcgintyi* Harry, 1985) occurring at 60 and 85 ft. depths off Mayport, in northeastern Florida. Apparently the species is quite common on hard substrates in some parts of the Gulf of Mexico (Bieler, Mikkelsen, Lee, & ÓFoighil, 2004). Malacolog 4.1.1 (Rosenberg, 2009) lists this species from eastern Florida, the Bahamas, Cuba and Brazil. Mikkelsen and Bieler (2008:114) give the distribution as North Carolina to Florida, Bermuda, the West Indies, Gulf of

Mexico, the Caribbean coast of Central America, and South America (Colombia and Brazil). They did not give any details, so it is not possible to know whether “West Indies” is based only on records from Cuba which is one of the Greater Antilles, or whether they were also able to find records from the Lesser Antilles.

Both valves of one shell from Key West are illustrated in Mikkelsen & Bieler (2008:114), in which the authors describe the exterior color of the shell as ranging from cream to lavender and the interior as being cream, pinkish or light brown. They give the size range as up to 10 cm, describe the shell as equivalve, and give the shape of the outline of the valves as circular to D-shaped. Unlike the adductor muscle scar in the Ostreidae, the scar in this species is more or less circular, and is situated closer to the hinge line than to the margin. Both valves of a shell from Grand Bahama Island (ANSP 371816) are shown in Rosenberg (1992: 138) as the lower of the two images of “*Hyotissa hyotis*.” A good image of the interior of a valve is shown in Abbott & Morris (1995: 25, no. 5) as “*Parahyotissa mcgintyi*.”

Under magnification, *Hyotissa* and most other gryphaeids show a foamy (vesicular) shell structure (Text figure 1). This is diagnostic for the family and is visible even in a fragment that is old and worn. The vesicles of this foam-like structure in *Hyotissa* are very small, evenly sized, and closely packed. The foam structure exists throughout the shell, except for the very thin outer surface and most of the inner surface of the shell, where there exists a relatively thin lamellar shell layer. The foam structure shows on the outside of the shell if it has been chipped *post mortem*, and is visible on the inner surface where the edge is growing at the shell margins (Text figure 1).

Many of us have seen mollusk shells riddled with countless holes created by “boring sponges” in the phylum Porifera, family Clionidae. However, boring



Text figure 1: A close-up of the inner margin of the 56 mm valve of *H. mcgintyi* showing the foamy structure. Image by Dick Kenney.

sponges excavate galleries, not closed spherical, bubble-shaped spaces. Sponge galleries are not a closely-packed array, and the diameter of the galleries is usually considerably larger than the diameter of the foam vesicles in the shells of *Hyotissa*.

Observations

I have been studying the marine molluscan fauna of the Caribbean island of Nevis, Leeward Islands, West Indies (Map 1), in brief annual visits starting in the spring of 1997. My studies have been based almost entirely on beach drift. From 2000 to 2004 I found a few fragments of oyster valves that were a reddish purple on the outside, and whitish within. The identity of the species was a mystery to me; at that time I did not know to look closely at the structure of the shell. One or two people to whom I showed the fragments thought that they might just be pieces of round valves of the very common Caribbean true oyster *Dendostrea frons* (Linnaeus, 1758), but I was unconvinced.

An article of mine was published by the Nevis Historical and Conservation Society's newsletter in 2002, and as a result I made e-mail contact with Dick Kenney of Massachusetts. He is a shell enthusiast who visits Nevis each year in January, whereas I visit in late April and early May. Over the years Dick has sent me many images, asking me to confirm or suggest identifications. In 2005 he e-mailed me two views of a 56 mm, fairly fresh, intact valve of an "oyster" species with a dark purplish-red outer surface (Plate 1, Figure 1). He had found that valve, and another much smaller and very worn valve, in beach drift on the southeastern (Atlantic) side of Nevis in January 2005. I realized that this shell was something interesting, so I showed the



Map 1. Map of the eastern one third of the Caribbean Sea, including part of the Greater Antilles and all of the Lesser Antilles. An inset shows four of the islands in the inner arc of the northern Leeward Islands.

images to Dr. Paula Mikkelsen, who was then curator of mollusks at the AMNH. She told me to ask the collector to take a close-up view of the inner surface of the valve, near the margin. Sure enough, the close-up showed the foam-like structure (text figure 1). The shell was a valve of *Hyotissa mcgintyi*, and Paula told me, "That's a good find."

During my annual visits to Nevis from 2005 to 2007 I succeeded in finding a few fragments and extremely worn small valves of *Hyotissa mcgintyi*, and came to realize that on Nevis, any really thorough search of a beach that had a large amount of drift would usually yield at least a fragment of a shell of the species.

On October 16, 2008 Nevis was brushed with the edge of Hurricane Omar. An area on the west coast just north of the capital faced into the storm surges. The splash zone, intertidal zone and shallow subtidal zone in this area feature numerous boulders on a sand base. During the storm a lot of sand and a large number of shells were thrown up very high and became trapped between the rocks. Many of the shells were still there six months later, in late spring 2009, when I searched this part of the coastline.

I spent more than 16 hours intensively searching the drift and found approximately 38 valves of *Hyotissa mcgintyi*, whole and broken, both juvenile and adult. The juvenile valves were usually rather flat with a

smooth shell margin. One of the smaller valves and some of the larger valves had crenulate margins. The larger shells were mostly very worn, faded and chipped. The exterior color of the valves varied from a pale pinkish purple to lavender.

The largest valve is heavy and thick, and appears to be an attachment valve. It has a crenulate margin, is 73 mm across at maximum dimension, and weighs 85 grams. One part of the edge of the valve is 31 mm thick (Text figure 2). The best preserved valve is from a juvenile shell 23 mm across, and has some ligament remaining on the hinge line (Plate 1, Figure 2).



Text figure 2: Side view of the 73 mm valve from Nevis, 31 mm in thickness at this edge. Image by Susan J. Hewitt.

I am also able to confirm the presence of *Hyotissa mcgintyi* from the nearby island of Sint Eustatius (Map 1). A fairly fresh 26 mm valve with some ligament attached (Plate 1, Figure 3) was one of a small group of shells that were hand picked from the beach drift on April 13, 2008. This is reported in a separate paper included in this issue of *The Festivus*.

Hyotissa mcgintyi is present on the Caribbean and Atlantic coasts of the island of Nevis, presumably subtidally on hard substrates. In the beach drift on Nevis, valves of the species are very uncommon. The species is also present off the island of Sint Eustatius. While it is true that the marine molluscan fauna of many islands in the Greater and Lesser Antilles has not been well investigated, Gary Rosenberg's database Malacolog version 4.1.1 shows that several islands do have quite long species lists from published records. Within the Greater Antilles, Cuba has 1192 species, Jamaica has 666 species, Puerto Rico 751. In the Lesser Antilles, St. Croix, Virgin Islands has 472; Guadeloupe 288; Martinique 233; and Grenada has 202. However, except

for Cuba, none of these Malacolog lists feature *Hyotissa mcgintyi*. It is not known from which islands in the West Indies Mikkelsen and Bieler have records. This species, when alive, is well-disguised in its habitat by heavy overgrowths of encrusting organisms, and thus it can be overlooked by divers (Mikkelsen & Bieler, 2008). However, valves do wash up on Nevis and St. Eustatius after storms, and if the species were present around other islands in reasonable numbers, valves would very likely wash up there also and could be found in thorough searches of the drift.

Acknowledgments

I thank Paula Mikkelsen for identifying the first images of this species and permitting me to do museum research at AMNH for my Caribbean studies. I also wish to thank Dick Kenney for finding the first whole valve and letting me use his images of that shell. Thanks to Quentin Henderson for bringing me the group of shells which included the valve of this species from Sint Eustatius. The information from Gary Rosenberg's database Malacolog 4.1.1 is provided with permission from ANSP. The map and plate were assembled with expert help from Ron Hartley.

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Plate 1: Figures 1-3. (1) Two views of the 56 mm valve of *H. mcgintyi*. The valve has ligament attached. Images by Dick Kenney. (2) Two views of the 23 mm valve from Nevis. This valve also has ligament. Images by Susan J. Hewitt. (3) Two views of the 26 mm valve found in Sint Eustatius. This valve has ligament. Images by Susan J. Hewitt.

A THREE-MINUTE SURVEY OF THE MARINE MOLLUSKS OF THE ISLAND OF SINT EUSTATIUS, LEEWARD ISLANDS, WEST INDIES

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An introduction to the island of Sint Eustatius

Sint Eustatius, often written as St. Eustatius, and informally known as Statia, is a small (21 sq. km), narrow (approximately 8 km long and 1.5 km wide at the widest part), Caribbean island at latitude 17°30'N, longitude 62°58'W. The island is saddle-shaped in profile. It forms part of the inner arc of the northern part of the Leeward Island chain, which in turn is part of the Lesser Antilles, in the West Indies. Sint Eustatius lies directly between the island of Saba to the northwest and the islands of St. Kitts and Nevis to the southeast (Map 1).



Map 1. Map of Caribbean area with insert showing position of Sint Eustatius relative to the other islands in the Lesser Antilles. The inset shows the three islands of the northern Netherlands Antilles.

The capital of the island is Oranjestad, which is located on the southwestern coast, and the population of the island is approximately 3,000. St. Eustatius is in the Dutch kingdom. It is one of 5 islands (3 in the Leeward Islands and 2 in the southern Caribbean) that comprise the Netherlands Antilles, an autonomous state within the Kingdom of the Netherlands. In addition to St. Eustatius, the two other islands in the northern Netherlands Antilles are the very small island of Saba (13 sq. km), 27 km to the northwest; and Sint Maarten, which is the southern half of the larger island of Saint Martin (87 sq. km), 61 kilometers almost due north of St. Eustatius. The much more southerly islands that also form part of the Netherlands Antilles are Curaçao and Bonaire, off the coast of Venezuela. Previously Aruba was also part of the Netherlands Antilles, but seceded in 1986.

The coast of Sint Eustatius is mostly rugged and rocky with cliffs; this is especially so at both ends of the island, where there are hilly or mountainous remnants of volcanoes. The highest at 600 m is Mount Mazinga, aka the "Quill", at the southern tip of the island, (Text figure 1).

There are three main beaches on the island. As described on the island's tourism website, and somewhat paraphrased by me, Oranje Bay on the Caribbean side has no strong currents, no undertow, no sea urchins or dangerous fish, but the sand comes and goes, and at the present time there is very little sand. Zeelandia Beach on the Atlantic side is a deserted black and tan sand beach, more than 3 km long, with dangerous undertow, thus swimming is not recommended there, but it is ideal for sunbathing and beach hiking. Lynch Beach is a small beach also on the Atlantic side of the island, with light brown sand. The water there is shallow in spots and

good for children during certain times of year, however, stay near shore and watch out for currents and riptides.

Passenger boats and cargo boats arrive at two docks which are situated on Oranje Bay (Text figure 2). There is no government ferry service to the island, but there is an airport, and Winair (Windwards Islands Airways) flights arrive five times daily from Sint Maarten. A privately owned boat company called "The Edge" has started running boat service three times a week from Sint Maarten to Sint Eustatius, mostly via Saba. There are six small hotels, inns, or villas on St. Eustatius.



Text figure 1: Approaching Sint Eustatius from the south, visible are the volcano "the Quill" and the white limestone formation "White Wall" facing the sea. Image by Jim Johnson of Nevis.



Text figure 2: The smaller of the two docks on Oranje Bay. Image by Jim Johnson.

A variety of marine and terrestrial ecotourism opportunities are available in the Statia National Marine Park, the Quill/Boven National Park, and the Botanical Garden. These were created by the island government between 1996 and 1999 and are managed by "STENAPA", the St. Eustatius National Parks Foundation. The island is mostly known for dive tourism, but is not well known as a general tourist destination, presumably because of its relative inaccessibility and small size. Although Dutch is the official language, the residents also speak English, and often Spanish.

A National Marine Park completely surrounds the island from the high-water mark to the 30m depth contour, and collecting of both live mollusks and dead shells is prohibited within this entire area. Researchers need to apply in advance for a permit issued through STENAPA. Customs officers search bags at the airport and will confiscate items where no permit exists. In addition, any export of *Eustrombus gigas* or coral pieces specifically requires a CITES permit.

The three-minute survey

On April 13, 2008, a friend of mine, Quentin Henderson, a beekeeper and apiculture expert from Nevis, visited St. Eustatius on a day trip which is offered a few times a year by the Nevis ferry service. At the end of Quentin's visit, when he was waiting to board the boat back to Nevis, he remembered that I had said I would be interested in shells from anywhere he visited, especially St. Eustatius. Quentin had only three minutes before the boat left, but he asked two local children who were on the beach to help him find shells, and together they were able to rapidly gather 20 small shells from the beach drift right next to the main dock on Oranje Bay. Quentin described the locality as "a small area of damp sand beside rocks by the sea" (personal e-mail communication 2009). He presented me with the sample of shells when I saw him the next day.

I applied in retrospect for a general permit from STENAPA to cover this collecting event. Permission was granted and the permit was issued.

Results:

The material collected in St. Eustatius included shells of 14 species. Most of the shells are beach worn and faded. Five of the shells are shown in Text figure 3.

Gastropoda**Lottiidae:**

Tectura antillarum (Sowerby 1, 1834) – 3 shells

Fissurellidae:

Diodora listeri (d'Orbigny, 1847) – 1 shell

Fissurella rosea (Gmelin, 1791) – 3 shells

Hemitoma octoradiata (Gmelin, 1791) – 1 shell

Cypraeidae:

Luria cinerea (Gmelin, 1791) – 1 adult shell

Hipponicidae:

Hipponix antiquatus (Linnaeus, 1767) – 1 shell

Hipponix subrufus (Lamarck, 1822) – 1 shell

Bivalvia**Arcidae:**

Barbatia cancellaria (Lamarck, 1819) – 1 valve

Cucullaearca candida (Helbling, 1779) – 1 juvenile valve

Gryphaeidae:

Hyotissa mcgintyi (Harry, 1985) – one fresh valve of a 26 mm juvenile

Plicatulidae:

Plicatula gibbosa Lamarck, 1801 – fragment

Spondylidae:

Spondylus ictericus Reeve, 1856 – one valve of a 36 mm juvenile

Chamidae:

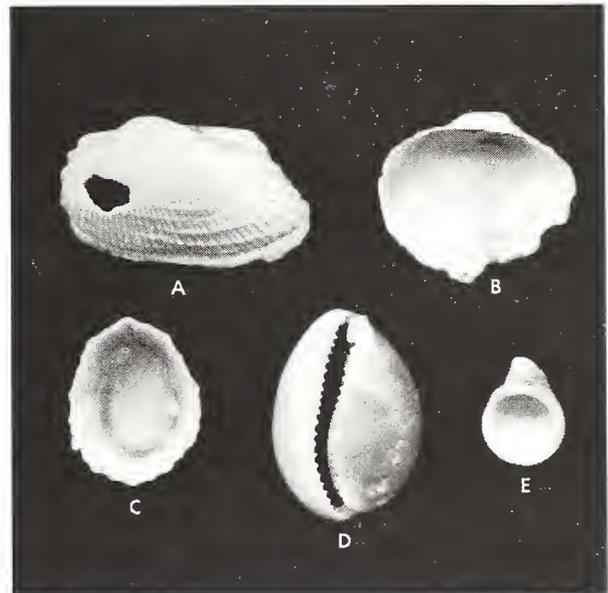
Chama congregata Conrad, 1833 – 2 small upper valves

Lucinidae:

Codakia orbicularis (Linnaeus, 1758) – one broken valve

Gary Rosenberg's online database Malacolog 4.1.1 records only one species from St. Eustatius, and that is *Caribachlamys ornata* (Lamarck, 1819), a small scallop which is a "common" Caribbean species (Abbott, 1974; Warmke & Abbott, 1961).

The current species list is what one might expect for a locality on the leeward side of an island, where there



Text figure 3: Beachworn shells of *Cucullaearca candida*, *Hyotissa mcgintyi*, *Hemitoma octoradiata*, *Luria cinerea* and *Hipponix antiquatus*, all to the same scale. Maximum dimension of largest shell: 33 mm.

is some sand, but which is nonetheless surrounded by rocky habitat. There are six limpet-like species, four cemented bivalves, two nestling bivalves, one gastropod that inhabits rocky areas, and only one infaunal sand-dwelling bivalve.

The most noteworthy species in this list is the gryphaeid foam oyster or honeycomb oyster *Hyotissa mcgintyi*, a species that is rarely collected. I have also found that species to be present on Nevis, widespread but not common in the beach drift. More detail on this species is given in a separate paper included in this issue of *The Festivus*.

Because there was previously only one record in the literature from this island, the 14 species collected in St. Eustatius are a useful addition to the knowledge of its fauna. Moreover, 14 species collected at random in three minutes from one small area of beach, by non-specialists, may predict a reasonably rich species diversity well worth investigating.

Acknowledgments

I wish to thank Quentin Henderson and the two anonymous local children of Sint Eustatius for collecting the material for me. Thanks also to Captain Arthur Anslyn M.B.E. of Nevis for information on the coastline of the island of Sint Eustatius. Thanks to Carole Hertz for encouraging me to write this paper. The information from Gary Rosenberg's database Malacolog 4.1.1 is provided with the permission of ANSP. The map and plate were assembled by Ron Hartley.

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AMS/WSM 2010 San Diego, California, June 26-July 1, 2010

As the current President of AMS, it is my pleasure to announce the exciting upcoming joint 76th Annual Meeting of the AMS and 43rd Annual Meeting of the Western Society of Malacologists (WSM). The meeting will begin with a welcome reception the evening of Saturday, June 26th, with scientific sessions held Sunday to noon on Wednesday, June 27-June 30. We are also planning options for one or more organized excursion(s) on July 1.

We are fortunate to have reserved our meeting site at San Diego State University. Their relatively new convention center is attractive and easily accessible by car or via public transportation. They have new affordable dorms with a new impressive optional meal option, also close to many affordable university district restaurants. Public transit options include a new trolley stop immediately adjacent to the convention center or a brief walk across a footbridge from the dorms. The trolley connects directly to the downtown train station and airport (search in Google maps for SDSU Transit Center, San Diego), and also provides convenient direct access to outstanding restaurants and bars in famous Old Town, San Diego. The meeting will be affordable for students and close to world class ocean beaches and other well known attractions that make San Diego such a popular destination to visit.

The scientific sessions are always great when AMS and WSM meet jointly on the West Coast. Dr. Peter Marko

from Clemson University and Dr. Alan Kohn Professor Emeritus University of Washington are organizing an AMS-sponsored symposium on *Biogeography of the Pacific*. An impressive line-up of speakers have agreed to present their research on Pacific molluscan biogeography on June 29. This symposium and associated contributed papers and poster sessions are expected to be a memorable highlight of the meeting. Dr. Jennifer Burnaford from Cal State Fullerton is organizing a complementary special session on invasive mollusks, and Dr. Eric Edsinger-González from UC Berkeley will present a timely computer-based Student Workshop, *Genomic Tools for Molluscan Ecology and Evolution*.

Of course, we will also have the ever-popular auction, banquet, reprint sales, and other fun activities. Please plan to attend and spread the word. Contact me if you would like to ship donations for the auction. Help us to make this joint meeting a success by planning to attend, responding when the call for contributed talks and posters is announced, getting involved, and especially encouraging students and colleagues, including those from Latin American countries, to participate. If you have any questions, please feel free to contact the meeting organizers, Doug Eernisse (deernisse@fullerton.edu) or WSM President, Dr. George Kennedy (gkennedy@bfsa-ca.com). See you in San Diego!

Doug Eernisse, Professor of Biology, Cal State Fullerton

IN REMEMBRANCE OF MARGARET MULLINER 1926 - 2010

Margaret Maughan Quirk was born in Philadelphia, Pennsylvania on January 20, 1926. Her family later moved to the San Diego area where she attended San Diego State College and met her future husband, David K. Mulliner. She and Dave were married in 1947 and Margaret received her BA from San Diego State in June of 1950. Margaret (aka Peg, Peggy and Peggetha) was a mother and homemaker all her married life, raising four children – Stephen, Bruce (deceased), Donna and Paul. She was an avid reader and worked for a time at the local Public Library. She was also an active member of the San Diego Shell Club from 1965 until she became too ill to attend meetings, and served as its treasurer off and on for 15 years. Many of the shell books from the Mulliner's fine library were donated to the Club by Margaret.

Peg and Dave were great Baja-files. They traveled and camped throughout Baja for many years. Margaret would tell how, in their early years together, they traveled everywhere with her on the back of Dave's motorcycle. Later, after we (Jules and I) met them and became friends, we often traveled together to Baja. By then the Mulliners were traveling in their camper. Since Jules and I had no camping gear we all (Dave, Peg, their kids and Jules and me with our two daughters) squashed into the Mulliner's camper. Some of us slept outside and the rest slept in layers inside. Meals were delicious, sometimes fresh fish for breakfast given to us by a fisherman) and VERY casual. Often we'd all drive in the pickup truck (the camper having been separated during our stay) through the desert to great shell collecting areas – leaving in the dark early mornings and arriving at low tide as the sun woke up. We had many adventures together in Baja, most marvelous – some harrowing – but all wonderful if the shelling was good. Our afternoons would usually be spent sorting and cleaning our treasures and trying to identify our finds – or maybe napping. Then, of course, there were night low tides but that is another story.

Later on Margaret tried her hand at writing up some of her shelling adventures (see column 2). She became very interested in minute shells and enjoyed sorting them under the microscope and struggling, like the rest of us, with the identifications. Epitoniums were one of her favorite families.



Margaret at a San Diego Shell Club Christmas Party.

Margaret died peacefully in her sleep at home on February 13, 2010. She is survived by sons Stephen and Paul, daughter Donna, three sisters and four grandchildren. We will miss her.

Publications of Margaret Mulliner in *The Festivus*

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

April 8, 2010

Number: 4

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 Overseas (air mail):\$50.00; Mexico/Canada (air mail):\$30.00.
 Address all correspondence to the San Diego Shell Club, Inc., c/o
 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM.
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PROGRAM

COME TO THE AUCTION/POTLUCK
 SATURDAY APRIL 17TH

(There will be no regular meeting this month. For further information,
 contact Carole Hertz at 858-277-6259 or e-mail at <jhertz@san.rr.com>.)

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CLUB NEWS

Minutes of the San Diego Shell Club Meeting 18 March 2010

The meeting was called to order at 7:45 PM by Benjamin Pister, President. The previous minutes as published in *The Festivus* were approved as written. VP Jules Hertz reminded everyone that the Shell Club auction will be held in April in place of the monthly meeting. Silvana Vollero gave the treasurer's report. Marilyn Goldammer, librarian thanked Bob Dees for donating a copy of *Between Pacific Tides* to the Club library.

The sign up lists to bring treats to the meeting and food to the auction were circulated. Carole Hertz reviewed the schedule and needed help for the April Auction (for more information see below).

The March Speaker was Dr Victoria Fabry from the University of California at San Marcos. She discussed ocean acidification and the impact it has on pteropods. Ice core data from the past 800,000 years show the atmospheric carbon dioxide (CO₂) has never exceeded 280 ppm. Atmospheric concentrations of CO₂ are currently 388 ppm and that has significant implications for the oceans pH, as increased CO₂ lowers the pH.

Reduction in pH has a significant impact on increased solubility of calcium carbonate which is used by corals, mollusks, foraminifers, echinoderms, and calcareous algae. Research at sites in the Mediterranean with shallow water CO₂ vents show that marine algae may benefit, but mollusks occur in low numbers, and those present have badly eroded shells. On the Pacific coast, the pH in up-welling water columns can be nearly as low. Exposure to pteropod shells at these lower pH levels causes the shells to erode quickly. The implication is that the thin shells of larval mollusks are at risk of being damaged or lost as ocean pH increases. The possible implication of changing pH on oyster spat production, pearl production, coral reefs, and decreased food resources for 'higher' organisms was discussed. If you are looking for additional information on this subject you may do a search for papers written by Dr. Fabry, or use the key words Ocean Acidification.

The meeting was adjourned at 8:50 PM for social time and refreshments which were provided by Marty Schuler and Paul Tuskes.

Paul Tuskes

Report on the Bay Area Malacologists Meeting March 20, 2010

The 34th meeting of the Bay Area Malacologists took place at the newly reconstructed California Academy of Sciences on March 20, 2010, the first meeting since 2003. Fifteen malacologists were in attendance. Terry Gosliner of the Academy's Department of Invertebrate Zoology & Geology discussed the facilities and, together with Academy post-doc Rebecca Johnson, gave a tour of the department and its collections.

Carole Hickman of the University of California, Berkeley (UCB), discussed her work on the microgastropods that have been assigned to the Skeneiidae, particularly the genus *Crosseola*. Erin Meyer, a student of Hickman, reported on her work on human exploitation of Caribbean populations of the large intertidal gastropod *Cittarium pica*. Matthew James of Sonoma State University discussed his continuing work on the California Academy of Sciences expedition to the Islas Galápagos in 1905-1906. Neil Fahy, an Academy Research Associate, illustrated rodent predation on the Caribbean gastropod *Cerion*. Eric Gonzales of University of California, Santa Barbara, discussed the genomics of *Lottia* and its implications for the study of gastropod development. James H. McLean of the Los Angeles County Museum of Natural History gave an update on the three books he has nearing completion, one on the Liotiidae, including the subfamilies Liotiinae and Areneinae, and two on the gastropods of the northeastern Pacific. Eugene V. Coan, an Academy Research Associate, noted the book soon to be completed on the Panamic bivalves (with Paul-Valentich-Scott of the Santa Barbara Museum of Natural History), as well as an issue of *Malacologia* in press that will have a catalogue and a reclassification of the families of the Bivalvia. Barry Roth, an Academy Research Associate, discussed his work on the taxonomy of the land-snail genus *Oxyloma*.

Also in attendance were Mike Kellogg of the City of San Francisco, Heidi Weiskel and April Ridlon of U.C. Davis, Jessen Bredeson of UCB, and Jonathan R. Hendricks of San Jose State University.

