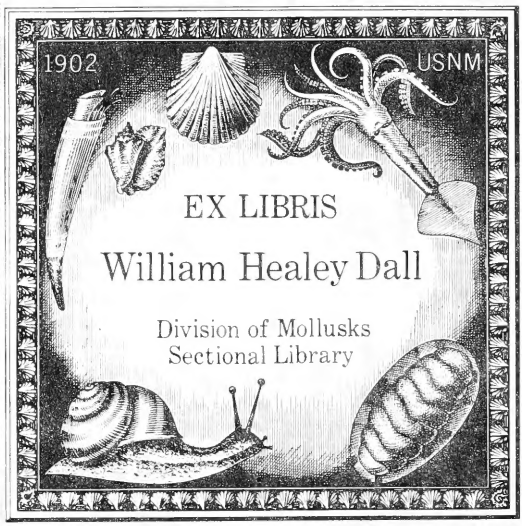
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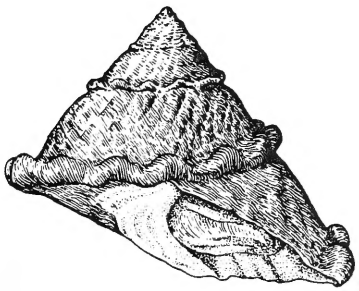
# THE WESTERN SOCIETY OF MALACOLOGISTS

## ANNUAL REPORT

Formerly "The Echo"





Pomona, California

June 19-22, 1974

**Volume 7**

The Western Society of Malacologists

Annual Report

Volume 7

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Formerly "The Echo"

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June 19-22, 1974

Issued: NOV 1 2 1974

The Annual Report of the Western Society of Malacologists is based on its yearly meeting. Distribution is free to regular and student members in good standing as of the time of issue. Membership dues are $5.00 per year for regular members, with each additional member of a family being able to join for $1.00. (A family receives only one Annual Report.) Student memberships are $2.00. Copies are available to the public upon donation (tax-deductible) of $5.00, plus 50¢ mailing costs, and members may obtain additional copies at the same price. Requests regarding membership and orders for copies of the Annual Report should be addressed to the Treasurer of the Society, Mr. Bertram C. Draper, 8511 Bleriot Avenue, Los Angeles, California 90045.

All "contributed papers" in the Annual Report are reviewed by two members of the Editorial Board in addition to the Editor.

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PROGRAM SUMMARY

Wednesday, June 19

10:30 - 2:30 - Registration
12:00 - 1:00 - Lunch
2:30 - 5:30 - Contributed Papers - Session I
6:00 - 7:00 - Dinner
7:30 - 8:30 - Slides of past AMUPD and WSM meetings and of the new Baja California road
8:30 - 10:00- Reception

Thursday, June 20

7:30 - 8:30 - Breakfast
8:45 - 12:00- Paleontology Symposium, Dr. Louie Marincovich, Chairman
12:00 - 1:00 - Lunch
1:00 - 1:15 - Group Photograph
1:30 - 5:00 - Contributed Papers - Session II
5:00 - 6:00 - Executive Board Meeting
6:00 - 7:00 - Dinner
7:00 - 8:15 - Executive Board Meeting
7:30 - 8:30 - Silent Auction

Friday, June 21

7:30 - 8:30 - Breakfast
9:00 - 12:00- "Opisthobranch" Symposium, Mr. Hans Bertsch, Chairman
12:00 - 1:00 - Lunch
1:15 - 4:30 - Contributed Papers - Session III
4:30 - 5:00 - Business Meeting
6:00 - 7:00 - No host cocktail party
7:00 - 10:00- Banquet - Dr. Clyde E. Roper, speaker

Saturday, June 22

7:30 - 8:30 - Breakfast
9:30 - 5:00 - Open house, Mollusk Research Collection, Department of Invertebrate Zoology, Los Angeles County Museum of Natural History

## NOTICE OF THE EIGHTH ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The eighth annual meeting of the Western Society of Malacologists will be held jointly with the American Malacological Union from June 22 to 26, 1975, on the campus of San Diego State University, San Diego, California. The program will feature contributed papers, symposia, displays, a silent auction of shells, field trips, and workshops.

Inquiries about the meeting should be made no later than May 15th to Mr. Clifton Martin, 324 Kennedy Lane, Oceanside, California 92054. Applications for membership should be sent to Mr. Bertram Draper, 8511 Bleriot Ave., Los Angeles, California 90045. Dues are $5.00 for regular members, $1.00 for additional family members, and $2.00 for students. Regular members and students receive the Annual Report of the Society.