Gene Coan

SHELL MICROSTRUCTURES IN EARLY MOLLUSKS

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Abstract: Shell microstructures in some of the oldest known mollusk fossils (from the early to middle Cambrian Period; 542 to 510 million years ago) are diverse, strong, and in some cases unusual. We herein review our recent work focused on different aspects of shell microstructures in Cambrian mollusks, briefly summarizing some of the major conclusions from a few of our recent publications and adding some new analysis. Overall, the data suggest that: (1) mollusks rapidly evolved disparate shell microstructures; (2) early mollusks had a complex shell with a different type of shell microstructure in the outer layer than in the inner one; (3) the modern molluscan biomineralization system, with precise control over crystal shapes and arrangements in a mantle cavity bounded by periostracum, was already in place during the Cambrian; (4) shell microstructure data provide a suite of characters useful in phylogenetic analyses of mollusks and mollusk-like *Problematica*, allowing better determination of the magnitude of disparity during the Cambrian as well as understanding of how the body plans of extant phyla were built through time; (5) calcitic semi-nacre, a type of shell microstructure characteristic of brachiopods and bryozoans, occurred in Cambrian mollusks, suggesting a deeper level of homology in the shells of these lophotrochozoan taxa; and (6) laminar shell microstructures, which are the strongest (most fracture resistant) but most energetically expensive and slowest to build, were common in Cambrian mollusks, suggesting predation was a powerful selective force at that time and providing additional evidence that the origin of mobile predators was a contributing cause of the Cambrian diversification event (Cambrian explosion) and the appearance of mineralized skeletons.

Introduction

The rapid diversification of animals beginning around 542 million years ago was one of the most significant events in the history of life. This event, known as the “Cambrian Explosion,” is characterized by the independent appearance and rapid diversification of shells in many animal lineages (Bengtson & Conway Morris, 1992). The Cambrian explosion is the time when most fossilizable phyla first appear in the fossil record and when most phyla first develop mineralized skeletons. Although there have been significant advances over the past few decades in our understanding of this interval, we are far from knowing the causes of the event or its detailed pattern.

One of the more prominent hypotheses about the Cambrian explosion is that it was caused by the onset of predation, which likely drove adaptation in various

lineages towards diverse defensive solutions. The evidence is limited but overall is consistent with this hypothesis, including the following supporting observations: (1) the earliest signs of predation occur at the base of the Cambrian or just before (Bengtson & Zhao, 1992); (2) many different types of fossil evidence of predation have been recovered from Cambrian rocks, including predatory appendages on fossil arthropods (Whittington & Briggs, 1985), drill holes (Conway Morris & Bengtson, 1994), bite marks (Conway Morris, 1998), ingested prey preserved in the digestive tract of predators (Whittington, 1985), and healed shell scars (Skovsted et al., 2007); and (3) shells, thought by many to be primarily a tool of defense (Vermeij, 1987), appeared in many different animal lineages during the Cambrian explosion (Bengtson & Conway Morris, 1992) and were made of diverse components and had different microstructures (Bengtson & Conway Morris,

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1992), and so likely evolved independently in many clades. Nevertheless, in spite of this preliminary support, the hypothesis that predation was a major driving force of the Cambrian explosion is still disputed.

The Cambrian Period is also characterized by many problematic taxa ("Problematica" or "Incertae sedis", class uncertain) that cannot easily be classified into modern groups of animals. Gould (1989) emphasized such taxa in his popular book *Wonderful Life: The Burgess Shale and the Nature of History*, wherein he inferred much higher morphological disparity (i.e., many more phyla, more basic anatomical designs) of animals in the Cambrian than later in Earth history. By this logic, many of the problematic fossils in the Cambrian are members of phyla that went extinct by the end of the Cambrian. The title of the book was a reference to the 1946 movie, *It's a Wonderful Life*, because Gould (1989) envisioned contingency in the history of life: by his reasoning, if you re-ran the tape of life (i.e., a "do over" in schoolyard speech), different groups of animals would go extinct during the Cambrian, and our planet would have a very different fauna, with perhaps no vertebrates and probably no humans. Conway Morris (1998) strongly objected to Gould's reasoning, pointing out the commonality of convergent evolution throughout the history of life and suggesting that lineages will be pulled towards certain forms by natural selection. Convergent evolution is the phenomenon where distantly related lineages independently evolve similarities in form as a result of adaptation to similar environments (e.g. torpedo shape with fins in dolphins, sharks, and ichthyosaurs — an extinct group of reptiles). Gould (2001) was unconvinced by Conway Morris' argument, seeing no inevitability in evolution or the survival of vertebrates or humans, and maintained his opinion on contingency. Meanwhile, Gould's (1989, 2001) claim of higher disparity during the Cambrian was disputed by researchers who used multivariate morphospace analyses to try to quantify disparity in arthropods and priapulids, noting that disparity by these measures was about the same in the Cambrian as today (Wills, 2001). However, Gould (1989) emphasized disparity among, not within, phyla, so it is unclear to what extent the results reported by Wills (2001) bear on Gould's hypothesis.

Since the publication of Gould's *Wonderful Life*, a number of previously problematic fossils have been assigned to the stem lineages (Figure 1) of modern phyla, although numerous fossils from the earliest assemblages of animals remain problematic. While some

of these are likely members of extinct phyla, as Gould suggested, many of these still problematic fossils are probably members of a stem lineage of an extant phylum, and as such are critical in understanding the early evolution of animal morphology (cf. Budd, 2003). The body plans of extant phyla were built in a piecemeal manner through time, and understanding which fossils are members of which extinct stem lineages can help us understand how the body plans of extant taxa originated (Figure 1). Moreover, understanding which of these fossils are not members of stem lineages of extant phyla will help us better assess the extent of phylum-level disparity in the Cambrian, allowing improved testing of Gould's (1989) hypothesis of higher Cambrian disparity.

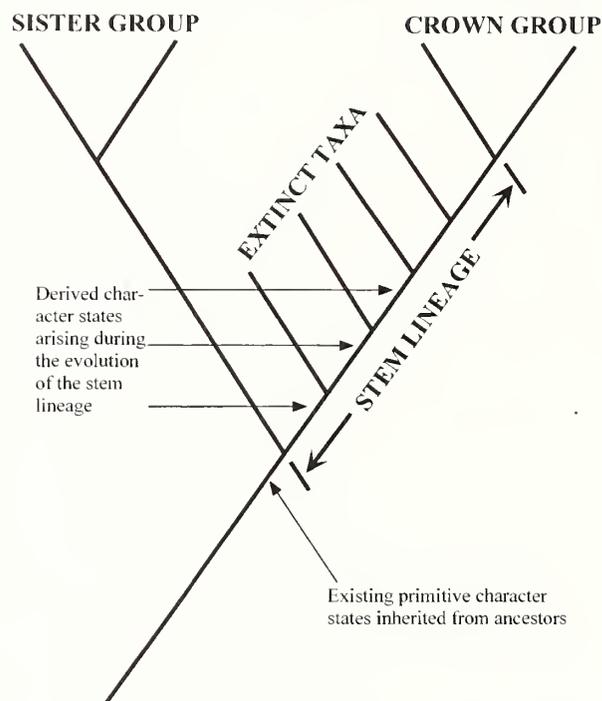


Figure 1. The character states that define the crown group of a taxon are likely to have arisen in a piecemeal manner. The crown group is defined as the last common ancestor of all living members of a taxon of interest (e.g., Mollusca) and all of its descendants. The stem lineage is comprised of any taxa outside the crown group that are more closely related to the crown group than they are to the most proximal extant outgroup (i.e., the sister group). The basal taxa of a stem lineage would therefore be expected to share only some of the characters uniting the crown group. They would lack any apomorphies (derived character states) arising in any members more closely related to the crown group. (Diagram modified from Budd, 1998.)

Mollusks occur in many of the early animal fossil assemblages and clearly began to diversify in the early

Cambrian. Most of the earliest (early Cambrian) shelled mollusks were univalves with slight coiling but some had shells with greater coiling and others were bivalves (Figure 2). The relationships among these earliest mollusks remain controversial because there are so few characters that are well known from their fossil shells. Pioneering work by Bruce Runnegar (1985) revealed that phosphatic molds of Cambrian mollusks (internal or external coatings of the shell) preserve details of their

shell microstructure (the shape and arrangement of mineral crystals in the shell) in sub-micrometer detail. Runnegar showed that coatings on the inner shell surface of secondary calcium phosphate – probably precipitated as a result of bacterial decay shortly after the death of the animal (Lucas & Prévôt, 1991) – could preserve imprints of shell microstructures in both inner and outer shell layers (Figure 3). The nature of the shell microstructure contributes to the beauty and strength of

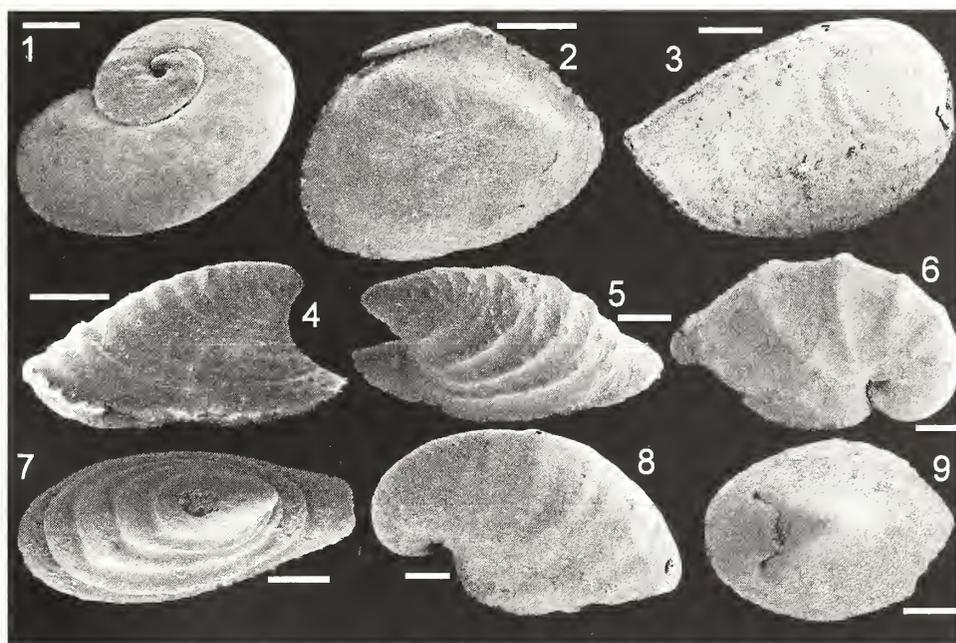


Figure 2. Some Cambrian mollusks (1-8) and a mollusk-like problematic fossil (9). All specimens are calcium phosphate internal molds. 1, *Aldanella*, early Cambrian, Siberia. 2, *Pojetaia*, early Cambrian, Australia. 3, *Watsonella*, early Cambrian, Siberia. 4, *Mellopegma*, middle Cambrian, Australia. 5, *Paraisanella*, early Cambrian, Australia. 6, *Oelandiella*, basal Cambrian, Siberia. 7, *Mackimmonia*, early Cambrian, Australia. 8, *Anabarella*, early Cambrian, Siberia. 9, *Emarginoconus*, early Cambrian, Siberia. All scale bars 200 μ m.

the mollusk shell, and provides information about the underlying process of biomineralization. Shell microstructure is rarely preserved in Early Paleozoic fossils, and so Runnegar's work revealed a new suite of potential characters that could be used to better understand the degree of diversification, phylogeny, and shell strength of the early mollusks. In spite of the great potential, little analysis has been done since on shell microstructures in Cambrian mollusks outside of major contributions made by Kouchinsky (1999, 2000).

Modern mollusks have remarkably variable shell microstructures (Figure 4), with a greater number of types of shell microstructure than in any other animal phylum (Carter, 1990). Moreover, Carter and Clark (1985) inferred that mollusks have a greater ability to

control crystal shapes and arrangements compared with other skeletonized phyla. Runnegar (1985) documented that some of the more common varieties of shell microstructure in modern mollusks (e.g. crossed lamellar, prismatic, nacre, foliated calcite) also occurred in Cambrian forms. His results suggested the shells of mollusks by the middle Cambrian had already diversified at a microstructural level, although the detailed pattern of evolution of shell microstructures in the earliest mollusks is still unclear.

The continuing goal of our work is to better document the distribution of various shell microstructures in Cambrian mollusks (Vendrasco et al., 2010), so that details of the earliest evolution of molluscan biomineralization can be deciphered. The

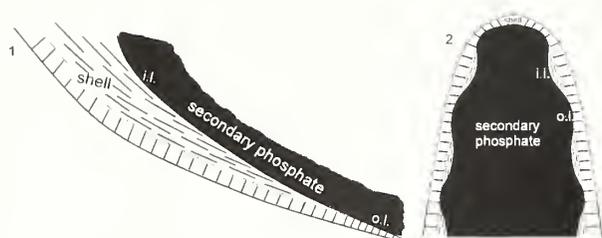


Figure 3. Two different ways that the outer layer of shell microstructure can be preserved in an internal mold. 1, side view of a radial section of a typical mollusk shell that thins out at the distal (lower right) margin. External surface of shell facing down, inner surface and internal mold of calcium phosphate facing up. 2, cross-sectional view of a mollusk with pronounced inner ridges — the phosphatic inner mold in this case replicates the outer layer of shell microstructure in the troughs on the inner part of the shell (corresponding to “ridges” on the internal mold). Such preservation is seen in Cambrian mollusks such as *Mackinnonia*. Key: i.l. = region of internal mold where the inner layer of shell microstructure can be replicated; o.l. = region of internal mold where outer layer of shell microstructure can be replicated. Gray line shows boundary between outer and inner shell layers.

shell microstructure data can serve as a source of phylogenetically useful information to help determine affinities of early animal Problematika (Vendrasco et al., 2009), work that has implications for the magnitude of the Cambrian explosion as well as the macroevolution of modern animal groups. Finally, the data can provide evidence to test the hypothesis that predation drove the evolution of early animal skeletons.

Materials and Methods

New cases of shell microstructure in Cambrian mollusks were documented from newly and previously collected rocks from the early Cambrian of Australia, Siberia, and China, and the middle Cambrian of Australia. Detailed descriptions of the localities and processing of specimens are provided in Vendrasco et al. (2009, 2010). The fossils were isolated from the enclosing limestone matrix by ~10% buffered acetic acid. The fossils were then sorted and placed on Scanning Electron Microscope (SEM) stubs. These stubs were gold coated and examined on Scanning Electron Microscopes at the Santa Barbara Museum of Natural History, the Swedish Museum of Natural History, and the Nanjing Institute of Science and Technology.

Results and Discussion

We found many new occurrences of preserved shell microstructure in over twenty species of early and

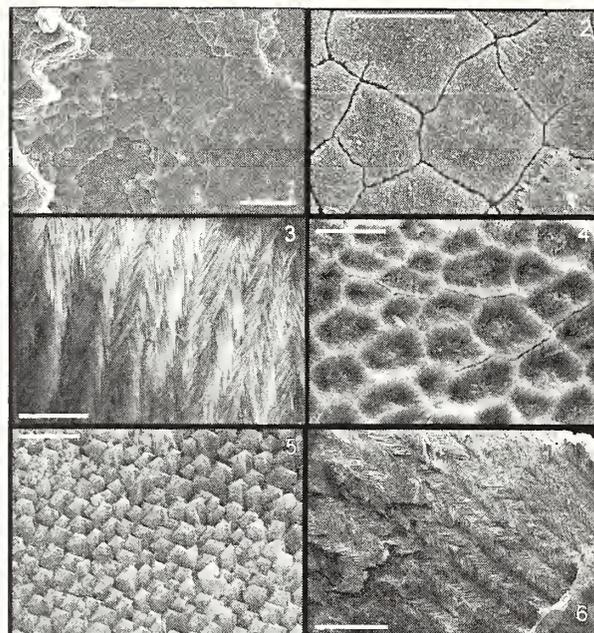


Figure 4. Some of the more common varieties of shell microstructure that occur in extant mollusks. 1, nacre, *Haliotis cracherodii*, horizontal section (parallel to shell surface), image shows numerous thin laminae, scale bar = 20 μm . 2, nacre tablets of aragonite in *Haliotis cracherodii*; grooves bordering tablets represent spaces where organic molecules had been. Scale bar = 5 μm . 3, crossed lamellar shell microstructure, *Lottia digitalis*, horizontal section, scale bar = 20 μm . 4, prismatic shell microstructure near valve margin in *Donax gouldii*, shell treated briefly with dilute acetic acid, horizontal section, scale bar = 20 μm . 5, simple calcitic prismatic, *Mytilus californianus*, horizontal section, scale bar = 5 μm . 6, spherulitic (aragonitic) prismatic, tangential section (perpendicular to shell surface), *Donax gouldii*, scale bar = 100 μm .

middle Cambrian mollusks (Vendrasco et al., 2009, 2010, personal observations). In addition, we have re-assessed cases of shell microstructure described and/or photographed in the literature in order to improve estimates of temporal and phylogenetic patterns of shell microstructures in Cambrian mollusks. We are continuing and expanding this work in a broad synthesis paper to come, but our initial results and interpretations are summarized below.

Our studies have added to the known diversity of types of shell microstructures in Cambrian mollusks (Figure 5; Table 1). In addition to the varieties that Runnegar (1985) listed, we also found numerous mollusks with calcitic semi-nacre (Figure 5.2, 5.4) and others with lamello-fibrillar (Figure 6.2) shell microstructures. More recent unpublished work (MJV and Antonio Checa) has revealed the occurrence of

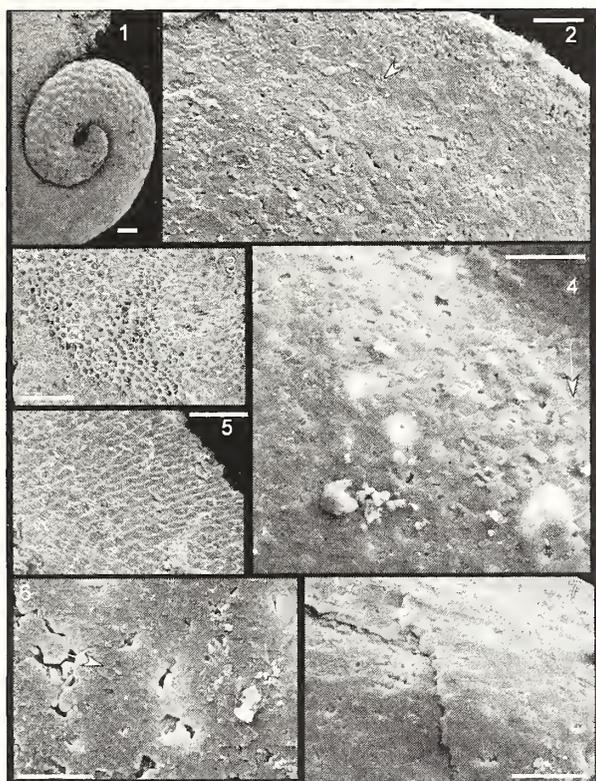


Figure 5. Shell microstructures in Cambrian mollusks. 1, *Aldanella*, early Cambrian, Siberia. Prismatic shell microstructure. Scale bar = 100 μm . 2, *Mellopegma*, middle Cambrian, Australia. Calcitic semi-nacre. Arrow shows location of a complete calcite rhomb. Scale bar = 10 μm . 3, *Mackinnonia*, early Cambrian, Australia. Prismatic. Scale bar = 50 μm . 4, *Anabarella*, middle Cambrian, Australia. Calcitic semi-nacre. Arrow shows location of a complete calcite rhomb. Scale bar = 20 μm . 5, *Pojetaia*, early Cambrian, Australia. Prismatic (Runnegar, 1985) or large tablet nacre (Carter, 2001). Scale bar = 50 μm . 6, *Ribeiria*, middle Cambrian, Australia. Laminar microstructure, possibly calcitic semi-nacre. Arrow shows imprint of the ends of crystal tablets. Scale bar = 10 μm . 7, *Eotebenna*, middle Cambrian, Australia. Foliated calcite. Scale bar = 20 μm .

foliated aragonite in the earliest bivalves. Our results add support to the idea that even though molluscan shells may not have been very diverse in overall form or external ornament, these similarities belie the pronounced underlying variation at a microstructural level.

The diversity of shell microstructures in the earliest mollusks (Table 1) suggests one of two scenarios: (1) many groups of mollusks originated shells independently of each other, and the precise method of biomineralization evolved differently between groups; or

(2) conchiferans very quickly diversified in their mechanisms of biomineralization soon after the shell originated in one or a few groups of mollusks. We favor the latter hypothesis because of the similarities in the shell and its basic structure among conchiferans (e.g., all have periostracum, and many have prismatic shell microstructure in the outer layer). Prismatic shell microstructure may be the most primitive type of shell microstructure in mollusks (Runnegar, 1985); new evidence in support of this hypothesis includes its occurrence in the earliest known mollusk *Oelandiella* and that it is the most commonly preserved variety of shell microstructure in early Cambrian mollusks (personal observations). Prismatic shell microstructure is common in the outer shell layer of modern mollusks, where the polygonal network of the periostracum serves as a template for isotropic nucleation of crystals that grow to merge together and then grow inward, forming the prismatic pattern (Checa, 2000). Other early Cambrian mollusks, younger than *Oelandiella*, show more diverse types of shell microstructure, including crossed lamellar (Runnegar *in* Bengtson et al., 1990), calcitic semi-nacre (Vendrasco et al., 2010), lamello-fibrillar (Feng & Sun, 2004; Vendrasco et al., 2009), foliated calcite (Runnegar, 1985), foliated aragonite (unpublished observations, MJV and Antonio Checa), and many types of unusual shell microstructures that are difficult to classify (Kouchinsky, 1999; Carter, 2001; Vendrasco et al., 2010). This rapid diversification of shell microstructures and hence specific biomineralization methods suggests that: (1) mollusks may have been experiencing selective pressure to modify their types of shell microstructure; and (2) the very earliest mollusks had the genetic framework to rapidly evolve different microstructures that would better suit them to their environment (although after the initial diversification, shell microstructures appear to have become more entrenched — see discussion below on utility of shell characters in phylogenetic analyses).

Our research has also shown that many of the early molluscan shells were complex, with each shell containing multiple types of shell microstructure. Runnegar (1985) demonstrated that this is true for *Mellopegma georginensis* from the middle Cambrian of Australia, and we have discovered many more cases from the middle Cambrian (Vendrasco et al., 2010) and early Cambrian (personal observations). In internal molds the imprints of the outer layer of shell microstructure are preserved at the shell margin or in

regions of internal troughs in the shell, where the shell thins out (Figure 3). Commonly the outer shell layer is prismatic and the inner layer is laminar, a typical pattern for modern mollusks, in particular extant monoplacophorans (McLean, 1979; Bouchet et al., 1983; Warén & Bouchet, 1990; Warén & Hain, 1992; Warén & Gofas, 1996). The commonality of a complex shell with different types of shell microstructure in outer and inner layers suggests that the modern method of molluscan biomineralization was present already in the earliest representatives. In particular, the precipitation of the outer shell layer was likely controlled by the periostracum as in modern mollusks, with crystals nucleating at equally spaced locations on the inner surface of the periostracum and growing together to form a prismatic structure, and the underlying shell layer was precipitated within the mantle cavity (Checa, 2000). Preservation of the periostracum is rare in Paleozoic mollusks, but a few early and middle Cambrian mollusk specimens contain a layer replicated by phosphate that covered the shell (e.g., Gubanov et al., 2004, figs. 5n, 6s, 9g-h), and we interpret those structures as replaced periostracum.

Our work has also revealed a remarkable level of control over the orientation of crystals within the shell, with a consistent orientation of crystal tablets throughout shell layers of many Cambrian mollusks (Figure 5). In these mollusks, the crystal tablets in the shell are oriented in the same way throughout the layer (Figure 5.2, 5.4-7), with particular crystal faces consistently aligned in the same direction. This is true from specimen to specimen of the same species (Vendrasco et al., 2010). Rather than the haphazard arrangement of crystals that one might expect given that these are among the earliest shell-forming mollusks, the evidence suggests that quickly in the evolution of the molluscan shell these organisms evolved precision in control over which mineral was deposited in the shell, how the nascent crystals were oriented, and which crystal faces grew at what rates.

While the presence of highly diverse, evolutionarily flexible, precisely controlled shell microstructures may at first seem to explain why mollusks came to dominate many marine environments, it should be remembered that brachiopods, with their apparently simpler method of biomineralization (*sensu* Carter & Clark, 1985), were more common than mollusks through most of the Paleozoic Era (540 to 250 million years ago). In any case this refined ability in mollusks to control biomineralization and to evolve a more suitable type of shell microstructure for a particular environment

appears to have helped them survive the extinctions of the Paleozoic and evidence from the fossil record suggests this ability gave them an advantage over other prey when larger shell crushing predators became common during the Mesozoic Era (250 to 65 million years ago) (Vermeij, 1987).

Our work has also shown that laminar shell microstructures were common in early mollusks (Vendrasco et al., 2010). The most famous type of laminar shell microstructure is nacre, a type of microstructure composed exclusively of the mineral aragonite. Nacre is widely considered to be the most fracture-resistant type of shell microstructure, many times stronger than bone (Currey, 1990). Nacre consistently outperforms other types of shell microstructures in strength tests, especially in tensile, compressive, and bending strength (Taylor & Layman, 1972; Currey, 1988). The great strength of nacre allows *Nautilus*, with gas-filled internal shell chambers, to inhabit depths of over 500 meters with just a thin shell (Runnegar, 1990). This shell microstructure appears to owe its great resistance to breakage in part to the fact that the crystal elements are largely embedded in organic matrices, making it more difficult for cracks to propagate through the shell (Taylor & Layman, 1972; Jackson et al., 1988; Currey, 1990, 1999; Smith et al., 1999). For a crack to propagate through nacre, it must be transmitted from layer to layer; the organic sheaths surrounding nacre tablets help to prevent this by absorbing much of the energy as they shear (Currey, 1990). Nacre is a slow and energetically expensive type of shell microstructure to form (Palmer, 1983, 1992; Currey, 1988), with each thin horizontal lamina requiring the molecular construction of an interlamellar organic membrane via chitin molecules which then become covered by proteins secreted into the extrapallial space, followed by aragonite nucleation and crystal growth to fill out the layer (Cartwright & Checa, 2007). This process gets repeated as the nacre is built upward, lamina by lamina. In fact, Currey (1977) argued that nacre is not suitable for shells that must be built quickly, as much of its strength comes from the precise geometric arrangement of tablets within the organic framework. This slow, energetically expensive type of shell microstructure is not one that would be expected to evolve unless there is a strong selective advantage for it (Palmer, 1983, 1992). With shell-crushing predators present in an environment there is such an advantage.

Some of the early Cambrian mollusks appear to have had foliated aragonite, a likely precursor to nacre, while others had the very similar form, calcitic semi-

nacre (Vendrasco et al., 2010), and still others had a plywood-type microstructure called lamello-fibrillar where the fibers in successive layers had different orientations (Vendrasco et al., 2010), providing greater resistance to breakage than if the fibers were oriented in the same direction throughout the shell. In the case of calcitic semi-nacre, a type of shell microstructure that has not to our knowledge been tested for fracture resistance, the overall characteristics are similar to nacre in that they consist of roughly equidimensional tablets that merge together to form thin laminae. The abundance of organic material in the shell, which gives nacre much of its strength, is difficult to accurately estimate in these fossils, but some signs point to its high abundance: (1) organic molecules are common in all modern mollusks examined, making up to ten percent of the weight of the calcified layers of the shell (Watabe, 1988); (2) many early mollusks appear to have had a large organic component to their shells, in some cases consisting of a thick organic layer in which isolated crystals were embedded (Figure 6.2, 6.4; Kouchinsky, 2000); (3) some Cambrian mollusks show a thick organic periostracum that covered the calcareous parts of the shell; and (4) the earliest mollusks prior to the origin of the shell probably had a tough organic coat that later served as template for mineral precipitation. Thus calcitic semi-nacre and the other types of shell microstructures in Cambrian mollusks probably had a high abundance of organics in the shell, and hence probably had relatively fracture resistant shells.

In addition to the evidence for strong, fracture resistant shell microstructures in the earliest mollusks, we also observed numerous cases of healed shell scars in *Mellopegma* from the middle Cambrian of Australia (Figure 6.5-6). Most of these cases of damage are preserved as indentations on the internal molds. Most signs of damage, both scars and missing regions of shell, have smooth borders, suggesting the breaks occurred and were healed during the lifetime of the animals. It is difficult to absolutely rule out a mechanical source of this damage, but a number of observations suggest that predation is the likely cause of this damage: (1) the damage occurred at highest frequency in the region of the shell with the largest aperture width and hence easiest access to the animal's flesh; (2) most cases of damage occur over broad regions, a pattern consistent with being caused by a crushing appendage, not impact from debris; (3) in many cases (Figure 6.5-6.6) the wound tapers upward toward the apex of the shell, consistent with an appendage whose force would be most concentrated at

its tip and inconsistent with mechanical damage that would produce more variation in wound patterns; (4) coprolites (fossil feces) from predators are preserved in these beds; (5) predation is the predominant cause of shell injury in modern mollusks, inferred in part by observations of mollusks in turbulent waters without predators suffering much lower rates of shell injuries than those in calm waters with predators (Vermeij, 1987); and (6) similar tiny mollusks from the early Cambrian have healed shell damage in a low-energy environment, suggesting predation was also the cause of that damage (Skovsted et al., 2007). These observations support the idea that the earliest mollusks were under strong predatory pressures, consistent with the hypothesis that the onset of predation helped drive the Cambrian explosion.

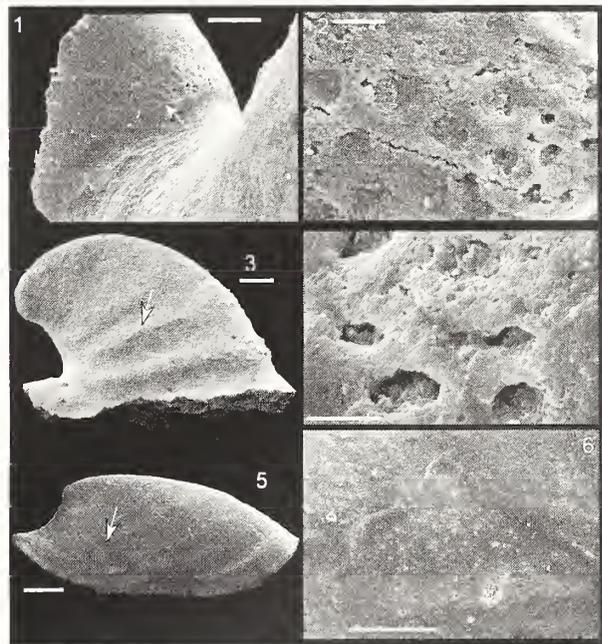


Figure 6. 1-4, phosphate-replaced thick organic sheets in the shells of *Parailsanella*. 5-6, *Mellopegma*, showing imprint of shell damage. 1, view of sub-apical shelf of *Parailsanella*, same specimen as in Figure 2.5, arrow shows location of 2, scale bar = 50 μm . 2, close-up of replaced organic matrix, scale bar = 10 μm . 3, side view of another specimen, arrow shows location of 4, scale bar = 100 μm . 4, close-up of replaced organic matrix, scale bar = 5 μm . 5, *Mellopegma* from the middle Cambrian of Australia, arrow shows imprint of damage on shell, magnified in 6, scale bar = 200 μm . 6, marking on internal mold caused by a portion of the shell that was caved in, note smooth margin around damage near the base, suggesting this wound was healed, scale bar = 100 μm .

We also observed that many of the Cambrian mollusks had shells composed at least in part of calcitic

semi-nacre (see above), a type of microstructure previously unknown in mollusks but common in brachiopods (Williams & Wright, 1970; Williams, 1997; Pérez-Huerta & Cusack, 2008) and bryozoans (Weedon & Taylor, 1995; Taylor & Weedon, 2000). This type of shell microstructure was confirmed in Cambrian mollusks by making measurements such as the interfacial angles of crystallite imprints. The interfacial angles in most cases were much closer to what would be expected for calcite rhombs instead of aragonitic tablets (Vendrasco et al., 2010), and so these imprints were not likely formed by nacre, which by definition is aragonitic in composition (Carter, 1990). The results suggest that calcitic semi-nacre occurred in at least two species of middle Cambrian mollusks, and probably in at least five others (Vendrasco et al., 2010), and likely occurred in early Cambrian mollusks as well.

The more extensively coiled Cambrian mollusks (probable gastropods) and *Ocruranus*, possibly the earliest known chiton (Vendrasco et al. 2009), shared a type of laminar microstructure that is uncommon in modern mollusks: lamello-fibrillar (Vendrasco et al., 2009, 2010) (Figure 7). This is a plywood type of shell microstructure where the orientation of fibers differs between adjacent horizontal layers. The type of microstructure in these fossils is similar to crossed-bladed, which is the only variety found in brachiopods but poorly developed in mollusks (Carter, 1979). Moreover, in contrast to the other, highly ordered types of shell microstructure in Cambrian mollusks (see above), lamello-fibrillar shell microstructure represents a looser control over biomineralization, similar to what Carter (1979) inferred as a commonality between early mollusks and brachiopods.

Brachiopods and mollusks were for many decades thought to be distantly related, and so similarities in their shells like those highlighted above were interpreted as convergent. Recently, however, both brachiopods and mollusks have been shown to belong to the major metazoan clade Lophotrochozoa (or Spiralia), and in fact are fairly closely related within that clade (Dunn et al., 2008). This prompts a re-examination of the degree of homology between the shells of these two taxa. The shells of brachiopods and early mollusks share a number of similarities, including: (1) pores in the shell; (2) a high component of organics in the shell; (3) a periostracum (outer organic layer of shell); and (4) similar shell microstructures—all types of microstructures seen in brachiopods – including calcitic semi-nacre as discussed above – also occur in mollusks (Carter & Clark, 1985; Vendrasco et al., 2010). The most recent common

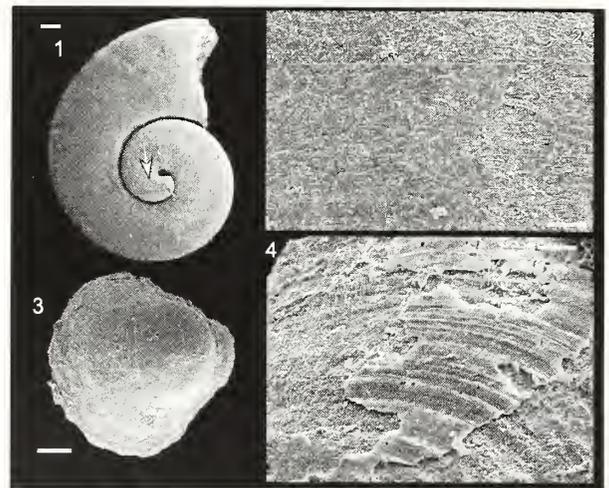


Figure 7. Lamello-fibrillar shell microstructure in a mollusk, *Aldanella*, early Cambrian, Siberia (1-2) and in a problematic fossil, likely a mollusk and possibly a chiton, *Ocruranus*, early Cambrian, China (3-4).

ancestor of brachiopods and mollusks probably did not have a shell, as many soft-bodied taxa appear to be more closely related to mollusks and brachiopods than the latter two are to each other (Dunn et al., 2008). However, the most recent common ancestor of mollusks and brachiopods likely possessed an outer organic coat likely formed by mechanisms that later became independently co-opted for formation of a mineralized shell when the origin of mobile predators drove such evolution in the early Cambrian.

Similarities in shell microstructure among Cambrian mollusks that otherwise look very similar have been noted in a few cases, including bivalves (Runnegar & Pojeta, 1992) and rostroconchs (Kouchinsky, 1999; rostroconchs are an extinct class of mollusk with a univalved larval shell and a bivalved adult shell). Our new data have provided many more examples of Cambrian mollusks with similar overall form and similar shell microstructure. Some examples include: (1) highly coiled forms sharing lamello-fibrillar microstructure; (2) species of *Mellopegma* and similar forms such as *Ribeiria* sharing calcitic semi-nacre; (3) bivalved forms sharing an unusual shell microstructure that is similar to the foliated aragonite of modern monoplacophorans (Checa et al., 2009); and (4) tall, bivalve-like forms sharing foliated calcite (Vendrasco et al., 2010). These observations are consistent with preliminary cladistic analyses of Cambrian mollusks using only microstructural characters, which are highly congruent with those using other characters (Vendrasco et al., 2006).

Altogether, these results provide evidence that shell microstructures in the early mollusks had a strong phylogenetic signal, with similar patterns of shell microstructure in closely related species. Therefore shell microstructures may be particularly useful in determining relationships among the early mollusks, which otherwise often differ little. In addition, microstructural data can be used to help determine relationships of some of the many still problematic Cambrian taxa, helping to decipher the stem lineages of modern animal phyla and thereby allowing better understanding of how the body plans of major animal taxa were built.

Concluding Remarks

The Cambrian explosion is unusual because body plans became diverse very quickly, and since then relatively few new body plans have appeared. The same pattern can be seen in shell microstructures in Cambrian mollusks. Many Cambrian fossils look familiar and seem relatively easy to classify into modern phyla, but there are also many unusual forms (*Problematica*) that seem unusual by modern standards and cannot comfortably be placed in modern groups. Likewise, many Cambrian mollusks had shell microstructures or patterns that are common today (e.g. prismatic outer shell layer, laminar inner one), but other cases of shell microstructures in Cambrian mollusks are more unusual and difficult to classify. Additional fossils and SEM work will help us better assess both problematic taxa and shell microstructures from this important time period.

We are fortunate that shell microstructural data is common in phosphatic molds of mollusks in many Cambrian sedimentary deposits, and that phosphatized fossils, rare from most other time periods, are so abundant in Cambrian rocks (Porter, 2004b). This good fortune has allowed researchers like us to learn much about how and why the earliest mollusks formed their shells, and has improved our understanding of the relationships among modern and fossil groups of animals. Many species of Cambrian mollusk remain to be closely examined for traces of shell microstructure. Thus our continued work on this subject promises improved understanding of the Cambrian explosion, the most dramatic evolutionary radiation in the history of life on Earth.

Acknowledgments

We thank Stefan Bengtson (Swedish Museum of Natural History, SMNH) and Bruce Runnegar

(University of California at Los Angeles, UCLA) for providing samples and for helpful discussions. S. Bengtson also allowed use of the SEM at the SMNH. Henry Chaney (Santa Barbara Museum of Natural History, SBMNH) allowed use of facilities at SBMNH, including the SEM. Daniel Geiger (SBMNH) provided advice that improved the quality of our SEM images. Douglas Eernisse improved the clarity and accuracy of this paper through a thoughtful review; the more precise wording in the caption to Figure 1 was provided by him. MJV thanks Carole Hertz for inviting this paper and improving it. This research was funded by a grant from NASA Exobiology (EXB04-0000-0117) to SMP. AK received support from the NordCEE (Nordic Center for Earth Evolution) project (Danish National Research Foundation (Danmarks Grundforskningsfond) grant to D. Canfield. GL's work was funded by the National Science Foundation of China.

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Table 1. Varieties of shell microstructure seen in Cambrian mollusks, and their descriptions.

Descriptions of the types of shell microstructure taken from the *Glossary of Skeletal Biomineralization* in Carter (1990), except for foliated aragonite, which was described after that publication. Abundance defined as follows: Rare, fewer than five cases; Common, five to twenty cases; Abundant, more than twenty cases. There is uncertainty in the abundance of calcitic semi-nacreous structure because of the numerous cases of uncertain types of lamellar shell microstructures in Cambrian mollusks. Lamellar microstructure is defined as consisting of "rods, laths, blades or tablets comprise sheets which are oriented parallel or nearly parallel to the depositional surface" (Carter, 1990, p. 611); lamellar microstructures include nacre, calcitic semi-nacre, and foliated calcite. Many Cambrian fossils have a lamellar shell microstructure that shares similarities with calcitic semi-nacre as well as other types of lamellar microstructures (Vendrasco et al., 2010); hence the uncertainty indicated here.

Type of shell microstructure	Description from Carter (1990, pp. 610-612)	Occurrence in Cambrian
Prismatic	"Mutually parallel, elongate, adjacent structural units that do not interdigitate strongly along their mutual boundaries"	Abundant
Semi-nacreous	"Laminae consisting of polygonal tablets which show more abundant screw dislocations and less lateral continuity of the laminae than in typical nacreous structure. Generally calcitic, rarely aragonitic"	Rare to common
Lamello-fibrillar	"The horizontal fibers in successive laminae differ in orientation by irregularly varying angles."	Common
Foliated calcite	"More or less mutually parallel calcitic blades or laths arranged in laminae dipping at a generally uniform angle and in the same general direction over large portions of the depositional surface."	Common
Crossed lamellar	"Numerous mutually parallel rods, laths or blades aggregated into variably shaped but commonly lensatic to braching first order lamellae. Each first-order lamella is oriented with its height axis more or less perpendicular or uniformly oblique to the depositional surface, and with its length axis usually parallel or perpendicular to a major morphologic axis. The second-order lamellae in adjacent first-order lamellae show two predominant dip directions, and these dip directions regularly alternate between adjacent first-order lamellae."	Rare
Foliated aragonite	N/A; defined in Checa et al. (2009) for a microstructure consisting of laminae comprising elongate aragonite laths.	Rare

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

May 13, 2010

Number: 5

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The *Festivus* is published monthly except December.
The publication date appears on the masthead above.
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Rare Cowries of the World

David Waller will present a voyage around the world starting and ending in La Jolla, California where he found his first cowrie. We will set anchor at a number of well known locations for shell collecting and show some

photos of some of the rare cowries of the regions. No voyage would be successful without a map, so we will explore the meaning of the word "rare," as it applies to these magnificent shells, before getting underway.

Meeting date: May 20, 2010

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CLUB NEWS

The Auction/Potluck – 2010

It was fantastic, as always. The 35 or so members and guests began arriving at 5 PM. “Dave’s Punch”, wine and soft drinks were ready as was the marvelous assortment of shells to be voice auctioned and the silent auction available for check out. Members got to greet rarely seen friends and enjoy the social time as they perused the auction shells. By 6 PM it was dinner time. And what a grand assortment of marvelous food – fantastic salads and entrees – just the best ever. Our Club eats well!

Then promptly at 7 PM auctioneer Carole Hertz opened the voice auction. There was so much -- many impressive shell books, two beautiful shell paintings and an incredible amount of wonderful shells on which to bid. A magnificent dead-collected specimen of *Austrotrophon catalinensis*, a *Cypraea leucodon* and a *Cypraea rashleighana* were the top shell favorites of the evening eliciting some very energetic bidding.

At the break members set aside those shells they still wanted to bid on during the second half and then enjoyed some delicious desserts while revisiting the silent auction and making a mad dive for the mountain of shells on the dollar table.

After the break, bidding resumed with the auctioneer cajoling and teasing at times to raise the bids on the remaining goodies. It all ended at 10:30 PM and was a wonderful, fun evening with many people able to take home some exciting treasures to add to their collections.

The following people generously donated material to the Club auction: Elyse Agnew Collection, Twila Bratcher & Billee Dilworth Estates, Wes Farmer, Ian Hamilton, Carole & Jules Hertz, John Jackson, Arnold Klinkenberg, George Metz, Margaret Mulliner, Lois Nelson, Tony Phillips, Don Pisor, Chuck Powell, Marty Schuler, and Carol Skoglund.

Many others also helped to make the auction/potluck a success. The Club Board worked hard preparing the shells for auction and assisted in setting up for the affair. Treasurer Silvana Vollero logged in all the bidding information and her sons Christian and Daniel helped distribute the shells. John LaGrange brought all the ingredients and prepared “Dave’s Punch.” Paul Tuskes brought in the soft drinks and also distributed the shells after the boys had to leave. Bill

Schneider brought all the lights for the auction tables and he and Jim Goldammer set them up. Jim also took care of distributing all the silent auction material to the winning bidders. Additional thanks go to those who stayed to help in the clean-up when the auction was over.

And most of all our great appreciation to Wes Farmer who has generously hosted this event for 23 consecutive years!!

Missed the Roster

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The Club’s Science Fair Winner - 2010

Once again the San Diego Shell Club has participated in the Greater San Diego Science and Engineering Fair. This year the Club judges Marty Schuler and Bill Schneider chose a winner from the Junior Division since entries in the Senior Division did not provide any marine life choices for the judges.

Our winner is Katherine Houk whose project in the Animal Sciences section is *Correlation of Owl Limpet Size to Population Density*. Katherine is a student at the Rhoades School. We hope to have her come to a meeting and give an overview of her project and receive her prize she chooses from the Club’s three listed books.

The AMS/WSM 2010

The 43rd annual meeting of the Western Society of Malacologists and the 76th annual meeting of the American Malacological Society will take place on the campus of San Diego State University at its Aztec Conference Center from June 26-30, 2010. Since the two societies meet together only occasionally, this meeting will be a special event.

In addition to the scientific sessions, there will be the ever-popular auction, banquet, reprint sales and other fun activities. If you have donations for the auction, contact George Kennedy <gkennedy@bfsa-ca.com>. For further details see the website at <<http://www.malacological.org/meetings/>>.

LEARNING TO CLAM ALONG OREGON'S CENTRAL COAST

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Wanting to know more about the clam shells I collected and the animals who created them, I recently persuaded my wife Vân and two friends, Andrea and Archie Waterbury, both retired biologists from Cal-Poly San Luis Obispo, that we should go on a clamming expedition. Since none of us had ever clammed before, we knew we wanted to go where clams were both plentiful and easy for beginners to collect. After doing some reading and exploring Internet sites about west coast clamming, we eventually planned a week's trip along the central Oregon coast in June 2009.

Vân and I decided we would fly to Portland, rent a car, and meet Andrea and Archie, who would be traveling up the California and Oregon coasts by motor home, in the seaside community of Lincoln City, Oregon. After a day or two seeing the countryside and feeling our way into clamming around Lincoln City, we would then all head north to Cannon Beach, see more beautiful countryside, and acquire more collecting experience. My role as the group's only experienced (though still a novice) shell collector was to figure out where to go and how to get the clams. As it turned out, the abundance of clams and clamming sites along the Oregon coast made my job easier than I expected.

In preparing for my first clamming trip, I started by making sure I had all the right equipment. Other than a shellfishing license (non-residents pay \$20.50 for the calendar year or \$11.50 for three days), the only equipment needed is a shovel, a bucket, and rubber boots. Andrea and Archie were bringing our boots and a bucket or two in their motor home. I also packed some plastic two-quart containers (handier for collecting, I thought) in my suitcase, along with two short-handled beach shovels. After we got to Oregon, I also bought a "clam shovel," essentially a spade with an elongated, curved digging end.

On the advice of other clammers I talked to, I also purchased two "clam guns" over the Internet (\$15.95 each) and had them sent to Andrea and Archie's house so they could bring them along in their motor home. A clam gun is a 3-foot long, 4-inches in diameter PVC

tube, capped at one end, with a handle and a small hole that acts as an air vent. You push the open end of the tube down over the clam's siphon (a squirt of water, a small hole, or a tell-tale dimple in the sand), then create a vacuum by putting your thumb over the air vent. You next lift the tube out of the sand, release your thumb, and empty the sand and the clam it contains out onto the beach. Clam guns are used mostly for collecting Pacific razor clams (*Siliqua patula*) along sandy beaches, where they are highly effective. Shorter, lighter clam guns called "shrimp guns" have a 2" diameter and are used for collecting small clams or shrimp.

Having seen to matters of equipment, I also did some reading on what kinds of clams we might find. Oregon is a rich resource for abundant varieties of shellfish. Dungeness crab, for instance, are abundant and popular. We saw crabbers catching them in baskets of every size and design at several of the beaches we visited. Some of the most popular commercial and recreationally-taken clams include cockles (especially *Clinocardium nuttallii*) (Figure 1), littleneck, butter,



Figure 1. *Clinocardium nuttallii* (Conrad, 1837).
Photo: Linda Schroeder, Pacific Northwest Shell Club,
www.pnwsc.org

gaper, and softshell clams (*Leukoma staminea*, *Saxidomus gigantea*, *Tresus nuttallii* and *T. capax*, as well as *Mya arenaria* and *Macoma nasuta*, respectively). A commonly found invasive Asian clam,

Nuttallia obscurata (Reeve, 1857) made its first noticeable appearance along the Washington coast in the early 1990s. Increasingly large, dense populations have since spread south to the bays and estuaries of northern and central Oregon (Coan, 2005). Commonly known as the “Varnish Clam” or “Dark Mahogany Clam,” *N. obscurata* is medium-size (to 2¼”/5.7 cm), with a flat, oval shell covered by a shiny, dark golden-brown periostracum; the interior is stained with a deep purple (Harbo, 2001). It was this ubiquitous non-native that gave us our first thrill of digging for clams in Oregon (Figure 2).

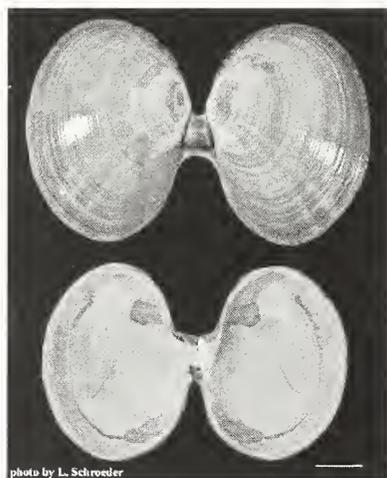


Figure 2. *Nuttallia obscurata* (Reeve, 1857).
Photo: Linda Schroeder, Pacific Northwest Shell Club,
www.pnWSC.org

When June came around, Vân and I headed for the airport, and Andrea and Archie began driving up the California coast to Oregon and Lincoln City. We spent the first afternoon settling into our hotel, doing some bird watching, and visiting a few shops in Lincoln City. Andrea and Archie were comfortably ensconced at a nearby motor home park. During dinner that night at a local restaurant, we quizzed our waiter about where to go clamming the next day. He advised us to drive south, pick a beach, and start trying our luck, which is what we did.

Vân and I were up early the next morning. After picking up Andrea and Archie, we drove a few miles south along Highway 101 and Siletz Bay to a large estuarine beach. The tide was out, and there was a good quarter mile of empty mud-sand beach stretching from the shore to the water. Since a few other cars were parked there and we could see about a dozen people digging for clams, we figured we had come to a good place to learn about clamming. We quickly reminded each other about carrying the shellfishing licenses

(absolutely required!) we bought the day before at a local sporting goods store. Then we put on our boots, grabbed our buckets and the two short shovels I had brought in my suitcase, hefted the clam guns and the clam shovel I had purchased, and trooped excitedly down to the beach.

Once there, I found the clam guns barely worked at all. The sand was too coarse, and every time I plunged the barrel in, I uncovered one or two of the numerous ghost shrimp living just below surface. These were *Neotrypaea californiensis* (Dana, 1854), colorful translucent-bodied creatures, about three inches long, with visible reddish pink and orange organs (Figure 3).



Figure 3. *Neotrypaea californiensis* (Dana, 1854).
Photo: David Cowles, <http://rosario.wallawalla.edu/inverts>

I supposed they were edible, but I told myself I had come to Oregon for clams, and it was clams I was determined to find. Nonetheless, by mistaking the tiny craters made by the shrimp for clam locations, I kept finding shrimp instead of clams. Worse yet, as I pushed my clam gun into the sand, it was more often than not cutting the shrimps in half. After about forty minutes of clam-gunning, I realized that I had found little more than a few dozen ghost shrimps or their parts, as well as a lone broken valve from what might have been a *Mya arenaria*.

Meanwhile, the rest of our party had given up on my techniques and approached a large group of clammers with several buckets full of clams to ask them for advice. The group turned out to be two families from Portland on an annual clamming trip. They told us to forget the shovels and clam guns and to get on our hands and knees, gently sweeping away the sand in front of us until a clam appeared. Since their group had all the clams they could legally collect (twenty per person) and were going home that day, they left us an extra bucket and two pairs of rubber clamming gloves, essential for saving one’s fingers from the corrosive

effects of digging gritty sand and gravel by hand.

Following the Portland families' advice, we were all soon down on our hands and knees, scooping sand down to about 6-8 inches and uncovering—lo and behold!—clam after clam of *Nuttallia obscurata*. True to guidebook descriptions, the varnish clams lay scattered throughout the sand, a few inches apart on their sides, shiny dark golden-brown, and all about the size of a slim old-fashion pocket watch. Needless to say, we were thrilled and awed by what we were finding. In less than an hour we had three containers full, each with twenty carefully counted beauties. To prepare the clams for eating, we first soaked them overnight in freshwater, then sautéed them in a wine and butter mix. They were wonderful!

Our success with collecting the varnish clams only made us more anxious to try for other kinds. We left for Cannon Beach the next day. Once there, Vân and I checked into our hotel. Andrea and Archie nestled their motor home at a nearby park, and we planned another day's clam outing. After consulting a few local guidebooks, we decided to drive south a few miles back along Highway 101 the next morning to the small town of Garibaldi. We had driven through it on the way to Cannon Beach and seen people clamming out on the tide flats and along a pier. It was about an hour's drive from Cannon Beach, but everything we read about Garibaldi told us it was worth the trip. It was.

When we got to Garibaldi at 7:30 the next morning, about a half hour before maximum low tide (-1.3 ft.), it was raining. The only parking lots near the tide flats were jammed full, and dozens of people, clam buckets and shovels in hand, were lined up to get down the stairway leading from the railroad tracks to the beach. We eventually found a place to park and then sat in the car, hoping the rain would stop. When that eventuality seemed unlikely, we decided to join the crowds already on the beach. Clamming in the rain, we realized, was no big deal in Oregon.