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## NOTICE OF 1975 W.S.M. STUDENT RESEARCH GRANT

The Western Society of Malacologists will award a grant of $500 to an upper division undergraduate (junior or senior) or graduate (first or second year) student for the academic year 1975-1976. The grant is offered to initiate or further research concerned with some aspect of molluscan biology, ecology, systematics, paleontology, anthropology, or related fields. Grant funds may be applied to any aspect of the research, including purchase of materials, obtaining or copying literature, transportation, or publication costs.

Students must be registered in a part- or full-time status at a college, university, or marine or field station. The completed application and research proposal must be accompanied by an outline of the student's academic background and by a letter from a faculty member, instructor, advisor, museum curator or other professional scientist supervising or knowing of the student's work. The grant recipient would agree to present, if possible, the results of the research to the Society at its ninth annual meeting in the summer of 1976.

Applications and accompanying materials will be accepted no later than April 18, 1975.

Application forms may be obtained by writing:

Mr. James T. Carlton
Chairman, W.S.M. Committee on Student Grants
Department of Geology
University of California at Davis
Davis, California 95616

Memorial to JOHN Q(UINCY) BURCH (1894 - 1974)

John Q. Burch died on August 7, 1974, about a month after his 80th birthday. Some of the newer WSM members may never have met him, for after the sale of his book and shell business he retired from malacological activities. Thus these members may not realize how much we owe to the energy and persistence of John Burch in a time of need. During World War II, gasoline rationing made travel to meetings next to impossible. John Q., who had become interested in collecting through the activities of his son, Tom, took over editorship of the Minutes of the Conchological Club of Southern California and kept the club alive and thriving through issuance of the Minutes as a newsletter. Although he was then working daytimes in a shipyard, he spent his evenings and weekends typing out each month's notes. As a first step, he would make up a rough draft from his own files, making as many carbon copies as his typewriter would produce. These went to several cooperating collectors and curators, who provided additional notes and criticisms, all of which he collated in his final version, a mimeographed publication. Extracts from these Minutes later were issued as soft-bound volumes entitled, Distributional List of West American Marine Mollusca ... (1944-1946), still the most comprehensive review of West Coast species that is available.

After the war was over, the Burches ran a book and shell shop in Los Angeles that was a popular rendezvous. John Burch helped

in the organization of the AMU-PD and served as its third president, in 1950. Later he and his wife, Rose Burch, made several trips east to attend AMU conventions, and they also made a tour of European museums, studying the Olividae. By then his name was so well known from his years as a book dealer that he was given the kind of welcome usually reserved for academic professionals.

Although his chief monument may remain the "Minutes" -- which he edited for a period of about ten years -- he was author or joint author of several papers describing new species and new genera, the latest in 1963 at about the time of his retirement.

SUMMARY OF MINUTES, EXECUTIVE BOARD
AND ANNUAL BUSINESS MEETINGS,
June 20-21, 1974

(The complete minutes of these meetings are contained in the records of the Secretary of the Society and will be available at the eighth annual meeting.)

The meetings were presided over by the President, Dr. James H. McLean.

Minutes as written in the Secretary's book and summarized in The Echo were approved.

Jo Ramsaran, Auction Chairman, reported a successful auction, with 250 specimens sold for $362.

Bert Draper, Treasurer, reported a balance of $2121.06 and a membership of 242.

George Radwin announced that the joint meeting with the A.M.U. will be held at San Diego State with a tentative date of June 22-27, 1975, with a five- instead of a four-day conference.

Twila Bratcher, Nominating Committee Chairman, nominated the following:

| | |
|---|---|
| President: | Dr. George Radwin |
| 1st Vice President: | Dr. James Nybakken |
| 2nd Vice President: | Mrs. Helen DuShane |
| Secretary: | Mr. Clifton Martin |
| Treasurer: | Mr. Bertram Draper |
| Members-at-Large: | Mr. Glenn Burghardt |
| | Mr. Steven Long |

They were elected by a unanimous ballot.

The Board and Membership approved these actions:

(1) That Dr. Rudolph Stohler be presented with an Honorary Membership.

(2) That Dr. Katherine Palmer be presented with an Award of Honor.

(3) That a Student Grant of $500 be presented at the Eighth Annual Meeting in 1975 and that approximately $50 be allowed for expenses of the Committee on Student Awards.