Once on the beach, I was surprised by the number of people, easily a hundred or more, and the intensity of effort they were putting forth. The terrain was all sand and stone, so rock-filled as to require a sturdy shovel or even a pickax to dig. Nonetheless, individuals, small children, and couples young and old all scampered around with buckets and tools, trying one spot after another, looking here, there, then racing over to where a clam squirt had just occurred and digging furiously to get at its source. The rain had stopped by now, and the digging became even more serious. Whole families gathered around as men with shovels and hoes took

turns digging and pulling clutters of grapefruit-sized stones away to reveal the clams. Two Asian men took turns with a shovel and pitchfork, eventually creating a bombshell-sized crater that both of them fit into. People all around us kept turning up butter clams (*Saxidomus gigantea*) (Figure 4), cockles (*Clinocardium nuttallii*), or gapers (*Tresus capax*) (Figure 5)—sometimes more than one of each--then gleefully loading them into their buckets and returning to find more. A couple of people we talked to said they or others had also found geoducks (*Panopea abrupta*), but the few examples I saw were relatively small (2-3") and may actually have been a species called a "rough mya clam" or "false geoduck" (*Panomya s.s*) (Harbo, 2001).

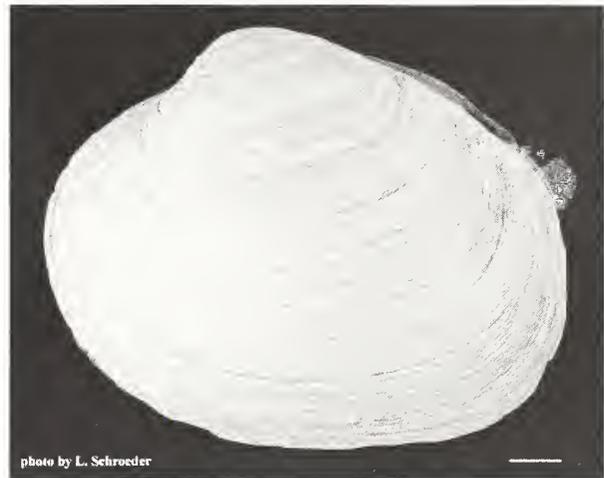


Figure 4. *Saxidomus gigantea* (Deshayes, 1839).
Photo: Linda Schroeder, Pacific Northwest Shell Club,
www.pnwsc.org



Figure 5. *Tresus capax* (Gould, 1850).
Photo: Linda Schroeder, Pacific Northwest Shell Club,
www.pnwsc.org

It was not long before we saw clammers who had arrived earlier in the morning starting to leave the beach, their buckets brimming with beautiful, huge, mud-covered, baseball-size clams and cockles. This was exciting to see, but none of our group knew how to spot the clams or where to dig or how deep. We felt like the complete novices we were. For the first half hour we just sort of wandered around the beach watching people intently digging away at 1-2 foot deep, ever-widening craters in the ground. Several offered advice—look for the squirt, dig in an already excavated hole, try the less rocky areas. Some people watched for a squirt and then placed a small bamboo garden stick next to it to mark where to dig. I poked around in several spots but found nothing until I tried a small crater someone else had dug earlier. I hacked away at the coarse sandy soil and dug out small boulders by hand until I was sweating. Then all of a sudden—success. A cockle! My first, a big yellow-brown, thick-ribbed beauty – *Clinocardium nuttallii*, for sure. Ván saw my find and raced over to cheer. So did Andrea and Archie. We soon were all digging adjacent holes, pulling up cockles, butter clams, soft-shell clams (*Mya arenaria*) (Figure 6), and even



Figure 6. *Mya arenaria* Linnaeus, 1758.
Photo: Cathy Klingler, Carnegie Museum of Natural History

Leucoma staminea, the littleneck clam (Figure 7). The limit was a total of twenty clams, cockles, or combination of species per person, and we soon had all we needed for a wonderful shellfish dinner or two. We sorted through our collective finds, mostly keeping the butter clams and cockles, whose shells I was already envisioning in my collection back home.

As we left the beach, two Oregon Fish and Game wardens inspected everyone's bucket, counted every specimen, and asked to see our shellfishing licenses.



Figure 7. *Leucoma staminea* (Conrad, 1837).
Photo: David Cowles, <http://rosario.wallawalla.edu/inverts>

Their presence reminded us that the great clamming we had just experienced was the result of nature as well as careful monitoring of a precious resource by the state of Oregon. It was reassuring to know that the bountiful communities of clams, cockles, oysters, crabs, and other intertidal treasures we had seen on our trip were being protected for the enjoyment of present and future generations.

The day at Garibaldi was our last clamming effort during our visit to Oregon. Andrea and Archie, Ván, and I are also serious birdwatchers, so we spent the last few days seeing more of the Oregon coast and its birds. I planned to save the clam guns for our next trip, when we would have time to go after razor clams and other species that Oregon has to offer. On our last day, from the mussel-covered rocks near our hotel, we collected several empty *Mytilus californiensis* shells, all long (10-11") and thick, with shiny black and brown exteriors and beautiful blue interiors. By then we had dined to our full on local oysters, had great salmon dinners, and sampled endlessly different clam chowders at every place we stopped. Best of all, we learned about clamming and some of the wonderful creatures that make it all possible.

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STRAMONITA BISERIALIS AT POINT LOMA, CALIFORNIA

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On February 25, 2010, at approximately 13:00, I observed a single live adult specimen of *Stramonita biserialis* (Blainville, 1832) on Point Loma, San Diego (Figure 1). I was conducting tidepool monitoring for Cabrillo National Monument at the time. The snail was clinging to bare bedrock in an open sea cave approximately 300 yards north of the Point Loma Waste Water Treatment Plant, on the west side of Navy Base Point Loma. I measured the specimen at 65 mm in length and found it in the rocky intertidal, slightly below 0.0 during low tide.

The historical range for *Stramonita biserialis* extends south from Ensenada, México. Adults have been recorded at Scripps Institution of Oceanography in 2001 and in the Channel Islands in 2000 and 2007. Recent sightings, since 2001, correspond with El Niño conditions. Point Loma is one of the locations we might expect to see *Stramonita biserialis* when it does extend this far north, being the first major rocky shoreline on the mainland within the U.S.



Figure 1. *Stramonita biserialis* (Blainville, 1832). Length: 65 mm, intertidal at Pt. Loma, California.

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

June 10, 2010

Number: 6

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 Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

World of Islands: The Use of Shells in Oceania.
 How and Why pre-European Pacific Islanders used shells for Survival, Prestige and Trade.

Terry Rutkas, of the Pacific Conchological Club, will give an illustrated presentation on how mankind took its first step into the Pacific 40,000 years ago. He says it might surprise us to learn why they wouldn't have gone far without seashells.

Meeting date: June 17, 2010

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**Minutes of the San Diego Shell Club Meeting
20 May 2010**

The meeting was called to order at 7:35 PM by Vice President Jules Hertz. The previous minutes were approved by the membership. Silvana Vollero gave the treasurer's report, and reminded everyone to promptly pay their invoices from the shell auction. Marilyn Goldammer announced that we now have an updated list of books in our library.

Under new business, Bob Yin briefly talked about a series of books that he and his co-author completed called, *Under Sea Encounters*. The books target junior high school students and the effort is to increase their interest and knowledge of the marine environment.

Katherine Houk, Shell Club winner in the junior division of the Greater San Diego Science and Engineering Fair, attended the meeting and presented her study on Owl Limpets to the group. After her presentation, the Club's fair judge Marty Schuler awarded her the Club's book prize of *Between Pacific Tides*.

WSM president George Kennedy reminded members of the June malacology meetings at San Diego State University, and asked members to help with registration or assist with computer presentations. For more information, contact George directly.

David Waller gave the May presentation on Rare Cowries. There are many factors that influence the rarity and value of a shell. To be a pricey shell, it must be desirable and its availability in the market limited; the individual shell judged by condition, color, size, markings etc. David started the presentation with his first find of the chestnut cowry in La Jolla, and continued east to Africa, Australia, New Caledonia, the Philippines, Hawaii and back to San Diego. He provided excellent slides of the various species in each of those regions, and brought specimens of many for members to examine. The meeting was adjourned at 8:50 PM for time to examine the shells brought in by David and social time while enjoying the refreshments brought by Marilyn & Jim Goldammer and Carole & Jules Hertz.

Addition to the Roster

YIN, ROBERT, 1275 Torrey Pines Rd., La Jolla, CA 92037, (858) 454-2342. E-mail: ryin1@san.rr.com

**Conchologists of America Convention
August 27-31, 2010**

The COA Shellebration Boston, hosted by the Boston Malacological Club, will be held at The Boston Park Plaza Hotel in downtown Boston.

There will be field trips on Thursday August 26th and the morning of Friday the 27th. The convention opening will be Friday afternoon the 27th and the Welcoming Party and buffet that evening. There will be programs and many silent auctions. The oral auction will be held Saturday evening the 28th. The convention opening, welcome party, all programs and the oral auction will be held in the Stanbro Room at the hotel.

The 2010 International Dealers' Bourse of shells and shell-related items will be held in the Boston Park Plaza Castle located across the street from the hotel on Monday the 29th and Tuesday the 30th. [Dealers participating in the Bourse go to www.conchologistsofamerica.org for necessary information.]

For further general information go to the website above. Other convention contacts, e-mail Don Robak at shellsnail@comcast.net, phone: (617) 889-1841 or Warren Graff at lowhurdler@gmail.com or phone (978) 346-8977.

The September Party

The Club needs a host for the Annual September Party. Larry and Debbie Catarius have hosted this function for several years and deserve a break this time. If you are willing to host this party at your home/garden, please contact Carole & Jules Hertz at jhertz@san.rr.com or call at 858-277-6259.

Upcoming Programs for 2010

June 17 .. Terry Rutkas The Use of Shells in Oceania
July 15 .. Lindsey Groves .. on fossil abalone
August 19 .. Dr. Greg Rouse .. To be announced
September ?.. Host needed .. Annual September Party
October 21 .. Tim Stebbins ... To be announced
November 18 .. Dr. Michael Hollmann.. To be announced
December 11 .. Annual Christmas Dinner Party

CALIFORNIA BUTTERCLAM, *SAXIDOMUS NUTTALLI*, A NORTHERN RANGE EXTENSION TO CRESCENT CITY, CALIFORNIA

WENDELL WOOD

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ww@oregonwild.org

Coan *et al.* (2000) reports the geographic range of the California Butterclam, *Saxidomus nuttalli* Conrad, 1837, as occurring from Punta Rompiente, Baja California Sur, México to Humboldt Bay, Humboldt County, California, USA.

Recently I discovered several shells of the species at Crescent City, California, approximately 85 highway miles, or 60 miles direct distance (“as a crow flies”) north of the previously known range at Humboldt Bay. *Saxidomus nuttalli*, the California Butterclam, is also sometimes known as the Washington Clam (Figure 1). The often shared common name “Washington Clam” is probably better applied to *Saxidomus gigantea*, the only species of the two which actually does occur in Washington State — ranging from Alaska to central California.

Several fresh shells of both *Saxidomus* species, some with bits of flesh still attached, were found at two locations at Crescent City, California, where dredge spoils were being placed following the 2009-2010 dredging of the Crescent City boat harbor. The Army Corp of Engineers dredging operation began in late November 2009 to provide boat access to a depth of 15 feet for both the inner basin channel, as well as to maintain an access channel to the open ocean. *Saxidomus nuttalli* shells, as well as other species of mollusk shells, most partially broken, were found at a small dredge pond on the northwest end of the Crescent City Harbor, as well as at the principal beach, dredge disposal site at the most southeastern end of the harbor—near the end of Anchor Way road next to “Whaler Island.”

Four voucher specimens were confirmed (and

distinguished from *Saxidomus gigantea* shells also collected from the same location) by Paul Valentich-Scott, Curator of Malacology, Santa Barbara Museum of Natural History. These voucher shells provided to the museum in February 2010 were catalogued as SBMNH 149311 and entered in the Santa Barbara Museum of Natural History Collections Online Databases at: <http://www.sbcollections.org/>. The *Saxidomus nuttalli* shells collected ranged in size from 9 to 13 cm in length, some of which are in the author’s collection.



Figure 1. *Saxidomus nuttalli* Conrad, 1837.

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CATALOG OF RECENT AND FOSSIL CYPRAEIDAE, AND EOCPRAEIDAE: 2005 THROUGH 2009

LINDSEY T. GROVES

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Introduction: Fossil and Recent cypraeids and eocypraeids described subsequent to the compilation of Groves (2005) are listed herein. Names introduced without valid descriptions are not included and neither are forms or varieties. Forty-five cypraeid and eocypraeid taxa are treated herein of which 38 (one subfamily, one genus, 18 species, and 18 subspecies) are Recent taxa and seven are fossil taxa. Of the Recent taxa 34 were described as new, two were not listed in Groves (2005), one was not listed in Groves (2000), and one was a replacement name. Of the fossil taxa six are described as new and one was not listed in Groves (2005). Taxonomic allocations listed in the remarks sections, unless cited otherwise, are the opinion of the author. As it is difficult to keep up with all of the current literature, the author requests that taxa inadvertently omitted be brought to his attention for inclusion in future catalogs.

Abbreviations: The following abbreviations are used herein for locality and/or type numbers: **CS** = F.A. Schilder Collection (Berlin, Germany); **HNC** = Haus der Natur (Cismar, Germany); **HUJ** = Hebrew University, Jerusalem, Israel; **LACMIP** = Natural History Museum of Los Angeles County, Invertebrate Paleontology Section, California; **MGPD** = Istituto e Museo di Geologia dell' Università, Padova, Italy; **MHNT** = Muséum d'Histoire Naturelle de Tours, France; **MM** = Museo Malacologico, Cupra Marittima, Italy; **MNHN** = Muséum National d'Histoire Naturelle, Paris, France; **SAM** = South Australian Museum, Adelaide; **SMNS** = Staatliches Museum für Naturkunde, Stuttgart, Germany; **TAU** = Tel Aviv University, Israel; **WAM** = Western Australian Museum, Perth; **ZM** = Zoology Museum, Bologna University, Italy; **ZMB** = Zoological Museum of

Natural History, Humboldt University, Berlin, Germany.

Acknowledgments: Many thanks to Dirk Fehse (Berlin, Germany) for supplying the author with periodic updates of new papers and with PDFs and reprints of his papers. Luigi Bozzetti (Milano, Italy) and Adam Yates (Johannesburg, South Africa) also provided PDFs of their papers. Eddie Heiman (Rehovot, Israel) provided supplements of *Triton*. Bernie Landau (Albufeira, Portugal) supplied the PDF of a key reference (Soriano, 2006).

RECENT TAXA

FAMILY CYPRAEIDAE

angela, *Cribrarula* Moretzsohn & Beals, 2009:5-8, fig. 1 + 1 unnumbered fig., pl. 1, pl. 2, figs. 1-3.

Type Locality: Off North West Cape, Western Australia (ca. 21°40' S, 114°09' E).

Type Material: Holotype WAM S41201, 1 paratype in the collection of M. Beals (Inglewood, California), 1 paratype in the collection of R. Bolin (Los Alamitos, California), 1 paratype in the collection of F. Lorenz (Buseck-Beuern, Germany).

archilyra, *Cypraeovula capensis* Van Heesvelde & Deprez, 2006:22-23, fig. 1 [lower right.], pl. 4, figs. 9-11.

Type Locality: 140 m, off mouth of Tugela River mouth, Natal, South Africa.

Type Material: Holotype MNHN, 1 paratype in the collection of J. Deprez (St. Gillis-Waas, Belgium), 5 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 2 paratypes in the collection of J. Van Heesvelde (Gent-Wondelgem, Belgium).

Remarks: Junior synonym of *Cypraeovula capensis* Gray, 1828.

avrilae, *Pustularia cicercula* Heiman, 2009:27-31, figs. 3-11.

Type Locality: around Huahine and Tahiti, Society Ids., French Polynesia (148°154' E, 16°18' S).

Type Material: Holotype HUI 40733, 2 paratypes HUI 40734, 2 paratypes TAU 62623, 8 paratypes in the collection of E. Heiman (Rehovot, Israel).

Remarks: Probable junior synonym of *Pustularia cicercula* (Linné, 1758).

bulbosa, *Ransoniella* Dolin, 2007:5-6, pl. 2 + unnumbered fig. on p. 8.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Philippines.

Type Material: Holotype MNHN 9549, paratypes MNHN 9550-9557, paratypes MHNT 316750, 326719, 326729.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

erminea, *Ransoniella* Dolin, 2007:9-10, pl. 4 + unnumbered fig. on p. 9.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Philippines.

Type Material: Holotype MNHN 9561, paratypes MNHN 9562-9565, paratypes MHNT 311338, 311342, 311426, 313901, 313905, 320920, 326794.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

fusula, *Ransoniella* Dolin, 2007:10-11, pl. 5 + unnumbered fig. on p. 10.

Type Locality: Panglao Id., Bohol Prov., Philippines (9°35.9'N, 123°44.7'E).

Type Material: Holotype MNHN 9498, paratypes MNHN 9499-9500, 9566-9569, paratypes MHNT 285426, 301495, 301497, 311343, 311350, 313912, 316647.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

gabensis, *Zoila orientalis* van Heesvelde & Deprez, 2007:54-57, pls. 1-4, 5 + 1 unnumbered fig.

Type Locality: 110-130 m, off Adelaide, South Australia, Australia.

Type Material: Holotype SAM D19375, 2 paratypes in the collection of J. Deprez (St. Gillis-Waas, Belgium), 1 paratype in the collection of J. van Heesvelde (Gent/Wondergem, Belgium), 1 paratype in the

collection of A. Edinger (Australia), 1 paratype in the collection of A. Bishop (Australia).

Remarks: Junior synonym of *Zoila orientalis* Raybaudi, 1985.

glandina, *Ransoniella* Dolin, 2007:11-12, pl. 6 + unnumbered fig. on p. 11.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Mindanao, Philippines.

Type Material: Holotype MNHN 9570, paratype MNHN 9571, paratypes MHNT 316757, 326722, 326772.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

gorda, *Cypraeovula capensis* Van Heesveld & Deprez, 2006:23-26, fig. 1, [lower left 2 figs.], pl. 4, figs 1-5.

Type Locality: 140 m, off Tugela River mouth, Kwazulu, Natal, South Africa.

Type Material: Holotype MNHN, 2 paratypes in the collection of J. Deprez (St. Gillis-Waas, Belgium), 7 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 7 paratypes in the collection of J. Van Heesvelde (Gent-Wondergem, Belgium).

Remarks: Junior synonym of *Cypraeovula capensis* Gray, 1828.

hawaiiensis, *Mauritia maculifera* Heiman, 2005:7-9, figs. 6-11.

Type Locality: Maui, Hawaiian Ids.

Type Material: Holotype HUI 50047, 4 paratypes HUI, 69 paratypes in collection E. Heiman (Rehovot, Israel).

ipacoyana, *Palmadusta androyensis* Bozzetti, 2006:3-4, 1 unnumbered fig. on p. 3.

Type Locality: Lavanono, Tulear Prov., Madagascar.

Type Material: Holotype MNHN, 1 paratype in collection of L. Bozzetti (Milano, Italy).

Remarks: Junior synonym of *Palmadusta androyensis* Blöcher & Lorenz, 1999.

kesslerorum, *Cypraeovula* Lorenz, 2006:14-16, pl. 3, figs. 1-3.

Type Locality: 90-110 m, 5 km offshore of East London, Cape Prov., South Africa.

Type Material: Holotype MNHN, 1 paratype in the collection of E. Kessler (Zumikon, Switzerland), 1 paratype in the collection of M. Chiapponi (Lecco, Italy), 3 paratypes in the collection of B. Cargile (Woodside, California).

kostini, *Zoila friendii* Lorenz & Chiapponi, 2007:39-41, pl. 7, figs. 1-2, pl. 8, figs. 3, 5.

Type Locality: 150 m, between Freemantle and Geraldton, Western Australia, Australia.

Type Material: Holotype WAM S33040, paratypes WAM S12876-S12878, S33041-S33042, 5 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 2 paratypes in the collection of A. Kostin (Moscow, Russia).

labiosa, *Ransoniella* Dolin, 2007:13-14, pl. 8 + unnumbered fig on p. 13.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Mindanao, Philippines.

Type Material: Holotype MNHN 9575, paratypes MNHN 9576-9577, paratype MHNT 316748.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

leforti, *Ipsa childreni* Heiman, 2009:32-34, figs. 2-4.

Type Locality: Around Huahine and Tahiti, Society Ids., French Polynesia.

Type Material: Holotype HU 40735, 6 paratypes HU 40736a, 6 paratypes TAU 62626, 206 paratypes in the collection of E. Heiman (Rehovot, Israel).

Remarks: Probable junior synonym of *Ipsa childreni* (Gray, 1825).

lovetha, *Cypraea hungerfordi* Poppe, Tagaro & Buijse, 2005:24-25, unnumbered fig. on p. 25, pls. 1-2.

Type Locality: Aliguay Id., offshore Dipolog, Mindanao, Philippines.

Type Material: Holotype and 1 paratype in the collection of Conchology Inc., Mactan Id., Philippines, 1 paratype MNHN, 1 paratype in the collection of J. Buijse (Netherlands).

Remarks: Junior synonym of *Erronea hungerfordi* (Sowerby, 1888).

malani, *Cypraeovula castanea* Lorenz & de Bruin, 2009:71-73, figs. 12-17.

Type Locality: Off Danger Pt., Cape Prov., South Africa.

Type Material: Holotype MNHN 21235, 6 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 1 paratype in the collection of J. Deprez (Belgium), 1 paratype in the collection of M. Brooks (England), 1 paratype in the collection of A. Kostin (Moscow, Russia), plus 7 additional paratypes.

marina, *Zoila friendii* Kostin, 2005:30-33, pls. 1-5.

Type Locality: From the Jurien Bay/Cervantes area northwards across the Abrolhos Ids. to the Kalbarri area, Western Australia.

Type Material: Holotype WAM, 2 paratypes in the collection of A. Kostin (Moscow, Russia), 5 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 7 paratypes to "be distributed among institutions and collectors."

Remarks: Junior synonym of *Zoila friendii* (Gray, 1831).

meyeri, *Ransoniella* Dolin, 2007:14-15, pl. 9 + unnumbered fig. on p. 14.

Type Locality: 6-8 m, off Pamilacan Id., Bohol Prov., Philippines (9°29.4' N, 123°56' E).

Type Material: Holotype MNHN 9502, paratypes MNHN 9507, 9578-9579, 9636, MHNT 319347, 311438, 320911.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

micheloi, *Erosaria turdus* Chiapponi, 2009:95-97, figs. 1-5.

Type Locality: Sfax, Tunisia.

Type Material: Holotype MNHN 21251, 1 paratype SMNS 0071866, 141 paratypes in the collections of M. Chiapponi (Lecco, Italy) and F. Lorenz (Buseck-Beuern, Germany).

Remarks: Probable junior synonym of *Erosaria turdus* (Lamarck, 1810).

nabeqensis, *Erronea caurica* Heiman & Mienis, 1999:12-18, figs. 1-6.

Type Locality: Nabeq, 25-30 km north Sharm-el-Sheikh, Sinai Peninsula, Strait of Tiran, Egypt.

Type Material: Holotype HUJ 40637, 6 paratypes in the collection of E. Heiman (Rehovot, Israel).

Remarks: Junior synonym of *Erronea caurica* (Linnaeus, 1758).

namibiensis, *Cypraeovula algoensis* Massier, 2006:3-4, 2 unnumbered figs. on p. 4, 4 unnumbered figs. on p. 5.

Type Locality: Elizabeth Bay, Lüderitz Dist., Namibia.

Type Material: Holotype MM, 5 paratypes in the collection of W. Massier (Swakopmund, Namibia).

Remarks: Junior synonym of *Cypraeovula algoensis* (Gray, 1825).

nigromarginata, *Zonaria pyrum* Deprez & Govaert, 2009:91-93, pl. 1, pl. 2, figs. 1-8, pl. 3.

Type Locality: Near Cadiz, Spain.

Type Material: Holotype MNHN, 10 paratypes in the collection of J. Deprez (St. Gillis-Waas, Belgium, 7 paratypes in the collection of F. Govaert (Wemmel, Belgium), 8 additional paratypes in the collections of F. Govaert and F. Swinnen.

Remarks: Junior synonym of *Zonaria pyrum* (Gmelin, 1791).

oriettae, *Umbilia* Lorenz & Massiglia, 2005:37-41, fig. 3 (middle row), fig. 4 (middle row), pl. 1.

Type Locality: Moreton Bay, Queensland, Australia.

Type material: Holotype WAM, 8 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 2 paratypes in the collection of D. Massiglia (Italy).

oryza, *Ransoniella* Dolin, 2007:15-16, pl. 10 + unnumbered fig. on p. 15.

Type Locality: 5-24 m, off Alona Reef, Panglao Id., Bohol Prov., Philippines (9°33' N, 123°46.5' E).

Type Material: Holotype MNHN 9503, paratype MNHN 9637, 9850, paratypes MHNT 311348-311349, 311439 -311440, 313907, 313910, 320921, 326795.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

piae, *Bistolida owenii* Lorenz & Chiapponi, 2005:22-28, pls. 16-17.

Type Locality: Cargados Carajos Shoals north of Mauritius, Mascarene Islands.

Type Material: Holotype MNHN, 5 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany), 2 paratypes in the collection of M. Chiapponi (Malgrate, Italy), 1 paratype in the collection of E. Couacaud (Quatre Borne, Mauritius).

Remarks: Junior synonym of *Bistolida owenii* (Sowerby, 1837).

profuudorum, *Cypraeovula capensis* Seccombe, 2003:9-12, figs. A-C.

Type Locality: On flat reef off East London, Cape Prov., South Africa.

Type Material: Holotype and 2 paratypes in Natal Museum, 2 paratypes on collection of A. Seacombe (Hout Bay, South Africa).

Remarks: Junior synonym of *Cypraeovula capensis* Gray, 1828.

Pseudozonariinae Soriano, 2006:54.

Type Genus: *Pseudozonaria* Schilder, 1927.

radiosa, *Ransoniella* Dolin, 2007:16-18, pl. 12 + unnumbered fig on p. 16.

Type Locality: 25 m, off Balabac Id., Palawan Prov., Philippines.

Type Material: Holotype MHNT 326778, paratype MHNT 325567.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

Ransoniella Dolin & Lozouet, 2005:80.

Type Species: *Cypraea punctata* Linnaeus, 1771.

Remarks: New name for *Ransonia* Dolin & Lozouet, 2004 preoccupied. Subjective synonym of *Notadusta* Schilder, 1935.

serrata, *Ransoniella* Dolin, 2007: 17-18, pl. 13 + unnumbered fig. on p. 17.

Type Locality: Off south point of Balicasag Id., southwest of Panglao Id., Bohol Prov., Philippines (9°31.3' N, 123°41.2' E).

Type Material: Holotype MNHN 9582, paratype MNHN 9638, paratypes MHNT 313897, 313909, 320940-320941.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

takahashii, *Pustularia cicercula* Moretzsohn, 2007: 44-46, pls. 1-3, pl. 4, figs 14a-b + 1 unnumbered fig.

Type Locality: Haleiwa, Oahu, Hawaii (21°35'44" N, 158°6'43" W).

Type Material: Holotype USNM 1090937.

Remarks: Probably a junior synonym of *Pustularia cicercula* (Linné, 1758).

toliarensis, *Cribrarula* Bozzetti, 2007:3-4, 3 unnumbered figs.

Type Locality: Toliar, Madagascar.

Type Material: Holotype MNHN, 2 paratypes in the collection of L. Bozzetti (Milan, Italy).

uvula, *Ransoniella* Dolin, 2007:18-19, pl. 14 + unnumbered fig. on p. 18.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Mindanao, Philippines.

Type Material: Holotype MNHN 9584, paratypes MNHN 9585-9588, 9639, paratypes MHNT 316753,

320955-920957, 326558, 326711, 326725, 326775, 326792.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

volvens, *Cypraeovula* (*Crossia*) Fazzini & Bergonzoni, 2004:50-56, figs.1-9.

Type Locality: Northeast of Port Alfred, Cape Prov., South Africa.

Type Material: Holotype ZM no. 41129, 4 paratypes in the collection of P. Fazzini (Forli, Italy), 2 paratypes in the collection of M. Bergonzoni (Calderara di Reno, Italy), 1 paratype in the collection of M. Passamonti (Bologna, Italy).

vulgata, *Rausoniella* Dolin, 2007:19-20, pl. 15 + unnumbered fig. on p. 19.

Type Locality: Off Zamboanga, Zamboanga del Sur Prov., Philippines.

Type Material: Holotype MNHN 9589, paratype MNHN 9590, paratypes MHNT 316756, 326712.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

zyzpha, *Rausoniella* Dolin, 2007: 22-23, pl. 16 + unnumbered fig. on p. 22.

Type Locality: Off Santa Rosa Pt., Olango Id., Cebu Prov., Philippines.

Type Material: Holotype MNHN 9594, paratypes MNHN 9595-9596, paratype MHNT 286054.

Remarks: Junior synonym of *Notadusta punctata* Linné, 1771.

FAMILY EOCYPRAEIDAE

alexhuberti, *Pseudocypraea* Lorenz, 2006: 7-8, pl. 1, figs. 1-4.

Type Locality: 55-62 m, "Bermuda Drop," near Kavieng, New Ireland, Papua New Guinea (2°45.325'S, 150°42.227'E).

Type Material: Holotype SMNS 0062987, 10 paratypes in the collection of F. Lorenz (Buseck-Beuern, Germany).

FOSSIL TAXA

FAMILY CYPRAEIDAE

ancillaria, *Archicypraea* Dolin & Pacaud, 2009:279, pl. 1, figs. 3-6.

Type Locality: Croce Grande, San Giovanni Ilarione, Italy, middle Eocene (lower Bartonian).

Type Material: Holotype MNHN J04442, 1 paratype MNHN J08908, 1 paratype MNHN J08886, 1 paratype MNHN A26521.

cadella, *Lyncina* (*Austrocypraea*) Yates, 2008:359-363, figs. 5A-L, 6A-B.

Type Locality: Immediately south of the type section of the Murbko Marl Member of the Cadell Formation, South Australia, Australia, middle Miocene.

Type Material: Holotype SAM P42972, paratypes SAM P42973-P42974.

Remarks: Junior synonym of *Austrocypraea amae* Fehse & Kendrick, 2000.

caepa, *Umbilia* Yates, 2008: 354-358, figs. 1A-G, 2, 3A,C, E, G.

Type Locality: East bank of Murray River, 6 km south of Morgan, South Australia, Australia, Murbko Marl Member, Cadell Formation, middle Miocene.

Type Material: Holotype SAM P42967, paratypes SAM P42968-P42969.

electra, *Archicypraea* Dolin & Pacaud, 2009: 280-281, pl. 2, figs. 5-8.

Type Locality: Monte Bastia, San Giovanni Ilarione, Italy, middle Eocene (lower Lutetian).

Type Material: Holotype MNHN J04443, 1 paratype MNHN J04445.

garonetti, *Schilderia* Fehse, 2004a:5-6, fig. 1, pl. 1, figs. 1, 2-6, pl. 8, fig. 8.

Type Locality: Poggiobonsi, Tuscany Dist., Italy, middle Pliocene (early Piacenzian).

Type Material: Holotype HNC, 1 paratype HNC, 7 paratypes in the collection of D. Fehse (Berlin, Germany).

lamdaui, *Proadutsa* Fehse, 2009:18, pl. 14, fig. 3.

Type Locality: Torino, Piedmont Dist., Italy, early Miocene (Burdigalian).

Type Material: Holotype CS 3416.

onkastoma, *Lyncina* (*Austrocypraea*) Yates, 2009:27-31, figs. 3A-G, 4.

Type Locality: 150 m south of the Onkaparinga River mouth, St. Vincent Basin, South Australia, Australia,

Ruwaring Member, Port Wilunga Formation, early Oligocene.

Type Material: Holotype SAM P40048, paratypes SAM P40049-P10042.

Remarks: Currently in the genus *Austrocypraea*.

ormenoi, *Muracypraea* DeVries, Groves & Urbina, 2006:103-105, figs. 3-5.

Type Locality: Between Yesera de Amara and the Rio Ica, less than 1 km north of Cerros Las Tres Piramides (= Ullujalla West), Ica Dept., southern Peru (14°34'50"S, 75°38'40"W) [LACMIP loc. 17783], lower Miocene Chilcatay Formation.

Type Material: Holotype LACMIP 8197.

Protoponda Dolin & Pacaud, 2009:286-287.

Type Species: *Bernaya* (s.str.) *vinassai* Schilder, 1932.

tethysianus, *Cypraeorbis* Dolin & Pacaud, 2009:282-283, pl. 3, figs. 2-4.

Type Locality: San Giovanni Ilarione, Italy, middle Eocene (lower Lutetian).

Type Material: Holotype MGPD 30086.

vicenzana, *Archicypraea* Dolin & Pacaud, 2009:302-304, pl. 2, figs. 2-4.

Type Locality: Cava Grola, Cornedo Vicentino, Italy, middle Eocene (middle Lutetian).

Type Material: Holotype MNHN A26057.

FAMILY EOCYPRAEIDAE

deangelii, *Lnponovula* Dolin & Pacaud, 2009:292, pl. 6, figs. 10-12.

Type Locality: Cava Zanconato, Chiampo, Italy, middle Eocene (lower Lutetian).

Type Material: Holotype MNHN A26059.

nogariolensis, *Grovesia* Dolin & Pacaud, 2009:289, pl. 5, figs. 4-7.

Type Locality: Cava Albanello, Nogarole Vicentino, Italy, middle Eocene (lower Lutetian).

Type Material: Holotype MGPD 29732, 1 paratype MNHN A26052, 1 paratype MNHN R63146.

spatiosa, *Apiocypraea* Fehse, 2004b:39-40, figs. 2-3, 5-6.

Type Locality: Tabbiano, Italy.

Type Material: Holotype ZMB no. 5001, 1 paratype ZMB no. 5144.

qnaggiottoi, *Lnponovula* Dolin & Pacaud, 2009:291-292, pl. 6, figs. 1-6.

Type Locality: La Tuilerie, Gan, Pyrénées-Atlantiques Dept., France, lower Eocene (upper Ypresian).

Type Material: Holotype MNHN J04456, 1 paratype MGPD 29727.

Taviana Dolin & Pacaud, 2009:288.

Type Species: *Cypraea* (*Cyproglobina*) *parvulorbis phaesolina* de Gregorio, 1880.

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Captions for "Having fun at the Auction/Potluck, 2010" →

Top row, l-r. Duffy Daughenbaugh, Jules Hertz and Mary Rider, Bob Dees.

Second row, l-r. George Kennedy, Rick Negus, Larry Catarius, Nancy Schneider, John LaGrange.

Third row, l-r. Daniel Petroski, Barbara Myers, Bob Petroski, Lourdes Schuler and Carole Hertz.

Fourth row, l-r. Kristin Komatsubara, Vân and Bob Dees, Jim Goldammer, Debbie Catarius.

Bottom row, l-r. Sandy Schuler, Kristin Komatsubara, Silvana Vollero, Don Pisor, Duffy Daughenbaugh, Paul Tuskes.

Having fun at the Auction/Potluck, 2010



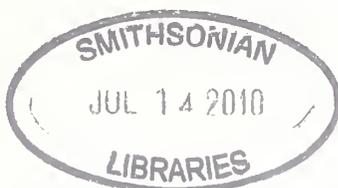
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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

July 8, 2010

Number: 7

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 Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
 Room 104, Casa Del Prado, Balboa Park, San Diego

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PROGRAM

ABALONE AND THE FOSSIL RECORD: NO BALONEY

Lindsey Groves of the Natural History Museum of Los Angeles County will give a slide presentation on the history of *Haliotis* from the Late Cretaceous of southern California when it first appeared to the Recent.

Meeting date: July 15, 2010

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**Minutes of the San Diego Shell Club Meeting
17 June 2010**

The meeting was called to order at 7:40 PM by Benjamin Pister, President. The previous minutes as published in *The Festivus* were approved as written. There was no treasurer's report as Silvana Vollero was not present. VP Jules Hertz reminded us that the July presentation will be on fossil abalone. George Kennedy passed out maps for the WSM/AMS meeting and announced a reception on Saturday evening the 26th of June for those attending. More info regarding the meetings is on the WSM web site.

Terry Rutkas, gave the presentation "World of Islands, the use of Shells in Oceania". Terry reviewed the geography of the area and the migration of people eastwards through the Pacific islands. Most of the western islands are continental in nature and the rock and clay provided materials for basic tools. As people moved east they found coral islands and atolls to be devoid of rock, and the use of shells as a substitute became critical. Volcanic oceanic islands provided rock but the use of shells remained common.

Shells were often modified, shaped, and attached to handles and could be used as adzes and blades for wood working and cutting. Shell scrapers, horns, fishing hooks, lures, tools for food preparation and personal grooming were common. They were also used for money, decoration (both architectural and personal), prestige, and as talismans. The shells most commonly used were tridacna clams, cassis, cowries, pearl oysters, limpets, and trochids. The presentation was well documented, illustrated, and very informative.

At the end of the talk at 9:15 PM, the shell drawing was won by Debbie Catarius and the refreshments for the social time were provided by John Bishop, Carole and Jules Hertz and Wes Farmer.

Paul Tuskes

The September Party

The Club still needs a volunteer for the Annual September Party. Debbie and Larry Catarius will be unable to host the event this year.

If you are willing to have this party at your home/garden, please contact Carole & Jules Hertz at jhertz@san.rr.com or call at 858-277-6259.

The Club's Website

If you haven't done so yet, check the Club's terrific website designed and managed by Bob Dees. The website is at: <http://www.sandiegoshellclub.com>

Bob continually updates the website with information on Club meetings, social events, and speakers; programs, news and articles in issues of *The Festivus*; Club library holdings; listing of shell clubs and organizations; and links to societies and resources.

Go to the site and enjoy!

Upcoming program in August

Dr. Greg Rouse of Scripps Institution of Oceanography will speak at the August 19th meeting. His topic is "Mollusks and Other Animals at Costa Rica Methane Seeps."

Scientists from Scripps, Caltech and Indiana State have been studying methane seeps that form hard carbonate rock off the Pacific coast of Costa Rica. This has been done using the submersible *Alvin* and the ship R/V *Atlantis* during cruises in 2009 and 2010. One outcome has been over 50 new animal species, including a series of bivalves and gastropods.

Don't miss this exciting presentation.

INTRASPECIFIC VARIABILITY OF THE SHELLS OF *SINEZONA RIMULOIDES* (CARPENTER, 1865)

ELIZABETH A. R. GARFINKLE^{1, 2}

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Abstract Shells of the marine mollusk *Sinezona rimuloides* vary in size, but are similar in shape and sculpture. Images of *S. rimuloides* were taken with a Scanning Electron Microscope (SEM), which were then measured. Averages and ranges were calculated, as well as comparisons of characteristics between shells in the same museum lot and shells in the same genus. Three different shells were compared, each with little damage and wear which is not a considered factor.

Introduction

Sinezona rimuloides (Carpenter, 1865), is in the Family Scissurellidae. Species in this family have been extensively studied by Geiger (2003, 2009). Specimens used in this study were collected off the Pacific coast of Mexico. Discussed here are measurements of the major components of the shell, which were then analyzed and compared to two other species. *Sinezona rimuloides* is a common shell that is likely to have further studies conducted in the future.

The study of three *Sinezona* species was conducted to compare and contrast the following: shell length and height, protoconch length and height, number of axials in the protoconch, varix, apertural margin, and aperture length and width. Further collecting is required to confirm my hypothesis that shell structure and characteristics are due to species and not locality.

Methods and Materials

Three lots of dry specimens of *Sinezona rimuloides* from the Santa Barbara Museum of Natural History (SBMNH), Department of Invertebrate Zoology were studied (SBMNH 85156, 85168, and 85160). Due to their small size, a dissecting microscope was used to clean the specimens. Shells were put in 75% EtOH to reduce surface tension, and then diluted with distilled water. The specimens were then placed in an ultrasonic cleaner, and finally dried. Specimens were handled by using paintbrushes and tungsten dissecting needles. Specimens were then mounted onto double-sided carbon adhesive

tapes, and sputter coated (Cressington 108 Auto/SE). Images were taken using a Zeiss Evo 40 XVP Scanning Electron Microscope. The images were edited using *Photoshop* and shell characteristics were analyzed.

Shell analysis consisted of measuring the protoconch, varix, apertural margin, and aperture. Data are summarized in Table 1 along with the measurements of *Sinezona zimмери* Geiger, 2003, from east Anakena on Easter Island and *S. milleri* Geiger & Saski, 2009, from Okinawa, Japan. All data were organized and compared in size from largest to smallest, and by the number of axials. Analysis of locality was done using Google Earth. Findings are summarized below.

Results

Details of shell shape in *Sinezona rimuloides* are shown in SEM photos (Plate 1, figs. 1c, 2c, 3c) and are described in Table 1. Shell maturity was determined by the amount of closure of the apertural margin. The protoconch consists of a varix, axials, and an apertural margin. The shells have similar shapes but vary in size. Overall, shell shape is similar in *S. rimuloides* (Plate 1, figs. 1c, 2c, 3c). Compared to shells of the snail *S. zimмери*, *S. rimuloides* is larger in length by approximately 200 μm and in width by about 500 μm . The protoconch in *S. rimuloides* is also larger than the protoconch in *S. zimмери* by approximately 30 μm in length. Despite the fact that *S. zimмери* is a smaller shell than *S. rimuloides*, it has about four to five more axials

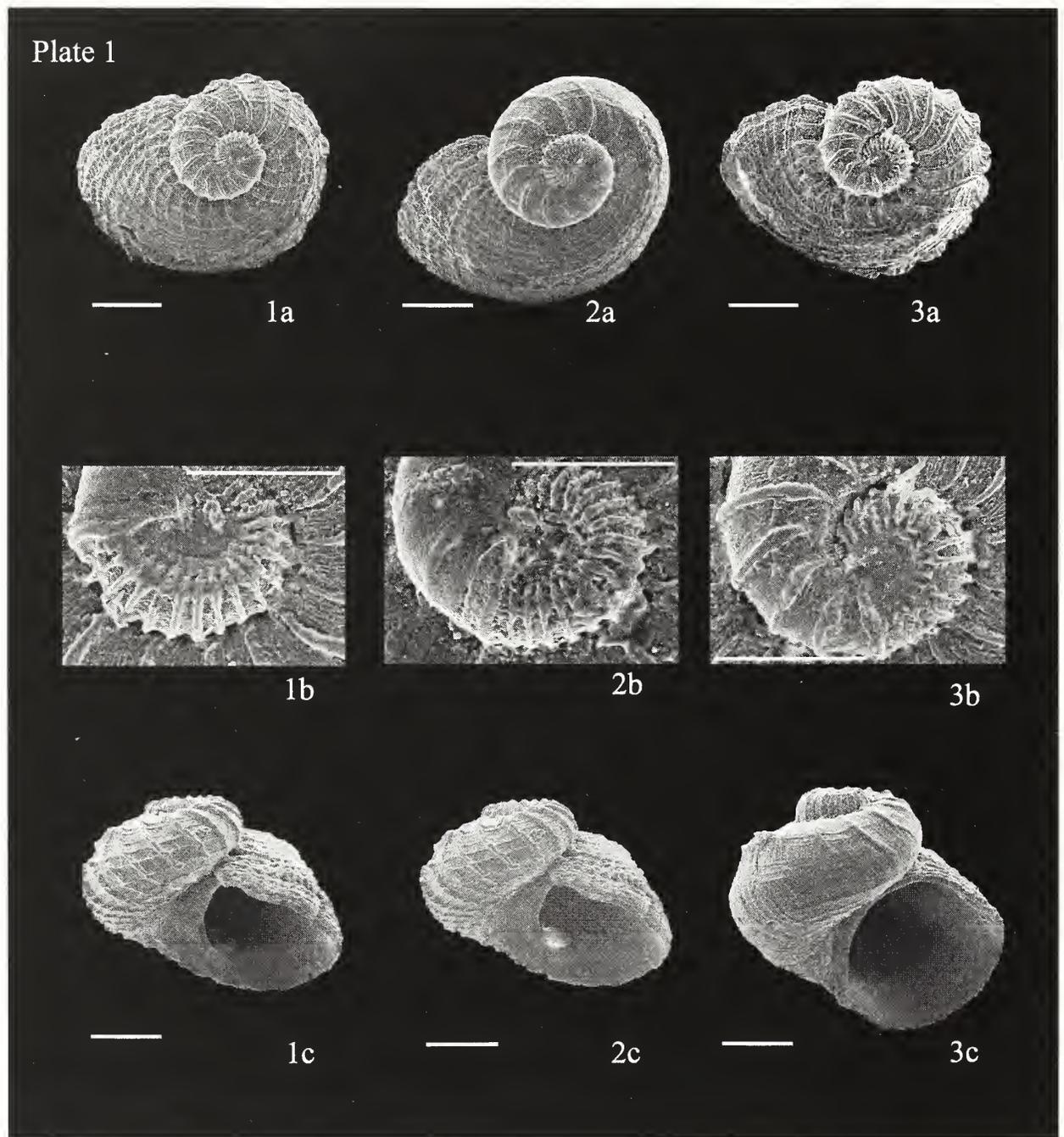


Plate 1, figs. 1 a-c - 3 a-c. *Sinezona rimuloides*. Views of three shells collected in the Gulf of California (SBMNH 85168). Top view (1a, 2a, 3a); protoconch view (1b, 2b, 3b); aperture view (1c, 2c, 3c). Scale bars for 1a-3a = 200 μ m. Scale bars for 1b-3b = 100 μ m. Scale bars for 1c-3c = 200 μ m.

on its protoconch. Although *S. rimuloides* and *S. zimmeri* are placed in the same genus, *S. rimuloides* is significantly larger than *S. zimmeri*. Compared to the shells of *S. milleri*, *S. rimuloides* is larger in length by approximately 100 μm and in width by approximately

100 μm . In addition, the protoconch is larger than the protoconch in *S. milleri* by 30 μm in length and approximately 20 μm in width. Despite the fact that *S. milleri* is a smaller shell than *S. rimuloides*, it has three more axials on its protoconch (Plate 2, figs. 1a-c, 2a-c).

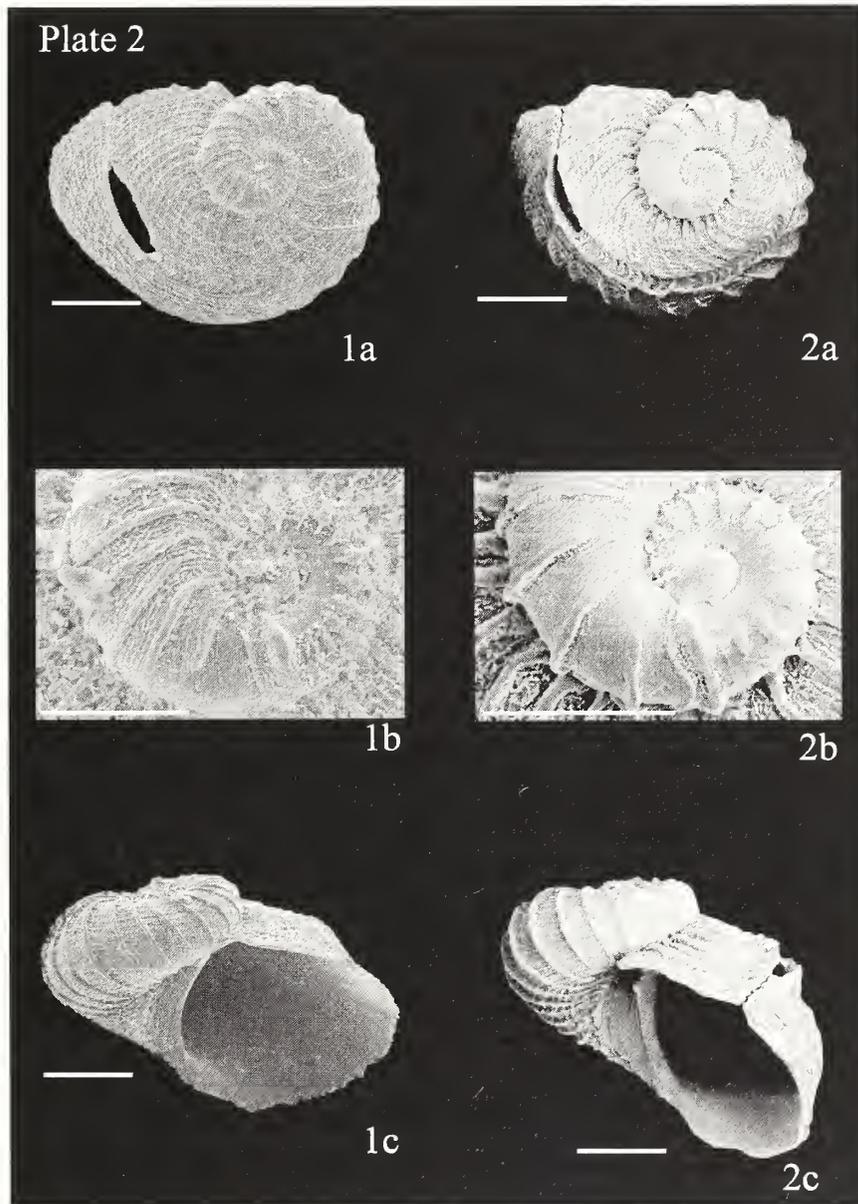


Plate 2, figs. 1 a-c. Holotype of *Sinezona milleri*. SBMNH 83548. North side, Ikei Jima, Okinawa, Japan. Scale bar shell = 500 μm . Scale bar protoconch = 100 μm . **Figs 2 a-c.** Holotype of *Sinezona zimmeri*. LACM 2912. Off Punta Rosalia, east of Anakena, Easter Island. Scale bar shell = 200 μm . Scale bar protoconch = 50 μm .

Discussion

In the genus *Sinezona*, *S. rimuloides* is the largest shell compared to *S. zimmeri* and *S. milleri*. The three specimens of *S. rimuloides* studied were collected in the Gulf of California, on the coast of Sonora, Mexico. One specimen of *S. zimmeri* was collected from east of Anakena on Easter Island and three specimens of *S. milleri* from Okinawa, Japan. Mexico is geographically closer to Easter Island, but the shells from these locations are the least related in size. The shells from Japan are more closely related in size and characteristics to those from Mexico, despite the fact that these locations are farther apart geographically.

S. rimuloides has the largest protoconch of the three species. The protoconch of the shells from Mexico are closely related to those from Easter Island, which is closer in distance. Although *S. rimuloides* is the largest in size and protoconch of the three shells, it has the fewest axials. The shells from Easter Island and Japan are more closely related in terms of the number of axials.

Conclusion

Similarities in structure and characteristics of the shells in the genus *Sinezona* appear to depend on the species and not the geographic location. This is a tentative conclusion based on the limited number of specimens studied. Further collecting is required to confirm my hypothesis that shell structure and characteristics are due to species and not locality.

Acknowledgments

I want to thank Dr. Daniel Geiger for the opportunity to write this paper and learn how to operate the SEM and Dr. F.G. Hochberg for the experience of working in a museum lab and with the museum collection on interesting projects. I also want to thank him for never passing up a learning experience and for treating me like a member of the lab. Daniel Geiger also provided all SEM images in Plate 2. Finally, I'd like to thank Patricia Sadeghian and Paul Valentich-Scott for all of the stories and museum lessons.

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Table 1. Morphological Measurements of *Sinezona* spp.
 Sample size = 7. All measurements are in microns (μm)
 nm = not measured; A = axials; L = length; W = width.

<i>Sinezona</i> species	Shell		Protoconch			Varix		Apertural margin		Aperture		Museum Cat. No.	Notes
	L	H	L	W	A	L	W	L	W	L	W		
<i>rimuloides</i>	857	685	184	125	17	100	12.5	228	28.6	400	485.7	SBMNH 85168	Figure 1
<i>rimuloides</i>	800	600	169	125	16	87.5	6.25	171	28.6	571	464	SBMNH 85168	Figure 2
<i>rimuloides</i>	886	657	131	106	17	68.7	16.3	257	257	314	485.7	SBMNH 85168	Figure 3
<i>zimmeri</i>	697	103	152	nm	21	nm	nm	nm	nm	nm	nm	LACM 2912 Holotype	Geiger, 2003
<i>milleri</i>	760	510	150	108	20	nm	nm	nm	nm	450	340	SBMNH 83548 Holotype	Geiger, 2009
<i>milleri</i>	780	540	144	112	20	nm	nm	nm	nm	450	350	SBMNH 83549 Paratype	Geiger, 2009
<i>milleri</i>	790	590	150	110	20	nm	nm	nm	nm	400	400	SBMNH 83549 Paratype	Geiger, 2009

UNUSUAL LOCATION FOR *LATIRUS MEDIAMERICANUS*

RICK NEGUS

3401 Woodland Way, Carlsbad, CA 92008, USA
RNegus@roadrunner.com

In 1992, I was diving with Larry Buck and Charlie Waters off the Redondo Beach breakwater and found the 73.1 mm *Latirus* specimen shown in Figures 1 and 2. It was collected live at 30-40 feet, 100 feet inside the breakwater, among rocks and sand. I had never seen this species in California waters and after much searching had the specimen identified, by Carole Hertz and confirmed by Carol Skoglund, as the Panamic species *Latirus mediamericus* Hertlein & Strong, 1951. The species is figured in Keen (1971, fig. 1330) and its distribution reported as Manzanillo, Colima, México to Santa Elena, Ecuador. Shasky (1976) found it intertidally in Panamá and Cantera-K, et al.(1979) found it at Isla Gorgona, Colombia. The distribution was extended north to Puerto Vallarta, Jalisco, México by Bishop (1997).