(4) That the Conservation Committee report as given by Eugene Coan be accepted.

(5) That authority be given to Editor Eugene Coan to phase out the name "The Echo."

(6) That the Historian be allowed $35 in expenses for this year.

TREASURER'S REPORT

August 7, 1974

| | | | | |
|---|---|---|---|---|
| **Income** | | | | |
| Dues for 1973 (8) | | $ 20.00 | | |
| Dues for 1974 (246) | | 1057.00 | | |
| Dues for 1975 (3) | | 15.00 | | |
| *Echo* sales - 1969-72 issues (8) | | 20.00 | | |
| *Echo* sales - 1973 issue (15) | | 37.50 | | |
| *Annual Report* sales - extra copy 1974 | | 2.50 | | |
| Interest on Savings Account | | 55.15 | | |
| Old check never cashed | | 1.07 | 1208.22 | |
| Conference receipts: | | | | |
| Lodging, meals, & facility fees | 3807.75 | | | |
| Social hours | 74.50 | | | |
| Photographs | 48.25 | | | |
| Shell auction | 362.30 | | 4292.80 | |
| Total income | | | | 5501.02 |
| **Disbursements** | | | | |
| Refund of two 1973 banquet tickets | | 13.50 | | |
| Mailing of 1973 group photos | | 1.29 | | |
| Student award for 1973 | | 250.00 | | |
| *Echo* expenses - 1973 issue: | | | | |
| Typing | 100.80 | | | |
| Printing | 599.81 | | | |
| Mailing, etc. | 100.95 | 801.56 | | |
| Historian's expenses | | 35.09 | | |
| Secretary's expenses | | 302.39 | | |
| Treasurer's expenses | | 80.07 | | |
| AMU annual dues | | 6.00 | 1489.90 | |
| Conference expenses: | | | | |
| Lodging | 1180.00 | | | |
| Facility fees | 669.50 | | | |
| Meals & banquet | 1739.25 | | | |
| Coffee breaks | 62.50 | | | |
| Social hours | 80.00 | | | |
| Misc. | 1.10 | | | |
| Photographer for group photos | 53.50 | 3785.85 | | |
| Less advance deposit | | -100.00 | 3685.85 | |
| Total disbursements | | | | 5175.75 |
| Year net increase | | | | $325.27 |

| | | |
|---|---|---|
| Balance, July 18, 1973: | | |
| Checking account | $ 694.69 | |
| Savings account | 1210.52 | |
| | | $1905.21 |
| Net increase for 1974 | | 325.27 |
| Balance, August 7, 1974: | | |
| Checking account | 964.81 | |
| Savings account | 1265.67 | |
| | | $2230.48 |

Submitted:

Bertram C. Draper, Treasurer

## AWARD OF HONOR

### DR. KATHERINE VAN WINKLE PALMER

Article X of the By-laws of the Western Society of Malacologists establishes an Award of Honor "to be conferred in recognition of outstanding accomplishments or contributions in the fields of Conchology and Malacology." At the Seventh Annual Meeting, the Award was presented to Dr. Katherine E. H. Van Winkle Palmer. The following remarks were given by Dr. A. Myra Keen at the banquet:

Dr. Palmer has been Director of the Paleontological Research Institution in Ithaca, New York, since 1951 and a resident of that area since the early 1920s. She received her Ph.D. degree at Cornell University in 1925. But before that she was a westerner. She was born in the state of Washington and graduated from the University there, working under the eminent paleontologist Dr. Charles Weaver. Several of her early publications were on the fossil mollusks of the Washington Tertiary. Later she shifted her attention to the mollusks of the Tertiary in the southeastern United States, working at the Paleontological Research Institute that had been founded by Dr. Gilbert Harris of Cornell. It was here that she married Dr. E. Laurence Palmer, well-known teacher of nature study. A discovery she made in the 1940s at McGill University in Canada -- type specimens from the collection of Philip Carpenter -- turned her attention westward again, and during the next twenty years she was responsible for several reports that are invaluable to us in our study of the West Coast molluscan fauna. Her major work in this series appeared in 1958 as a Memoir of the Geological Society of America: Carpenter's type specimens for the region north of San Diego. In 1963 she published a companion paper on his Panamic types other than his Mazatlán material. She supervised the reprinting of his Mazatlán Catalogue in 1967 and arranged for Carpenter's hitherto unpublished manuscript plates of that work to appear in print. We owe a real debt of gratitude to her for making all this information available to us.