I know of no other specimens of this species found in California and it remains a mystery as to how it got to Redondo Beach. There are periodic reports of Panamic species found in Southern California and whether it is a result of occasional El Niño conditions or some other means of transportation is unknown. It obviously is not an established species in California.

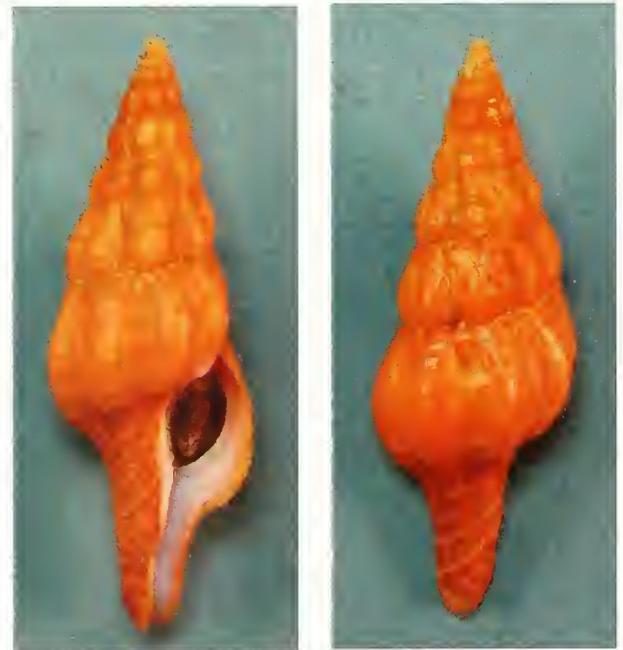
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Figures 1 & 2. *Latirus mediamericus* Hertlein & Strong, 1951. Found living off Redondo Beach, California.

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A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLII

August 12, 2010

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PROGRAM

MOLLUSKS AND OTHER ANIMALS AT COSTA RICA METHANE SEEPS

Greg Rouse, Professor of Marine Biology at Scripps Institution of Oceanography, will give an illustrated talk on the work of scientists from Scripps, Caltech and Indiana State who have been studying methane seeps that form hard carbonate

rock off the Pacific coast of Costa Rica using submersibles during cruises in 2009 and 2010. One outcome has been over 50 new animal species, including a series of bivalves and gastropods.

Meeting date: August 19, 2010

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**The San Diego Shell Club Meeting
17 June 2010**

The July meeting had to be canceled due to the serious illness of speaker Lindsey Groves' wife. Plans have been made to reschedule the program for January 2011.

The September Party

The Club's September party will be hosted this year by John LaGrange and will be held at his beautiful home and patio in Solana Beach at 5533 North Rios Ave. It will be held on Saturday September 11th beginning at 4:00 PM.. It is the Club's purely social function - for those significant others not especially interested in shells it's a chance to get together and have a good time.

A sign-up sheet for food donations will be passed at the August meeting. If you cannot attend that meeting and would like to come to the party, contact Carole Hertz (858-277-6259) and sign up for your food contribution. The Club will provide the wine, beer and soft drinks.

It's a fun party. Plan to come!

The Club's Website

If you haven't done so yet, check the Club's terrific website designed and managed by Bob Dees. The website is at: <http://www.sandiegoshellclub.com>

Bob continually updates the website with information on Club meetings, social events, and speakers; programs, news and articles in issues of *The Festivus*; Club library holdings; listing of shell clubs and organizations; and links to societies and resources.

Go to the site and enjoy!

News about the Club library

Our appreciation to librarian Marilyn Goldammer who has updated the list of holdings of the Club's library. If you wish a copy of the list, contact Marilyn at mgoldammer@san.rr.com and she can e-mail a new library list to you.

**Upcoming US Shell Shows from
August - December 2010***

Aug. 20-22 - Jersey Cape Shell Show, Stone Harbor, NJ. The Wetlands Institute, Stone Harbor. Contact Karen Lelli (856) 691-5831 or e-mail: kjlelli@comcast.net

Aug. 27-31 - Conchologists of America Annual Convention, Boston Park Plaza Hotel, 50 Park Plaza & Arlington Street. Contact Don Robak (617) 889-1841 or e-mail: shellsnail@comcast.net

Sept. 24-26 - North Carolina Shell Show, Wilmington NC, Cape Fear Museum of History & Science, 814 Market Street. Contact Ann Buddenhagen (919) 787-7103 or e-mail: abuddenhagen@nc.rr.com

Oct. 9-10 - Philadelphia Shell Show, Academy of Natural Sciences, Parkway & 19th Street, Philadelphia, PA., Contact: Paul Callomon (215) 299-1159 or e-mail: callomon@ansp.org

Date?? Sea Shell Searchers Shell Show, Lake Jackson, TX. Brazosport Museum of Natural Science, Clute, Texas. Contact Patty Humbird (979) 265-1320 or e-mail: shellclub@earthlink.net

* Our thanks to Donald Dan for providing this information.

A NEW LOCALITY FOR *VASUM GLOBULUS* (GASTROPODA,
TURBINELLIDAE, VASINAE): THE ISLAND OF SINT EUSTATIUS,
LEEWARD ISLANDS, WEST INDIES

SUSAN J. HEWITT *

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Vasum globulus (Lamarck, 1816) is a species of small, shallow-water vase snail. It is one of five species of *Vasum* which live in the Caribbean faunal zone, and one of three species of *Vasum* that live in the Caribbean Sea itself. According to Rosenberg, Moretzsohn & García (2009), *Vasum muricatum* (Born, 1778) occurs from Florida south to Venezuela and according to Rosenberg's database of Western Atlantic mollusks, Malacolog 4.1.1, *Vasum capitellum* (Linnaeus, 1758) has been recorded from Puerto Rico south to Venezuela.

Vasum globulus on the other hand, has an extremely restricted range. Prior to the publication of this paper, *V. globulus* was thought to be endemic to just two adjacent islands in the outer arc of the northern Leeward Islands of the Lesser Antilles, West Indies: the island of Barbuda and the nearby island of Antigua (Map 1). *V. globulus* seems to occur in very localized shallow subtidal areas of the coastlines of these islands, but individuals are usually described as being numerous in the small areas where the species does occur.

The shell of this species, like shells of other *Vasum* species, is solid and heavy for its size. Unlike other vase snails however, the shell is globular in overall shape, which led Tucker Abbott in 1950 to create the subgenus *Globivasum* for this species. Despite the globular shape, the shell aperture is quite narrow because there is an extremely thick columella which has three folds. Unlike the shells of *Vasum muricatum* and *V. capitellum*, the shell of *V. globulus* often has no spines, but the overall sculptural pattern of nodules and the funnel-shaped architecture of the umbilical area are quite similar to those of the other two species.

A color image of a shell of *V. globulus* is shown in Abbott & Dance (1982: 209) and another one in Lozet & Petron (1977: 87). There are also some images online. Malacolog 4.1.1 has much relevant data on the

species, including the history of the nomenclature. It is worth noting that the species does *not* also occur off Africa, as once thought. *Turbinella nuttingi* Henderson is a synonym. *Buccinella tuberculata* G. Perry, 1811, although 5 years earlier than the Lamarck description, was suppressed by Petit (2003) as a "nomen oblitum" or forgotten name. The Perry (1811) figure of the shell, although not a very accurate depiction, is shown here (reduced from color to black and white) as Text figure 1.

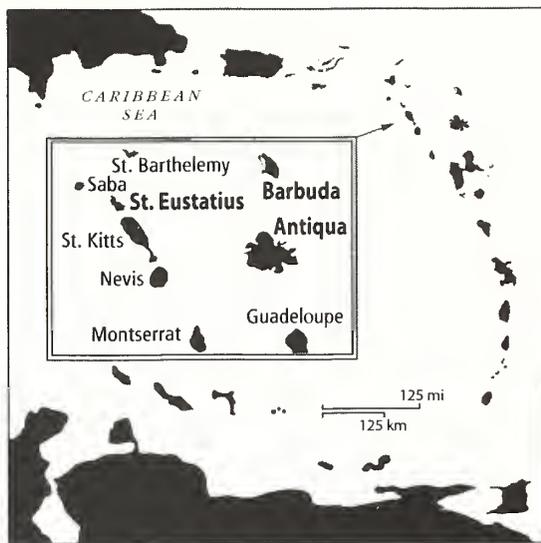


Text figure 1: A black-and-white version of the color illustration of a shell of *Vasum globulus* (described as *Buccinella tuberculata*) from Perry's 1811 publication.

The small island of Sint Eustatius is in the inner arc of the Leeward Island chain (Map 1). This island is only about 56 km north-northwest of the island of Nevis, my main focus of research. For more information on St. Eustatius, see the introduction in Hewitt (2010).

A form of *Vasum* which has a shell described as being intermediate in characteristics between that of *V. capitellum* and *V. globulus* was reported living off of the island of Anguilla, by Watters, Petuch & Serrand (1999).

Anguilla is 120 km northwest of Barbuda. In Map 1 it is visible as a long thin island on the upper right, but is not included in the inset



Map 1: The Lesser Antilles from Hispaniola to Venezuela, with an inset showing part of the inner and outer arcs of the northern section of the Leeward Island chain.

I recently started investigating the marine mollusk fauna of St. Eustatius. Until May 2010, I had not visited the island, but in April 2008, a friend brought me a small group of shells from there, see Hewitt (2010). In September 2009, while I was doing some background research about the island, the Tourism Authority for Sint Eustatius put me in touch with the St. Eustatius National Parks organization, STENAPA. I made e-mail contact with Nicole Esteban, who was then the manager of STENAPA, and who was also the first chair of the Dutch Caribbean Nature Alliance. Nicole showed me, via e-mail, a number of images which had been taken underwater by scuba divers Brenda S. Kirby and R. Duncan Kirby. One of these images (Plate 1, figure 1) was taken in April 2007 in the Southern Reserve of the Marine Park (which completely surrounds the island and includes two Reserves). The image showed a red hermit crab in a worn and somewhat encrusted marine gastropod shell. The shell had a curious and distinctive shape and yet at first I could not identify it. After a few hours however, I realized that it must be a shell of

Vasum globulus.

In October 2009, I received from Nicole Esteban a sample of mixed marine mollusk shells, both whole and fragments, which STENAPA Park Ranger Hannah Madden and a group of Junior Rangers (local school children) had hand-picked for me during a one-hour search of beach drift that had been thrown up above high water mark in the southwestern part of the island. This coastal locality is known as "Crooks Castle" and is about 1000 m northeast of the point where the red hermit crab had been photographed underwater. When I sorted the sample, I found that it included evidence of *V. globulus*: two complete shells (the larger one 26 mm), one very broken shell, and two fragments (Plate 1, figure 2). One of the whole shells was in reasonably good condition (Plate 1, figure 3). For comparison, a live-collected shell of *V. globulus* from English Harbor, Antigua, is shown in Plate 1, figure 4.

The shells the Junior Rangers had found for me confirmed the presence of *V. globulus* on St. Eustatius. The Junior Rangers had been encouraged to pick up all the shells they could find, and compared to the numbers of shells of other species that were present in the sample, *Vasum globulus* appears to have been common in the drift in this one locality.

In March 2010, I received from Nicole Esteban another packet of shells and shell fragments that the Junior Rangers and Hannah Madden had hand-picked for me on Zeelandia Beach, on the other side of the island, the northeastern coast. In this sample was what appears to me to be an extremely worn fragment of a larger shell of *V. globulus* indicating that the species might occur at more than one locality around the island. This was confirmed on May 3, 2010 when I visited Sint Eustatius and searched the same two localities as well as one more locality on the Atlantic side. I was able to find shells or shell fragments of the species in the beach drift at all three localities.

The regulations on collecting in St. Eustatius are as follows: the taking of any shells alive or dead, either underwater or on the beaches of the Marine Park (which completely surrounds the island) is prohibited, from the high water mark down to a depth of 30 m. Researchers need to apply in advance for a STENAPA permit. Customs officers search bags at the airport, and will confiscate items that are unaccompanied by a permit. In addition, any export of *Eustrombus gigas* or coral pieces is forbidden without a CITES permit.



Plate I, figs. 1-4. (1) Underwater image of a red hermit crab in a worn shell of *V. globulus* from St. Eustatius. The crab was found and photographed by Brenda and Duncan Kirby, currently of Grenada; image used with permission from the photographers and from STENAPA. (2) Shells and fragments from beach drift on Sint Eustatius, largest 26 mm. Image by Susan Hewitt. (3) Apertural view of one shell from beach drift on St. Eustatius, 23.5 mm. Image by Susan Hewitt. (4) Apertural view of a shell from Antigua, 30.4 mm (operculum not shown), live collected by an anonymous diver, shell sold by dealer Sue Hobbs and now in the Charles Whitman Collection. Image by Susan Hewitt.

Vasum globulus is present on the island of St. Eustatius, and it appears to be common in at least one area there. The species is already known to inhabit Antigua and Barbuda. These two islands are situated only about 50 km apart on the Barbuda-Antigua shelf, but St. Eustatius is not particularly close to them, being about 150 km to the west (see Map 1).

The nearest islands to Antigua (other than Barbuda) are Guadeloupe, Nevis, Montserrat and the very small uninhabited island of Redonda, which is not shown on Map 1. The nearest islands to Barbuda (other than Antigua) are Saint Barthelemy (aka St. Barts) and St. Kitts, with Nevis and Sint Eustatius being slightly further away.

I am, by now, quite familiar with the fauna of Nevis, which is 96 km from Antigua, 105 km from Barbuda, and about 56 km from St. Eustatius. I have never found any evidence of *Vasum globulus* on Nevis, despite intensive searches of beach drift over the last 12 years of annual visits. Why *V. globulus* would be easily found on St. Eustatius, and apparently not so on Nevis is a mystery. But it is part of a greater mystery: why *V. globulus* should be confined to these three small islands in the Leeward Island chain, whereas its locally occurring congeners, *V. capitellus* and *V. muricatum*, have ranges that are considerably larger.

It would be very interesting to investigate the reproduction and development of this species. If I can find someone on St. Eustatius who is interested and capable, I will recommend setting up a marine aquarium in order to try to study these aspects of the species. It would also be interesting to know more about the ecological requirements of *V. globulus*.

The marine mollusk fauna of most of the Leeward Islands has not been well investigated. According to Malacolog 4.1.1, Antigua has 132 published records of marine mollusk species, Barbuda 39, Saba 17, St. Eustatius 1, St. Kitts 35, Montserrat 14, Saint Barthelemy 37, Saint Martin 89 and Anguilla 38. Guadeloupe, which is a larger island, has published records of 288 marine mollusks.

Vasum globulus is relatively small and inconspicuous (maximum recorded size 43 mm, but more often about 25 mm in adult size) and it can be extremely localized in its occurrence, so it is conceivable that this species may occur, as yet undetected, on one or two other islands in the area. The islands of Saba and St. Barthelemy seem like possible places to search for *V. globulus*; both islands are rela-

tively close to St. Eustatius, and both have rocky coasts that may suit this species.

Acknowledgments

I wish to thank Nicole Esteban, Kate Walker and Jessica Walker of STENAPA for their very generous help, and also to thank National Park Ranger Hannah Madden and Junior Rangers Martijn de Jong, Naihillia Schmidt, Eslainy Windefelde and Bradley van Putten, for hand-picking shells for me on St. Eustatius. Thanks to Brenda S. Kirby and R. Duncan Kirby for allowing me to use the photograph of the hermit crab. Thanks to Charles Whitman for the loan of the Antigua shell, and to Harry G. Lee for help with the literature. The information from Gary Rosenberg's database Malacolog 4.1.1 is provided with the permission of the ANSP. The map and plate were assembled with expert help from Ron Hartley.

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REPORT OF THE COMBINED AMS/WSM MEETING - 2010

The 43rd annual meeting of the Western Society of Malacologists (WSM) was held jointly with the 76th annual meeting of the American Malacological Society (AMS) on June 26-30, 2010, at the Aztec Center, at San Diego State University, San Diego, California. The meeting was organized and ably run by WSM President George Kennedy and AMS President Doug Eernisse. There were approximately 115 attendees from as far as Alaska and La Paz, México. Many of the presenters and attendees were students which bodes well for the future of malacology. Figure 1 is montage showing many of the attendees.

Registration began with a pizza party on the evening of Saturday the 26th and the papers began on the 27th. There were concurrent sessions on three of the four days of presentations. On the 27th there was a special session on invasive mollusks concurrently with contributed papers on marine mollusks. Since my interest is the marine animals, I attended the latter session. I particularly enjoyed Jann Vendetti's paper, *Predation at a snails's Pace: Time-lapse photography in neogastropod whelks*. She used the time-lapse photography to record the predatory behavior of large buccinids using bivalve mollusks as the prey item. This technique provided comprehensive observation of predation mechanisms such as between-valve wedging, marginal chipping, smothering and engulfment. Another paper I enjoyed was *Observations on the biology of Neosimnia barbarensis and predator-prey interaction with the sea pen host, Acanthopithum sp.*, by Paul Tuskes and Jennifer Kelly. Although this study had been previously published in *The Festivus*, there was a lot of new information presented and new slides to see. Many in the audience were unaware of this particular predator-prey interaction and were fascinated by the photography. On the evening of the 27th, Patrick LaFollette presented a workshop on *Malacological Literature and Resources on the Internet*.

The concurrent sessions on the 28th were molluscan paleontology 2010 and contributed papers on terrestrial and freshwater mollusks. I chose to attend the paleontology session. Lindsey Groves opened the session with a tribute to LouElla R. Saul. He did a wonderful job summarizing her life and her contributions to malacology including all the papers she wrote and the species she named and/or those named for her. The tribute ended later in the morning with LouElla

receiving a special WSM award. Appropriately the first two papers of the session were coauthored by LouElla with Richard Squires. I particularly liked Edward Petuch's, *A. bernayine cowrie species radiation from the Plio-Pleistocene Everglades pseudoatoll*. In the Everglades region of Florida, the subfamily Bernayinae evolved the largest number of taxa and formed the largest single cowrie radiation ever found in the Americas. During the Pliocene and early Pleistocene, 97 species evolved in the carbonate and estuarine environments within the pseudoatoll. The author pictured many of these and it is amazing how well they are preserved and how diverse they are within the small area. In the evening, Eric Gonzales and Daniel Rokhsar presented a workshop entitled *Molluscan Genomics Workshop: Seq-based genomics for organismal biology*.

There was a single session on the 29th entitled *Molluscan Biogeography: Perspectives from the Pacific Ocean*. A paper entitled *Pleistocene glaciation, biogeographic dynamics, and evolutionary responses of Eastern Pacific molluscan assemblages* was given by Peter Marko. He described his study of population isolation with *Nucella canaliculata* and long-term population persistence with *Mytilus californianus*. He talked of future work with comparative genomics to clarify and expand his current studies. Cynthia Trowbridge presented a very interesting paper on sacoglossan opisthobranchs comparing the number found in both the NW and NE Pacific. Japanese sacoglossans generally have planktotrophic larvae with potentially long-distance dispersal, yet few of these are found on NE Pacific shores. The sacoglossan fauna of NW Pacific shores shows little similarity to those of Atlantic shores but considerable affinity to those of Indo-Pacific shores.

On the evening of the 29th, I attended the AMS/WSM Auction and Reprint Sale. There was a nice selection of books, photographs and miscellaneous art objects to auction. Hans Bertsch was the auctioneer and he did a fantastic job of entertaining the audience and getting the highest possible bids. Both the reprint sale and auction were very successful and the money will be used by both organizations to further student grants.

On the 30th, the last day of papers, there were once again concurrent sessions. One session had contributed papers on chitons and bivalves while the other session

featured contributed papers on tropical eastern Pacific species. I was particularly fascinated by the paper, *Chitons: Acapulco's gourmet delight*, by Sergio García Ibáñez. The chiton of choice is *Chiton articularis*. The exotic dish prepared from chitons is locally known as "Cucaracha del Mar a la Mexicana" (Mexican Style Sea Roach). If the chitons are soaked in sea water they become soft and slimy. If they are soaked overnight in fresh water they absorb the water and become very crispy. They are then prepared like ceviche. Many of the restaurants use other mollusks such as *Plicopurpura pansa* and *Fissurella gemmata* to complement the dish. Two additional papers by Jorge Cáceres Martínez and Rebeca Vásquez Yeomans on parasites found in *Chione fluctifraga* and histopathological alterations in *Crassostrea gigas* associated with algal blooms were very interesting. These studies are very important in supporting the commercial production of these two species. They emphasize the danger of eating raw bivalves. The afternoon was devoted to viewing the Poster Session and attending the general business meetings of the two sponsoring organizations.

A farewell dinner was held that night at the Casa Guadalajara in San Diego's Old Town. There were 56 attendees at the dinner and it was a fun event starting

with margaritas followed by a Mexican buffet and ending with flan and Mexican pastries. The atmosphere was festive augmented with songs by mariachis and the flashing of cameras.

The WSM Student Grant Awards for 2010 were announced at the WSM business meeting. First place (\$1000) went to Robyn Miekko Dahl for proposal *Paleoecological controls on Ordovician gastropod evolution in Laurentia*. Second place (\$500) was awarded to Maria Meza-Lopez for her proposal *Is community composition determined by biotic interactions between exotic and native aquatic plants and invertebrate herbivores?* The best Student Paper Award for the 2010 meeting was given to Ronald Cesar Zepeta Vilchis for *Morphometric analysis and diversity of Chitons from Oaxacan coast*. The best Student Poster Award went to Logan Froman for *Is a newly discovered chiton brooder on Santa Catalina Island an undescribed species?*

The 2011 WSM meeting will be held at the Centro Interdisciplinario de Ciencias Marinas, La Paz, Mexico. It will be run by President Esteban Félix-Pico from June 27-30, 2011. Janet L. Leonard will be in charge of running the 2012 meeting at the University of California at Santa Cruz, California on June 24-27, 2012.

JULES HERTZ

Figure captions. [An asterisk(*) indicates photos taken by Fabio Moretzsohn.]

Top row (left to right): Cynthia Trowbridge, Jules Hertz, Nora Foster, Edward Petuch, Louella Saul, Douglas Eernisse.

Second row (l-r): Kristen Jenkins, Jann Vendetti, Logo, Lindsey Groves.

Third row (l-r): *[Getting ready for the Group Photo], Jos & Kim Leal, [San Diego Natural History Museum field trip photo by museum volunteer] Barbara Myers, Paul Tuskes, Carole Hertz, Scott Rugh, Esteban Félix Pico, Fabio Moretzsohn.

Fourth row (l-r): George Kennedy, Paul & Ann Tuskes, Gary Rosenberg & Hans Bertsch.

Fifth row (l-r): *[At the Banquet] Carole & Jules Hertz, Esteban Félix Pico, George Kennedy, Jos & Kim Leal, [Auction] Carlos Cáceres Martínez, Nora Foster, Roland Anderson, Gary Rosenberg & Hans Bertsch. →



ADDITIONAL RECORDS OF THE NEWLY DESCRIBED *MURICOPSIS MCLEANI* FROM THE GOLFO DE CALIFORNIA

SHAWN WIEDRICK

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 E-mail: shawnwiedrick@hotmail.com

Muricopsis (Muricopsis) mcleani Wiedrick, 2009, is a Panamic muricid that was recently described and compared to other similar species of this genus. An illustration of the species was published by Myers (2000: 38, fig. 2), who misidentified the specimen as *M. (M.) pauxillus* (A. Adams, 1854: 71). It was concluded by Wiedrick (2009: 48) that *M. (M.) pauxillus* is a southern species ranging from Mazatlán, Sinaloa to Manzanillo, Colima, México with additional southern unconfirmed localities.

Muricopsis (M.) mcleani was recorded primarily from the Golfo de California with one record from Isla Santa Cruz, Islas Galápagos. Several authors (Dushane & Poorman, 1967: 429; Fair, 1976: 65, pl. 7, fig. 17; M. Mulliner, 1996: 65) listed "*M. pauxillus*" from within the range of *M. (M.) mcleani*, but these records are considered to be misidentified.

During a recent trip to Loreto, Baja California Sur, México, I was able to find additional records of *M. (M.) mcleani*. All records were found at Juncalitto, located south of Loreto. Three live specimens, including one juvenile, were collected under a rock at a depth of nine feet while SCUBA diving. The largest specimen (Figure 1) was in excellent condition and matches the holotype. Another crabbed specimen was collected intertidally at the same locality.

I thank James McLean for assistance in improving this paper.

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Figure 1. *Muricopsis mcleani* Wiedrick, 2009. Collected at Juncalitto, Baja California Sur, México in December 2009. Height 10.8 mm.



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ISSN 0738-9388

THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

September 9, 2010

Number: 9

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 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

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PROGRAM

THE SEPTEMBER PARTY

September 11th beginning at 4:00 PM until ?
 At the home of John LaGrange
 5533 North Rios Ave., Solana Beach

There will be no regular meeting this month.

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CLUB NEWS

The San Diego Shell Club Meeting 19 August 2010

The meeting was called to order at 7:40 PM by Vice-President Jules Hertz. The previous minutes were approved by the membership. Silvana Vollero gave the treasurer's report. The corresponding secretary was on travel.

Carole Hertz discussed the arrangements for the September party which will be held at John LaGrange's house. Date: Saturday, Sept 11th. Time: Begins at 4 PM.. Address: 533 North Rios Ave, Solana Beach. This is a pot-luck so a sign-up sheet was circulated. If you missed the sign-up sheet, call Carole Hertz at 858-277-6259 and she can add your name and what you are bringing to share to the list.

The speaker for August was Dr. Greg Rouse of Scripps Institution of Oceanography. Greg presented an overview of unique deep-water cold methane seeps off Costa Rica and discussed the biotic community. The unique characteristics of the seeps are not their depth of 1000 to 1800 meters, nor the macro-organisms dependence on bacteria. At this location, some of the bacteria and bacteria-like organisms form calcium carbonate that over time have generated stony reefs via a process called anaerobic methane oxidation. Some bacteria may reach a mm in length and are clearly visible without the use of a microscope. Oxygen levels are low at these depths and hydrogen sulfide exits the seeps with the methane. The bacteria live on the sulfur and via a sulfur oxidizing process extract it from the hydrogen sulfide. Many organisms from crabs to clams have symbiotic relationships with these bacteria, while others, such as chitons, limpets and snails may feed directly on the surface bacteria.

The *Alvin* is a three person submersible that allows researchers to observe and photograph the amazing diversity and collect samples. Dive time is approximately eight hours, and of that four hours may be required to descend and return to the surface.

Currently 43 species of mollusks have been found with bivalves (Vesicomidae, Solemyidae and Mytilidae) among the largest mollusks on site. Many of the snails range in size from a few mm to 1-2 cm. The largest found so far are Turbinidae and a *Neptunea*. Life is tough for some mollusks at these locations as both the pressure and pH of the water increase the rate at which

shell material dissolves. A good periostracum seems to help protect the shell. Turbans, without a periostracum can have a pearl-like appearance at maturity, as the outer shell dissolves. Unique adaptations of crabs, worms, and parasites were also discussed. They have found and collected two species of gorgonians at that depth. Morphological and DNA studies are being used to sort out the unique species. An outstanding presentation by Dr. Rouse.

The meeting was adjourned at 8:55 PM for social time. Refreshments were brought by Silvana Vollero and Nancy Schneider. The door prize was won by Richard Herrmann.

Agony with the August Issue

As you've all probably realized by now, your August issue was over a week late. It was not the fault of the publisher – but of the United States Post Office which never mailed them out after we delivered them to their local office! Once we realized what had happened, we were horrified and appeared at the Post Office whose employees assured us that it would have been mailed on time. After much discussion, and Jules (business manager) explaining that when he went to the special window for group mailings on August 12, the woman who accepted the box of issues could hardly speak English and didn't know what to do with these issues, the supervisor decided to institute a search and would call us with the results. That afternoon we got a call saying our issue would be in our mailbox shortly and it was that very day.

The envelope was canceled, but with no date. Quick delivery – but over a week late. And the first time in all these years that the issue didn't go out on time. We've since appreciated receiving e-mail notes from many of our members assuring us that they had finally received their issues.

Here's hoping this never happens again.

Additions and Changes to the Roster

New member

MORETZSOHN, FABIO, 4538 Coody Lane, Corpus Christie, TX 72413. E-mail: mollusca@gmail.com

Change of address

WIEDRICK, SHAWN, 1151 Walnut Ave., Apt. 51, Tustin, CA 92780.

E-mail: shawnwiedrick@hotmail.com

CYPRAEOIDEAN AND TRIVIOIDEAN LITERATURE 2005 THROUGH 2009

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ABSTRACT: Since 2004 at least 492 publications that refer to fossil and/or Recent cypraeoideans were published subsequent to Groves (2004). In addition to those publications, 228 papers not cited by Schilder & Schilder (1971) or Groves (1994, 2000, 2005) are listed. The entry “fig’d” is noted for citations in which the number of figures is unknown.

Introduction

At least 492 publications that deal entirely or partially with cypraeoideans and/or trivioideans were published from 2005 through 2009. In addition at least 228 publications not listed in Schilder & Schilder (1971) and/or Groves (1994, 2000, and 2005) that also deal with cypraeoideans and/or trivioideans are included. This list only includes pertinent references that emphasize and/or mention cypraeoideans and/or trivioideans in faunal surveys and lists, general interest and/or regional emphasis books, and papers dedicated to those superfamilies. Titles marked with an asterisk (*) are those which deal partially or entirely with fossil cypraeoideans and/or trivioideans. Unless otherwise noted, all references are in English, and those non-English titles that have English abstracts and/or summaries are noted. References not credited to a specific author, editor, or publisher are referred to as “anonymous.” Unpublished works are not listed with the exception of theses and dissertations. Cypraeoideans and trivioideans listed in price lists are likewise not included.

As with previous lists, an assertive effort has been made to include all pertinent references, particularly journals and other publications received by the Malacology and Invertebrate Paleontology departments of the Natural History Museum of Los Angeles County. Despite this effort some titles may have been inadvertently overlooked. Therefore, as in the past, the author requests that missed titles and/or improperly cited titles be brought to his attention for inclusion in future lists.

Acknowledgments

As in previous compilations many colleagues contributed to this project. Dirk Fehse (Berlin, Germany) provided copies of numerous personal papers and pdf files of acquired rare references and has continued to keep me abreast of new papers. Eduard Heiman (Rehovot, Israel) kindly provided pdf files of numerous supplements of the *Triton*. Kevin Bonham (University of Tasmania), Luigi Bozzetti (Italy), Daniel Geiger (Santa Barbara Museum of Natural History), George Kennedy (Brian F. Smith & Associates, Poway, California), Bernie Landau (Centro de Geologia da Universidade de Lisboa, Portugal), Felix Lorenz (Buseck-Beuern, Germany), Daniel Muhs (U.S. Geological Survey, Denver Colorado), Luiz Simone (Museo de Zoologia da Universidade de São Paulo, Brazil), and Adam Yates (University of the Witwatersrand, Johannesburg, South Africa) provided copies of personal papers, PDFs, or papers available at their respective institutions.

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ISSN 0738-9388



THE FESTIVUS

A publication of the San Diego Shell Club

Volume: XLII

October 14, 2010

Number: 10

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 Overseas (air mail):\$50.00; Mexico/Canada (air mail):\$30.00.
 Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The *Festivus* is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

CITY OF SAN DIEGO "ENHANCED" OCEAN MONITORING PROGRAM

Tim Stebbins, Senior Marine Biologist and Director of the City of San Diego's Ocean Monitoring Program, will give an illustrated talk on the environmental monitoring work conducted by the City in the coastal

waters off San Diego and Pt. Loma and South Bay ocean outfall regions as well as information on special studies and enhancements conducted by the City in collaboration with other scientific organizations.

BOOK AND REPRINT SALE

Meeting date: October 21, 2010

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CLUB NEWS

The September Party

It was a small but delightful party with the sixteen joining at John LaGrange's home, long-time friends happy to see each other and some delicious food to enjoy. The weather was mild and people were both indoors and out, some gazing at John's many beautiful and unusual specimens of nature's treasures.

The Club thanks John for his hospitality in once again hosting this year's annual September party.

The Annual Christmas Dinner Party

The Club's annual Christmas Dinner Party will be held on Saturday evening December 11th. It will once again be held at The Butcher Shop at 5255 Kearny Villa Road in San Diego (off Highway 163 at Clairemont Mesa Blvd.). Festivities will begin at 6 PM with no host cocktails, dinner to be served promptly at 7 PM. Because the restaurant has not yet readied their holiday menus, the Club's menu and cost of the evening will be published in the November issue.

The speaker for the evening has already been settled. It will be one of the Club's favorites, member-photographer, Richard Herrmann. His presentations are always special.

Please save the date and enjoy the event with your fellow members and friends.

Club Memberships for 2011

All membership/subscriptions received in October will automatically be for 2011 and will begin with the January issue of *The Festivus*. Memberships will remain the same for 2011 as it has been for this year (see front page).

Book and Reprint Sale at the October Meeting

Every year the Club tries to have a book and reprint sale of worthwhile material that has been donated to the Club but not available to be in the Club's library because either they are duplicates, more for children and/or – there is no room for the reprints in our limited space. We try to schedule it toward the end of the year, this year at the October meeting, always thinking in terms of gifts for the holidays.

Money received from the book/reprint sale goes toward the purchase of new books for the library.

The Annual SCUM meeting 2011

Just so you can save the date – the annual SCUM meeting will be held on January 21st at the Southern California coastal Water Research Project in Costa Mesa. SCUM is a relaxed setting, free to all those interested, and the programs and presentations are always of interest.

Save the date, further details will follow.

RETURN TO SAN FELIPE, BAJA CALIFORNIA, MÉXICO

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For more than 50 years shell collectors have traveled to San Felipe, Baja California at the far north end of the Golfo de California to take advantage of the rich molluscan fauna found there on the regular low tides. North of Isla Tiburón the tidal range increases rapidly until it reaches nearly eight meters at San Felipe on the lowest tides in the spring when low water conveniently occurs in the early morning daylight hours. Although I have collected there after dark in the winter months, I don't recommend it – it is not for the faint of heart, especially when the wind is blowing. After a few paragraphs about the changes to San Felipe, I will get on to shell collecting there today.

The many species of shells found in the various habitats around San Felipe have been described in detail in past issues of *The Festivus*. All of the reference citations contain useful information about the area or they discuss and illustrate many of the shells found there. The papers comprise a series of articles and supplemental publications mostly having to do with the collection assembled by Joyce Gemmell during the years 1965 to 1976. Joyce and her husband, Bill Gemmell, lived in San Felipe for many of these years in a trailer park known as Club de Pesca at the south edge of town where Bill pursued fishing and Joyce pursued natural history, especially malacology. This trailer park is still there, by the way, and is thriving complete with motor homes, trailers and many permanent structures. It also houses the largest community of ATV enthusiasts, some as young as seven or eight, to be found anywhere near San Felipe.

San Felipe has changed in major ways since the Gemmells and other San Diego Shell Club members collected there years ago, although my wife, Patricia, and I only made our first trip to San Felipe in 1986. We had visited Puerto Peñasco (Rocky Point), across the Gulf in Sonora, from our home in Tucson, Arizona. What we discovered was that the San Felipe area not only had a much different variety of shells than what

could be found in Bahía de Adair, near Puerto Peñasco, but that we liked visiting the Baja side more. And so, we have returned every three to five years and watched many more changes occur over the past 20 years (Figure 1).



Figure 1. San Felipe still supports an active fishery. Photo: McClincy.

The town seems to be prosperous today, although its livelihood is clearly based on tourism rather than fishing. The rustic beach camps of the 1960s and 1970s that were strung out along the beach north of San Felipe have morphed into sophisticated vacation communities. Substantial permanent homes are mixed together with motor homes, trailers and less substantial dwellings. Regardless of the climate, I have never been able to understand how a family could tent-camp on the beach for a week or more with no services but many do, even today in the warmer months.

Such old-time camps as El Paraíso (Pete's Camp) and El Dorado Ranch look today nothing like what old-timers might remember from 30 or 40 years past. El Dorado Ranch, in particular has been transformed into a "luxury executive vacation resort" complete with a subdivision-like layout, paved streets, comfortable perma-

ment homes, recreation center, golf club and swimming pool. If you can't afford an ocean-view lot, El Dorado Ranch extends westward across the highway where more homes can be found in the desert with mountain views.

The highway to San Felipe from the U.S. border in Mexicali (Mex. 5) has also changed drastically over the years. It has, of course, been widened and re-paved on occasion, but today it is being extended north from San Felipe as a fully divided highway complete with many new bridges over the dry washes. A few traffic lights have been installed near town and looping turn-arounds are provided every few miles or so to get from one side to the other. New PEMEX stations have sprouted near town and the usual strip development of convenience stores, restaurants, tire shops and souvenir stores is spreading north like a living creature. The entrances into many of the old beach *campos* now sport large masonry arches and lateral walls. Some advertise with billboard-size signs. Quite a few also restrict access to owners and guests with manned kiosks and gates or chains across their road. (Prospective customers are always welcome, of course.)

The town of San Felipe is also worth a few remarks for readers who might remember it from long ago. I don't know what the *malecón* (Paseo de Cortez) looked like prior to the mid-1980s, but today it is one continuous strip of bars, convenience stores, souvenir outlets, more bars and outdoor restaurants, each offering the best fish tacos in town. It is fun to make a circuit in early evening and the fried *filete de pescado* (never mind the tacos) is always fresh and delicious. The beach across the street is clean and it usually hosts a large collection of *pingas* which the locals still use for fishing around the mountainous Punta El Machorro (Punta San Felipe) at the north edge of town. You can also rent all sorts of water toys on the beach, including some to ride or be towed on behind a *pinga*. Curiously, parasailing doesn't seem to have caught on here. ATVs appear to be prohibited from the beach near town and on the tide flats, although hundreds of them swarm over and around any patch of sand within half a gas tank of town. Ambulances are a common sight and San Felipe today has a well-equipped hospital and police contingent.

A continuous parade of vehicles that appear to be chained together rather than acting independently can always be found crawling along the *malecón* and looping back down Avenida Mar de Cortez, both now one-way streets. Mar de Cortez looks much like the *malecón* on both sides of the street but souvenir stores

here outnumber the bars by a large margin. We spend part of each day there, for entertainment, shopping and dining. Beyond these first two streets running parallel to the beach, San Felipe quickly reverts to a Mexican town with the homes and shops of the locals. All manner of goods, from food to medicine, can be purchased locally and the city water is safe to drink, in my opinion.

A mile or two south of town the old hotels are mostly still there. The El Cortez is very popular, though basic, but it maintains a popular restaurant with an outside patio, a large swimming pool, and it is right on the beach just north of the Club de Pesca. Farther south our old favorite is now closed, along with the Hotel Riviera on the hill and across the street from the El Cortez. Our favorite hotel in San Felipe was called Hotel Castel San Felipe when we first stayed there in 1988. The two-storey buildings were arranged around three sides of a large rectangle where they enclosed tree-shaded lawns, flower beds and two large pools (one with a swim-up bar). The fourth side of the rectangle was left open to Bahía San Felipe to catch the breeze off the water and to provide a clear view. The hotel was located just north of the commercial marina where the fishing fleet docks inside a large breakwater. Over the years this hotel deteriorated, but when we came back in 1997 we found that it had been purchased, up-graded and re-named the Hotel Las Misiones. In 2007 we were disappointed to find that Hotel Las Misiones was closed. The new owners planned to add a third storey to some of the buildings, up-grade the whole place and refurbish the bar and restaurant. By 2010, with the project half completed, the proposed El Playa Club Habana resort redevelopment had been suspended for lack of money and tourists, and the whole project was shut down indefinitely, which is how it remains today.

Our most recent trip here earlier this year took on a whole new dimension since my wife, Patricia, has lost most of her sense of adventure when it comes to San Felipe's older hotels. This year she planned for us to stay in the partially completed Playa del Paraíso condominiums near the marina (Figure 2). After some initial confusion, we were ultimately given a suite of five tastefully furnished rooms, including a full kitchen with granite counter tops and new stainless steel appliances. From our private covered patio on the ground floor we could walk out to the beach just north of the marina. This beach, although technically still in town, has always produced a worthwhile assortment of live shells and it remains one of our favorite collecting



Figure 2. The new Playa del Paraíso condominiums in San Felipe. Photo: McClincy.

spots near San Felipe. During the past few years we have collected three pure golden *Oliva incrassata burchorum* Zeigler, 1969, here, together with many other species.

Collectors in years past frequented several beaches both north and south of San Felipe that we are not familiar with because our infrequent trips there are limited to the number of collecting sites we could visit in a few days and because we could not locate some of them. One in particular, Playa Alicia, was located well south of town and old directions to this beach were given in relation to a road that no longer exists. The new road from San Felipe to Puertecitos follows a different route and we have never been able to determine exactly where Playa Alicia was, or is, located. It was a favorite collecting spot 30 to 40 years ago. Locals that I have asked about it don't recognize the name.

Another formerly well-known beach was called Percebu and it is easily located because of its sign on the highway. The beach area is now heavily developed with vacation homes and cottages. We visited Percebu once about twenty years ago and had good collecting, especially of *Terebra petiveriana* Deshayes, 1857, *T. variegata* Gray, 1834, a few *T. bridgesi* Dall, 1908, and, especially, *Conus ximenes* Gray, 1839. The tide flats then had some rocky areas with a few white 'sea whips' that yielded *Simnia* sp. in small numbers. *Oliva incrassata* [Lightfoot, 1786], always common in the area, could be collected at the rate of several per minute so long as you were willing to bend over and pick them up. Sometime during the 1990s, however, ocean currents or a storm scoured the sand from the tide flats and excavated a deep channel parallel to the beach. Most of the sand appears to have been deposited as an island lying about 100 yards offshore and running

parallel to it. Consequently, the former Percebu tide flats are a thing of the past and we have been unable to collect there as recently as March of this year.

Playa Estrella, now signed as "Rancho Playa Punta Estrella" has been a favorite collecting spot for over forty years. The turn-off to this beach is 7.5 miles south along the coast road to Puertecitos as measured from the left turn where the road from town continues straight ahead to the airport. Lying about one mile from the main road, the beach supports a privately-owned camping area consisting of dozens of shelters lined up along the beach crest. The owner seems to be always present and charges US\$5 per hour to park. Shell collecting on the extensive tide flats that are exposed here on strong minus tides has always been productive, though unpredictable. The commonest species includes the ubiquitous *Oliva incrassata* that could be collected by the thousands with enough time and energy, but the important ones are the largest measuring over 70 mm (not common) and *O. i. burchorum* (rare; found here) (Figure 3).



Figure 3. *Oliva incrassata burchorum* Zeigler, 1969; 42 - 47 mm. Photo: McClincy.

These tide flats also offer many olives with a weak-to-strong pattern but with a yellow ground color. Internet sales offer these as the form *burchorum* but they are not, really, because of their evident pattern. These yellow olives are not uncommon but they are usually less than 50 mm.

Playa Estrella also hosts large colonies of *Conus perplexus* Sowerby, 1857, and of several terebras, including *Terebra variegata* at sizes exceeding 75 mm. This year we observed several dozen large *Polinices bifasciatus* (Griffith & Pidgeon, 1834) measuring over 50 mm. *Neverita recluzianus* (Deshayes, 1839) has also been collected here in small numbers and this year was no exception. Various bivalves are found here including

Laevicardium elatum (Sowerby, 1833) and *Simomactra dolabrifformis* (Conrad, 1867). Both can be found alive in small numbers, though not reliably. Most of these and other species found off Playa Estrella seem to occur in colonies restricted to only one or two of the many sandbars. Collecting here is usually productive but the results are unpredictable, even during the same month of consecutive years. The hundreds of *Conus perplexus* that were seen bumping on the return of the tide one April may be entirely absent the next, or maybe you didn't find the sandbar where the colony was that particular year. Collectors can usually find *Solenosteira macrospira* Berry, 1963, and *S. capitanea* Berry, 1957, in fair numbers.

The sand at the bottom of the beach slope at Playa Estrella has been composed of unusually coarse sand for as many years as we have visited here. In times past this coarse sand hosted a large colony of *Glycymeris maculata* (Broderip, 1832), one of the common bittersweet clams. This year, however, this clam was found to have expanded its range well out from the beach slope. For at least ½ kilometer seaward and twice that distance both north and south, this pest was found everywhere in uncountable numbers. Individual shells range from 5 mm babies up to more than 50 mm in diameter, and since they bump as well as make trails, it is virtually impossible to differentiate between them and other shells unless each one is dug up for inspection. This *Glycymeris* has made shell collecting at Playa Estrella nearly impossible because of their sheer numbers and the resultant frustration (Figure 4).



Figure 4. Shells of *Glycymeris maculata* (Broderip, 1832) littering the beach at Playa Estrella. Photo: McClincy.

Continuing farther north, towards town, the next

popular spot is a beach at the bottom of a sandy sloping access road long known as Radar Beach. Collecting here has always been productive but the selection of species is much the same as at Playa Estrella. This year we found that the access road was chained where it left the main road and inquiries informed us that a developer had recently purchased the site and was making plans for the future – so, access denied.

The various beaches between Radar Beach and the marina in San Felipe are all developed to one extent or another. Some allow access to non-residents and some don't. Some charge hourly parking fees. Over the past 20 years, however, we have never had good collecting at any of them and seldom wasted a good low tide to return where nothing was found on a previous visit. The main beach in town, at least at the southern end for the first mile north of the marina, has consistently yielded a good selection of shells and we have collected there on every visit, at least once. The morning tides seem to be more productive than the afternoon/evening tides.

The tide flats here extending from the north side of the marina (avoid the south side) reach out from the beach for only a few hundred meters but three or four bars are usually exposed on a minus 4-ft. tide with the shallow channels separating them lined with silted fine sand or even mud. The common shells to be found here include the ubiquitous *Oliva incrassata* and the rare *O. i. burchorum* (pure golden with no trace of pattern), tiny *O. undatella* and, rarely, a few *O. spicata* (Röding, 1798). Several olivellas, especially *Olivella dama* (Wood, 1828), are sometimes common. Terebras found here might include *Terebra petiveriana* (sometimes abundantly) and *T. bridgesi*. Occasional *Polinices* spp. and an infrequent *Sinum debile* (Gould, 1853) might be found together with several species of nassarids in very large numbers. Bivalves found here include *Trachycardium panamense* (Sowerby, 1833), several species of pitar and an occasional *Tivela byronensis* (Gray, 1838). The larger bivalves, and those collected for food, are mostly absent due to over-collecting by locals, often to make souvenirs for sale in town. Although present, tiny white clams seldom tempt me to bend over for them so I can't describe what species they represent. It is obvious that the southern geoduck, *Panopea globosa* Dall, 1898, lives here deep under the sand because an occasional hinged pair of valves can be found on the surface. The large rocks making up the north side of the marina enclosure are home to several species of ostrea and chama. The best specimens of these are found completely encased in living sponge

which prevents calcareous growths from attaching (poke all sponges with your finger to find the shells). At certain times in early spring *Turritella leucostoma* Valenciennes, 1832, and *Hormospira maculosa* (Sowerby, 1834) are fairly common on the sand bars.

One of the most popular collecting spots near San Felipe that was recommended to us years ago both by Carol Skoglund and the late Ginny Upton is the rubble area immediately adjacent to the south side of Punta El Machorro at the north end of town. This area lies immediately in front of the now abandoned camping site known as Campo Uno, or Rudy's Camp. At low tide the area consists of a field of rocky rubble at the base of the mountain. The rocky area is bordered by a muddy drainage channel and narrow sand flats. The sand flat is pretty barren except for several turrids, mostly *Crassispira kluthi* E.K. Jordan, 1936, and several other crassispiras, plus truly baby *Oliva incrassata*. The little olives, not commonly seen elsewhere in the area, are often less than 10 mm in length. The muddy channel used to be famous for *Typhisopsis clarki* (Keen & Campbell, 1964) and, although we have found them here in past years, the last few visits have yielded none. Carol Skoglund once told me that "they used to be all over the place", but that was then. Once past the mud the intertidal area consists of a rocky rubble band that winds northward all the way around the base of the point. Hundreds of species of small shells, columbellids, nassarids, trochids, small bivalves and many others, can be found under the loose rocks and in the sandy mud underneath. *Fusinus fredbakeri* Lowe, 1935, is always common here, although not always alive. The undersides of the rocks themselves are home to maybe one dozen species of chitons, a few corbulars, small peccens and any shell that the myriad small hermit crabs have taken a fancy to. On several occasions we have found up to one dozen of the large sea hare, *Aplysia californica* Cooper, 1863, nestled between these rocks.

The beach slope just below Campo Uno consists of a rubble band of clean diorite boulders that, at first glance, looks very unpromising. On every visit, however, we notice several Mexican families digging away in these boulders and finally decided that there must be something worthwhile underneath. After my curiosity finally got the best of me, I asked one gentleman what they were up to and he showed me his bag of *almejas* (clams) of which every one was a fine *Semele flavescens* (Gould, 1851). Farther down the beach where this rubble band was on flat ground others were digging for *Protothiaca grata* (Say, 1831).

The last collecting site near San Felipe that we

routinely visit is a small cove on the north side of Punta El Machorro. This cove is variously called Ensenada Blanca or, sometimes, Cactus Cove. It can be reached by a dirt track running around the mountain (no 4WD needed). The beach crest has a line of permanent structures and several of these are usually occupied by a few campers. A fence running to the beach here seems to divide private from public land and if you park on the north side of the fence, as we do, there should be no fee for parking. Playa Blanca is a mirror image of the south side of the mountain in terms of the structure of the intertidal area, but the fauna is different in the lee of the point. The rocky rubble holds fewer species and fewer shells in general but the large clam *Dosinia ponderosa* (Gray, 1838) can be found here wedged between the rocks at the water's edge. Most are sub-adult but a fully adult shell can sometimes be found. If you really want a few of these at their maximum size they can usually be bought at the marina for as little as US\$5 per dozen. Try chewing one and you will quickly learn why they are so inexpensive.

Playa Blanca is also interesting to us for an unexpected reason. Years ago we discovered that numerous small patches of sand on the flats out near the tide line were pock-marked with many small holes. These patches seldom measure more than 12 inches in diameter; often less. Curious, I once dug up a hand-full of sand from one of these patches and discovered that the holes were for circulating fresh water to hundreds of small hermit crabs densely clustered together beneath the surface. Now we never visit here without a plastic sieve. By sifting the mixture of sand and shells we have found many species of small shells, including several turrids formerly considered to be uncommon around San Felipe or not reported from the area at all. Chief among these is the elegant *Crassispira maura* (Sowerby, 1834) which turns up frequently and so must be common offshore. While the crabbed shells are all dead of course, many are in good condition and their sheer numbers assure a good selection when you sort them out later at home.

More beaches, camps and developments march up the coast north of San Felipe for many miles, but we never seem to have the time to visit them. For that matter, beach camps also extend south of town all the way to Puertecitos, a distance of some 90 km (56 mi.). You can even continue beyond Puertecitos to Bahía San Luis Gonzaga if you really feel adventuresome. However, destinations more than about an hour from town seem like separate trips and we always save them for a rainy day which never seems to come.

Leaving San Felipe after our last trip could have been a lot more interesting had we stayed three more days and experienced the big earthquake. The epicenter of the 7.2 magnitude quake that struck northern Baja California on April 4, 2010 was only a couple of miles west of Mex. 5 at a point just south of where the farms end south of Mexicali. The highway there was broken by the earthquake and the vertical displacement of the northern portion looked to be about 18 inches from photos we found on the web. Fortunately, there was no serious damage in San Felipe and no injuries were reported.

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CONE SHELL FOUND IN AN OCTOPUS MIDDEN ON BONAIRE

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The island of Bonaire is located in the southern Caribbean Sea just 50 miles north of Venezuela (Figure 1). It is a good place to observe octopus behavior (Anderson, et al., 2008; Anderson, 2002) as the octopuses can be found at popular dive sites at depths of a meter or less. The island only gets about 25 cm of rain a year and consequently is a true “desert” island where the predominant wild vegetation is four kinds of cactus. As a result of the low rainfall, there is little runoff and the marine waters are very clear and the visibility remarkable, frequently exceeding 30 m. The island is a popular SCUBA diving destination and the car license plates state “Bonaire – Divers’ Paradise.” Flamingos fly to Bonaire daily from Venezuela to feast on brine shrimp in salt evaporation ponds.

The common octopuses of Bonaire, *Octopus vulgaris* (Cuvier, 1797) are mostly generalist feeders (although some are specialists: Anderson et al., 2008). During the course of one study over five years (Anderson et al., 2008) 75 different species of prey were found in 38 octopus middens within one kilometer of shoreline, indicating the octopuses were taking advantage of the rich diversity of possible prey items there. No cone shells (*Conus* spp.) were reported in the middens in that study, nor have any cone shells been reported in the middens of any octopus.

During a research expedition to Bonaire in 2010 we found the cone shell *Conus regius* (Gmelin, 1791) in the midden of an octopus (*O. vulgaris*) (Figure 2). The octopus’ den was located in one meter of water 200 m south of the dive dock at the Sand Dollar Resort. The den was spotted by its typical cluster of cleaned shells, composed of *Ctenoides* spp., *Chlamys* spp., *Mithrax* spp., and several gastropods other than the *C. regius*



Figure 1. Map showing the island of Bonaire in the southern Caribbean Sea, just off the coast of Venezuela.



Figure 2. *Conus regius* shell found in water one meter deep in an *Octopus vulgaris* midden on Bonaire.



shell. Octopuses can typically be found by looking for the shell middens (Wood & Anderson, 2009). The *C. regius* shell was pitted with boring sponges and was likely "crabbed," once inhabited by a hermit crab, which the octopus likely captured and ate (Alan Kohn, pers. comm., 24 May 2010). In spite of their narrow apertures, *Conus* spp. shells are frequently inhabited by small hermit crabs (*ibid.*).

Conus spp. are venomous and some are even deadly to humans (Abbott, 1974). Cone shells experimentally presented to *O. vulgaris* were rejected with the octopuses displaying a learned avoidance (Nixon & Maconnachie, 1988). Octopuses are highly adapted and are capable of learning (Mather et al., 2010). They drill, inject venom, and eat numerous other gastropods (Anderson et al., 2008). But as *Conus* spp are venomous in return, octopuses either may have learned not to attack and eat live *Conus* spp or have evolved to eat them only when inhabited by hermit crabs.

ACKNOWLEDGMENTS

We thank Alan Kohn of the University of Washington for identifying the cone shell and we thank

Dr. Kohn and Jennifer Mather of the University of Lethbridge for thoughtful discussions on the subject. This work was partially funded by an NSF Graduate Research Fellowship to D.H.B.

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THE FESTIVUS

A publication of the San Diego Shell Club

ISSN 0738-9388

Volume: XLII

November 11, 2010

Number: 11

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 Overseas (air mail):\$50.00; Mexico/Canada (air mail):\$30.00.
 Address all correspondence to the San Diego Shell Club, Inc.,
 c/o 3883 Mt. Blackburn Ave., San Diego, CA 92111, USA.

The Festivus is published monthly except December.
 The publication date appears on the masthead above.
 Single copies of this issue: \$5.00 plus postage.

Meeting date: third Thursday, 7:30 PM,
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PROGRAM

MOLECULAR ANALYSIS IN THE NATICIDAE: SOME LESSONS LEARNED AND SOME OPEN QUESTIONS

The evening's speaker, Michael Hollmann, will give a presentation which will highlight how molecular analysis of DNA sequences can be employed to help solve long-standing taxonomic disputes, as exemplified by the successful differentiation of *Neverita delessertiana* (Recluz in Chenu, 1843) from *Neverita duplicata* (Say, 1822). In addition molecular analysis of the peculiar egg masses of the Naticidae (the so-called sand collars) will be shown to be a valuable

tool in taxonomy and biogeography.

Finally, data will be presented on how molecular analysis can uncover previously unrecognized taxonomic problems such as the existence of cryptic species. As examples, white *Polinices* species from the Indo-Pacific area will be shown to comprise more species than previously believed, and *Naticarius onca* will be shown to represent a species complex rather than a single species.

Meeting date: November 18, 2010

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CLUB NEWS

San Diego Shell Club Meeting Minutes 21 October 2010

The meeting was called to order by VP Jules Hertz at 7:45 PM. The previous minutes were approved and the treasurer's report was given. Carole Hertz reminded people to sign up for the Christmas party at the Butcher Shop. For more information contact Carole.

Tim Stebbins, Senior Marine Biologist and Director of the City of San Diego's Ocean Monitoring Program, gave an excellent presentation on the Enhanced Ocean Monitoring Program. The scope of this effort is significant as they are responsible for evaluating what happens after the effluent exits the sewer pipe. The City program monitors water quality, including chemical and biological, and evaluates the effect of the discharge on marine organisms.

In addition to the traditional water quality sampling, toxicological studies are conducted to evaluate bio-accumulation of chemicals and elements in marine fish. The Enhanced Program looks at deep water quality, studies the discharge plume and sediment and the impact of the Point Loma discharge on the benthic communities. The sampling covers about 340 square miles of ocean and extends from just south of the US-Mexico border, north to Del Mar. In addition the Ocean Monitoring Program participates in the Regional Program, with dozens of other agencies and interested parties, to evaluate the impact on the Southern California Bight. The Southern California Bight sampling is conducted every 5 years.

Our current waste water facilities remove 87% of the solids and the water is discharged at a depth of 300 feet off Point Loma. The Enhanced Program began in 1994 and no significant impact from the discharge has been found in our benthic marine community.

Book sales were brisk both before and after the meeting. It is always a great opportunity to find interesting literature at bargain prices.

The shell drawing was won by Don Smith. The meeting was adjourned at 9:00 PM and the refreshments were provided by Evelyn and Don Smith and Carole and Jules Hertz.

Paul Tuskes

The Annual Christmas Dinner Party 11 December 2010

The Club's annual Christmas Dinner Party on Saturday evening December 11th will once again be held at The Butcher Shop at 5255 Kearny Villa Road in San Diego (off Highway 163 at Clairemont Mesa Blvd.). Festivities will begin at 6 PM with no host cocktails, dinner to be served promptly at 7 PM.

The menu for the evening offers two choices of entree: Prime rib of beef (8 oz) or Fillet of salmon. The dinner includes a mixed green salad, garlic mashed potatoes and fresh vegetables, dinner rolls and butter and coffee or tea with Carrot Cake for dessert.. As always, dinner wine will be provided by the Club. The cost for the entire evening, with tax and gratuity is \$30 per person.

The speaker for the evening will be one of the Club's favorites, member-photographer, Richard Herrmann. His presentations are always special.

Also, part of the program is the Holiday gift exchange. Please bring a gift-wrapped shell (or related item) with data inside and only a very general location outside i.e. Atlantic, Caribbean, Panamic etc. The more people who participate in the exchange, the more fun the event will be.

Reservations (with check) must be received by December 3rd (send to the Club address) or bring to the November meeting). Please save the date and enjoy the event with your fellow members and friends.

The Annual SCUM XV

The annual SCUM meeting will be held on Saturday January 21st at the Southern California Coastal Water Research Project in Costa Mesa, from 9 AM (Meet and Greet, with donuts & coffee), followed by the usual format of introductions and presentations with a break for lunch - TBD. The meeting lasts until about 3 PM .

SCUM is a relaxed meeting, free to all those interested, and the programs and presentations are always of interest.

For further info: e-mail kbarwick@ocsd.org. For directions: < <http://www.sccwrp.org> > .

MARINE SHELLS: ESSENTIAL FOR THE NEOLITHIC COLONIZATION OF OCEANIA

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Mollusks and corals preceded mankind into the Central Pacific Basin – they even preceded the islands themselves. When volcanic islands first erupted from the ocean floor, they were the first to colonize the bare rock. Corals created a rich marine ecosystem, while the island's terrestrial ecosystem remained sparse. The indigenous peoples of the Pacific had many uses for seashells; that should be no surprise. If I told you that a few seashells changed the course of human history – now, that might raise an eyebrow.

While much of the earth's water was bound up in glaciers 40,000 years ago, the geography was very different than today. An ancient continent called *Sunda* combined Southeast Asia, Malaysia, Indonesia and the Philippine Islands; its neighbor, *Sahul*, combined New Guinea, Australia and Tasmania (Figure 1). It was possible to walk from Sunda to Sahul with only a few relatively small water crossings. This is exactly how the ancestors of the papuan people migrated from Sunda to Sahul (New Guinea) and how the Aboriginal peoples came to Australia.

"Near Oceania" is a term for the oceanic regions of New Guinea, the Bismarck Archipelago and the Solomon Islands. The initial settlement of Near Oceania involved the peopling of greater New Guinea followed by colonizations of the Bismarck Archipelago by 33,000 B.P. and the Solomon Islands by 29,000 B.P., if not before (Matisoo-Smith, E. & J. H. Robins, 2004). "Remote Oceania" is the ocean beyond, the greater Pacific, a region where no human had gone before.

Archeological evidence tells us that some time about 4,000 years ago Austronesians, from the region of modern-day Taiwan, arrived in Near Oceania. They came by sea with mature seafaring skills and an economy based on marine resources, particularly shell fishing. Their culture is called "Lapita" after the name of the archeological site where they were first discovered. Within 500 years, they had colonies in northern New Guinea and the Bismarck Archipelago.

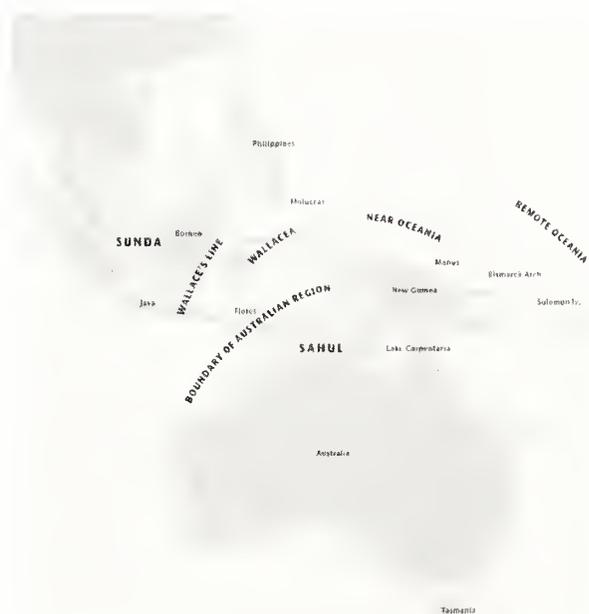


Figure 1. Map showing Sunda and Sahul showing present day mainlands (darker area), mainland extensions by lower sea levels during the Ice Age (lighter areas). From: Irwin, 2006.

The Bismarck Archipelago and the Solomon Islands have been called the "voyaging nursery" where the Lapita perfected their seafaring skills and struck out into "Remote Oceania". Three hundred years later they had expanded eastwards to Vanuatu, New Caledonia, Fiji, Tonga and Samoa.

Lapita settlements in Near Oceania are found on beaches and offshore islands, leaving the interior to the Papuans. The Lapita people kept to the margins, probably due to hostile neighbors. Their signature artifact is a uniquely decorated type of pottery. They also made shell tools, fish hooks and body ornaments which they traded among other Lapita colonies. Seashell artifacts excavated across the Pacific are

providing clues as to how these early seafarers progressed across the trackless ocean.

The Lapita stopped expansion eastward after they reached Tonga and Samoa. Archeological findings tell us that 1000 years later a new people appear with no evidence that they ever existed anywhere else. The conclusion most archeologists have reached is that Lapita peoples, living in isolation from other racial and ethnic groups became a distinct new people, genetically and culturally; the descendants of the Lapita transformed into the Polynesians. The Polynesians performed even greater feats of seafaring by discovering and populating islands from Hawaii to New Zealand to Easter Island and outlying islands as far away as Micronesia.

Lapita influences are found throughout Melanesia and Micronesia (Intoh, Michiko, 1999). Linguists have had some success teasing out the threads and establishing a linguistic family tree. The modern cultural descendants of the Lapita are found in Polynesia, in central and eastern Micronesia, and in north coastal New Guinea and the Melanesian archipelagos.

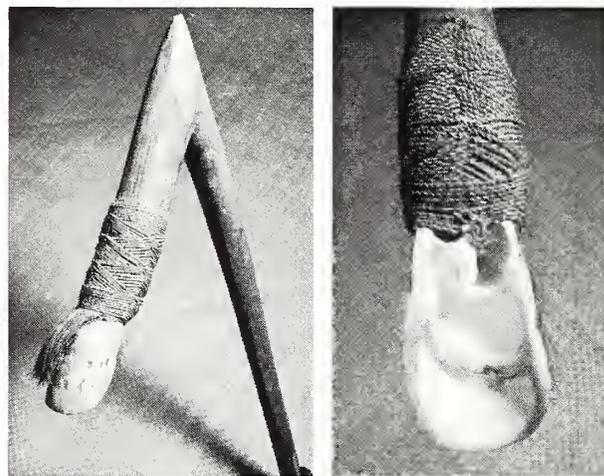
As people moved eastward into Oceania, they would encounter three different kinds of geology that would affect their survival:

1. **Continental Islands.** Islands throughout the Western Pacific (including New Guinea) are actually the tops of continents that were submerged (~450 feet) at the end of the Pleistocene glacial period. These islands provided the types of stone most Neolithic peoples needed for tool making: flint, obsidian and other useful resources.
2. **Volcanic Islands.** The Pacific (tectonic) Plate is located roughly north and east of New Guinea and it is nearly the size of the entire Pacific Ocean. Volcanic islands are *born* when “hot spots” beneath the plate erupt through the ocean floor. The Pacific Plate moves northwest 5-10 cm a year, to produce chains of volcanic islands over time. For example, the age progression of the Hawaiian Islands, from Kure atoll (89 km west of Midway) to Hawaii, is ca. 25 million years (Neall, Vincent E. & Steven A Trewick, 2008). As people moved into this region they left behind familiar stone resources but found suitable basaltic rocks.
3. **Coral Islands.** When the geological pressures that raised a volcanic island are spent, the great mass of basalt can subside under its own weight, even as the surrounding coral reef continues to grow upwards. In time, the basaltic island may

sink completely leaving only a coral reef enclosing a lagoon where a volcanic peak once stood. Coral sand and rubble, heaped up a few feet above sea level on the reef, is all the dry land there is. Neolithic peoples arriving on a remote coral island would find a complete absence of hard stone for tools.

This last point is particularly problematic. When Oceania was colonized by canoe, hard durable tools were needed to build and repair canoes. It could be years before a colony was established enough to mount another voyage or even return to their former home. At some point colonists would need to find hard, durable material for tools – or risk being stranded in the middle of the ocean. What do Stone Age people use when there is no stone? The answer is in the lagoons and on the reefs: seashells.

Seashells are the hardest materials to be found on coral islands – hard and durable enough to make adzes, chisels and drills. Of course, even the earliest Oceanians had known and used shell for tools. Giant Clams (*Tridacna gigas*, *T. maxima*), Helmet shells (*Cassis cornuta*, *C. rufa*), Auger shells (*Terebra maculata*) and Miter shells (*Mitra*) have been harvested for food and the shells used to make adze and chisel blades (Figures 2 & 3). These shells were essential for the colonization of Oceania.



Figures 2 & 3. (2) Adze blade made from *Terebra maculata* from Kiribati (3) detail of blade.

Other shell objects were perhaps less essential but nonetheless important for survival. Fish hooks and lures were made from the pearl shell *Pinctada margaritifera*, *Trochus* and *Turbo* shells (Figures 4-7). Scrapers and

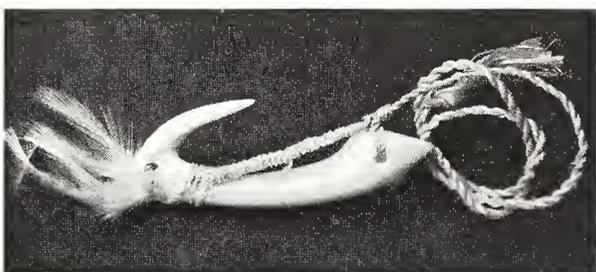
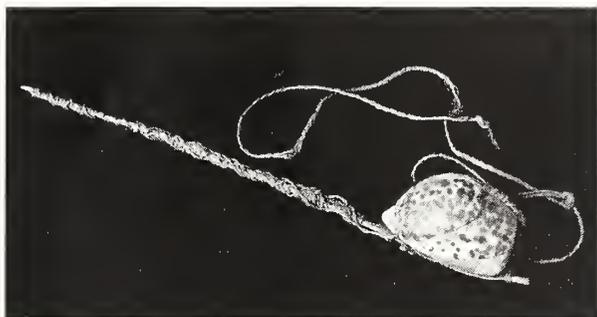


Figure 4. Tongan octopus lure made with *Cypraea* shell.

Figure 5. *Pinctada margaritifera* bone trolling lure from Hawaii.

peelers for processing coconut and pandanus, breadfruit and taro were all made from shell. Seashell body ornaments were used to signify a person's clan, role and rank in society. Easy availability and the intrinsic properties of strength, form and aesthetic appeal made shell the material of choice in Oceania.

The islands of Oceania were some of the last habitable land masses on earth to be colonized by humans – much of it, coral island (Kennett, Douglas, Atholl Anderson & Bruce Winterhalder, in review). Coral archipelagos spread out from the Tuamotus in eastern Polynesia to the Carolines in western Micronesia. There are hundreds of



Figures 6 & 7. (6) Pearl shell hook from Hawaii (7) *Tridacna* blade adze from Kiribati.

coral islands, each one having been discovered by Neolithic peoples and inhabited for thousands of years.

Consider how different human history would have been if mankind's progress into the Pacific was halted for lack of a stone. It is fortunate, indeed, that mollusks colonized Oceania first.

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CATALOGING DIVERSITY IN THE SACOGLOSSA: DOCUMENTING SPECIES THROUGH THE ENCYCLOPEDIA OF LIFE (EOL)

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The Sacoglossa is an order of marine and estuarine opisthobranchs with 28 named genera and 400 described species (Jensen, 2007). Most sacoglossan sea slugs are suctorial (sap-sucking) herbivores and many can sequester and retain photosynthetically active chloroplasts from the algae they eat, a phenomenon known as kleptoplasty. For this adaptation, these animals are known among opisthobranchs as the "solar-powered slugs" (Rumpho et al., 2000). Sacoglossans are often characterized by shell reduction or loss, dorsal cerata or parapodia, and a pair of rhinophores or a cephalic shield. All are simultaneous hermaphrodites, have planktotrophic, lecithotrophic, or poeciloginous development, and often possess noxious chemical defenses (Cimino & Ghiselin, 1998).

Current species lists of these gastropods frequently underestimate their true diversity because sacoglossans are generally small and cryptic in color. For example, in the most recent guide to Indo-Pacific opisthobranchs (Gosliner, 2008), more than half of all sacoglossans identified (n=122) were new to science and undescribed. This hidden diversity and the interest in these animals by biologists, amateur enthusiasts, and divers make this clade an excellent candidate to catalogue through the Encyclopedia of Life (EOL)

The EOL poster shown on p. 139 is an online database of species from across the tree of life (www.eol.org). It combines the expertise of specialist contributors with the biological and taxonomic information available online from resources such as the NCBI (www.ncbi.nlm.nih.gov), Barcode of Life (www.barcodinglife.org) and World Register of Marine Species (www.marinespecies.org). Such integrated information is presented as species web pages with photographs, descriptions, synonyms, common name(s) and details on geographic range, reproduction, habitat, associated flora and fauna, and conservation status. With these data the EOL endeavors to answer questions on

organismal diversity and provide the public with a trusted resource to which interested individuals may contribute.

As an Encyclopedia of Life Rubenstein Fellow (2010-2011) and postdoctoral researcher in the lab of Patrick Krug at California State University, Los Angeles, I am creating 400 species pages for the sacoglossan molluscs. Genera of particular focus are *Alderia* Allman, 1846; *Elysia* Risso, 1818; *Costasiella* Pruvot-Fol, 1951; *Thuridilla* Bergh, 1872; and *Plakobranthus* van Hasselt, 1824. I am drafting these pages through the LifeDesks platform (<http://sacoglossa.lifedesks.org>), which allows a primary curator and other collaborators to post pictures, contribute text, and edit classifications. When the LifeDesks pages are completed they are uploaded to the EOL where they are easily accessible and searchable.

___David M. Rubenstein fellowships are one-year appointments that support the organization and contribution of species-level information to the EOL. They are funded by a gift to the Smithsonian Museum of Natural History and match up to 50% of institutional financial support for an early career scientist. The inaugural 2010 cohort of 18 Rubenstein Fellows was chosen from approximately 100 applicants in the Fall of 2009 and yearly competitions are expected until 2013. The EOL aims to support at least 60 Fellows in total, many of whom will focus on marine organisms in keeping with the EOL's 2010-2013 marine theme.

Taxonomy professionals and amateurs can get involved in the EOL (with or without becoming a Rubenstein Fellow) by contributing images through Flickr, creating species pages through the LifeDesks (www.lifedesks.org) or Scratchpads (<http://scratchpads.eu>) online platforms, partnering with an existing LifeDesk or Scratchpad, or becoming an EOL content curator and reviewing submitted information for accuracy. For more information on all ways to participate see < www.eol.org > .

*Adapted from: EOL Poster, AMS/WSM Meeting, San Diego State University, 26-30 June 2010.

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Cataloging Diversity in the Sacoglossa: documenting species through the Encyclopedia of Life (EOL)



Juan E. Venúletti, Postdoctoral Researcher & 2010 Rubenstein Fellow, Department of Biological Sciences, California State University, Los Angeles

Abstract

The Sacoglossa is an order of mostly herbivorous marine and estuarine sea slugs with nearly 400 described species (Jensen, 1998; Krug et al., 1987). Many species can sequester actively photosynthetic chloroplasts from their algal hosts and others have evolved defensive adaptations such as crypsis, autotomy, and noxious anti-predator chemicals (Gimino and Ghiselin, 1999; Gevegrin et al. 2000; Pierce et al. 2003). Because sacoglossans are generally small and cryptically colored, current faunal lists are considerable underestimates of true species diversity (Trowbridge et al., 2009; Carlson and Hoff, 2009). For example, in the most recent guide to Indo-Pacific opisthobranchs, more than half of all identified sacoglossans (~120) were undescribed (Gosliner et al., 2008). This hidden diversity makes the Sacoglossa an excellent clade to catalogue through the Encyclopedia of Life (EOL).

1 The Encyclopedia of Life is an online resource and species database of taxa from across the tree of life (www.eol.org). As an EOL Rubenstein Fellow (Smithsonian Institution) I am using the LifeDecks platform to create 2 approximately 400 species pages 3 for the sacoglossan molluscs. Genera of particular focus are *Alderia* Altmann, 1846, *Elysia* Risso, 1818, *Costasiella* Pruvot-Fol, 1951, *Thuidia* Begh, 1872, and *Plakobranchus* van Hasselt, 1824. Species pages are being compiled with the collaboration of scientists, amateurs, and a variety of informative databases. An improved understanding of the Sacoglossa as a result of EOL species pages has the potential to inform comprehensive studies of their range, reproduction, development, speciation, phylogeography, morphological and molecular evolution.

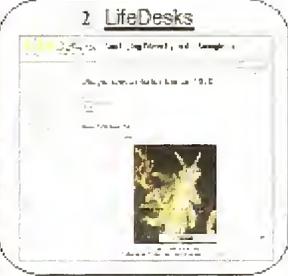


1 Encyclopedia of Life
<http://www.eol.org/>

- The EOL is an online reference that contains biological and taxonomic information from many sources (e.g. MCB, Barcode of Life, World Register of Marine Species, Catalog of Marine Life) with the expertise of specialists
- With these data the EOL endeavors to answer questions about organismal diversity and provide the public with a trusted resource to which interested individuals may contribute.

<http://sacoglossa.lifedecks.org>

- LifeDecks are a platform on which EOL species page drafts are created and organized. It allows collaborators to post pictures, add text, and edit classifications.
- When these pages are complete they are uploaded to the EOL.
- The LifeDeck I made, Cataloging Diversity in the Sacoglossa, has draft pages for approximately 1/4 of sacoglossan species.



Contributed Images from Three Major Sacoglossan Clades

<p>Limapontoriidae</p>	<p>Oxymonocerae</p>	<p>Plakobranchoidea</p>
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Species pages also include a description, type locality, nucleotide sequences, and information on reproduction, the history, habitat, algal host, chloroplast retention, and distribution. The images above were contributed by Clay Carlson, John Fraser, Patrick Krug, Angela Uebachs, Angel Valdés, and the author. They are hot to eat!

4 Collaborating Organizations

Rubenstein Fellowships
 David M. Rubenstein fellowships are funded by a gift to the Smithsonian Museum of Natural History. A one-year stipend that matches up to 50% of institutional funds supports the efforts of an early career scientist to engage and contribute species-level information to the EOL.
 The inaugural 2010 cohort of 18 fellows was chosen from 900 applicants by the Fall of 2009. Weekly core fellows are expected until 2013 with a goal of funding at least 50 taxonomic (especially with expertise in marine organisms) or Rubenstein fellows.

How to Get Involved

- Contribute images to the EOL using Flickr
- Create a LifeDeck with a theme of your choice (e.g. China, Darwin & Darwin, Invertebrates or any, etc)
- Become an EOL curator and use your taxonomic expertise to review submitted information for accuracy.
- Apply to be a Rubenstein Fellow. Applications are due in late Summer, early Fall.

For more information on all ways to participate visit www.eol.org

Acknowledgments
 Special thanks to the following content contributors:
 Vishal Sharma (Stanley Hooper Marine Station, China),
 David Berlow (University of California, San Diego),
 Clay Carlson (University of Guam),
 Patrick Krug (Cal State, Los Angeles),
 Angela Uebachs (Cal Poly, Pomona).
 To contact the author, email jvenuletti@calstatela.edu
 Please get in touch with me if you would like to contribute sacoglossa information to the EOL!

NATURE'S AMAZING HAPPENINGS

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Plastic Cup on a Carrier Shell

The Carrier Shell *Xenophora pallidula* (Reeve, 1842) finds and attaches ocean floor debris, probably for its added protection. It collects mostly shells. The glass sponge attachment is also quite commonly found on this species, but to have a plastic cup attached is not. Usually, the carrier shell is found in depths up to over 100 feet (30 meters). However, back in 1963, I collected one live specimen on a sandy beach at 2 feet depth (0.6 meters) in Davao City, Philippines. The specimen figured here (Figure 1) was taken from around Camote Island, Philippines. If only the shell could tell us how it got hold of the plastic cup



Figure 1. Carrier shell with plastic cup.

Shells and Barnacles on a San Miguel Beer Bottle

One *Spondylus butleri* Reeve, 1856, two small *Chama brassica* Reeve, 1846, and several barnacles took residence on an old San Miguel beer bottle (Figure 2). I understand that this design of the beer bottle is no longer used today. It was found in Leyte, Philippines.



Figure 2. Shells on San Miguel beer bottle.

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