A little over a year ago Dr. Palmer was awarded a medal by the Paleontological Society of America. Her latest adventure has been a trip to Japan in May, 1974, where she had an afternoon's visit at the Imperial Laboratory.

## Symbiotic Associations of Musculium transversum Say (Pelecypoda: Sphaeriidae)

Dr. Peter N. D'Eliscu
Department of Biology, California State University, San Jose, California 95114

The organisms associated with the marsupial clam Musculium transversum exist in several symbiotic levels. Serial sectioning, differential staining, and $C^{14}$ autoradiography have shown various taxonomic groups living in phoretic, commensalistic, mutualistic, and parasitic relationships with this host clam. The phoretic bryozoan Plumatella deposits resting sessoblasts on the shell of the host. The spinose rotifer Filinia lives in the mantle cavity as a commensal. Several aquatic mites parasitize gill tissues, and one lives as a commensal in the "cloaca" of the host. The endosymbiotic beetle Berosus is predaceous on the commensal coprozoic oligochaetes Aeolosoma and Chaetogaster. Rotifers and the parasitic nematode Seinura are captured by the predaceous fungus Endosphaerium funiculatum, which lives attached to the gills of the host. Endosphaerium is therefore mutualistic, conferring on its host some resistance to a destructive parasite. The asexual reproduction of the fungus is closely coordinated with marsupial tissue proliferation of its host. Zoospores from modified hyphae of the fungus are deposited in most intra-marsupial embryos of the clam, insuring continued mutualism in following generations.

Many of the symbionts detect, identify, and locate distant host clams. Berosus and Aeolosoma in particular seek out their hosts from great distances, and appear to be able to distinguish Musculium from other bivalve and gastropod mollusks.

Aestivating clams show several physiological adaptations for water conservation, including the production of uric acid crystals instead of ammonia and the production of hygroscopic mucous threads by pyramidal mantle cells. The moist environment provided by aestivating hosts also supports several symbionts, including juvenile Aeolosoma and Chaetogaster, and the resting stage of Endosphaerium. This support may be important in the repopulation of temporary and fluctuating habitats.

## Is There Double Trouble in Marsupial Clams?

Dr. Eugene V. Coan
Research Associate, Department of Invertebrate Zoology, Los Angeles County Museum of Natural History, Exposition Park, Los Angeles, California 90007 (Mailing address: 891 San Jude Ave., Palo Alto, California 94306)

Two distinct, largely sympatric species of the unusual bivalve genus Milneria occur on the northwest coast of America -- M. minima (Dall, 1871) and M. kelseyi Dall, 1916. Some authors have believed that Dall inadvertently reversed his type specimens when describing the second species.

No such reversal occurred. Lectotypes have been selected, and a review of material in the collection of the California Academy of Sciences has elucidated the differences between the two species.

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## The Effect of Heavy Metals on Byssal Thread Production in Mytilus edulis

Drs. Donald J. Reish and J. Michael Martin
Department of Biology, California State University, Long Beach, California 90840
and
Dr. Fred M. Piltz
Department of Biological Sciences, University of Southern California, Los Angeles, California 90007

Bioassays generally study the effects of a toxicant on a test organism over a 96-hour period. Data are recorded as to the number of specimens which either survive or are killed within a given concentration. Results are presented as 96-hour $LC_{50}$, that is, that concentration at which 50% of the animals live or die. While such data are useful, they do not measure the longer term effects on the biology of the organism, especially its reproduction. Furthermore, such organisms as pelecypods are able to keep their shells tightly closed during an experimental period.

The production of byssal threads by the mussel Mytilus edulis was found earlier to be related to the concentration of dissolved oxygen and salinity. Since the production of byssal threads indicates an active metabolic state in the mussels, a study was undertaken to test the effects of various heavy metals on byssal thread production over a 7-day period. Data were obtained on the concentration of heavy metal required to reduce the number of threads produced by 50% as compared to a

control. Only mussels measuring 15-20 mm in width were used in these studies. Metals tested include copper, zinc, cadmium, mercury, lead, and chromium. The concentrations of metals which caused a 50% reduction were, in order of decreasing toxicity, mercury - 0.06 ppm, copper - 0.25 ppm, chromium - 0.5 ppm, cadmium - 0.95 ppm, zinc - 2.5 ppm, and lead - 4.0 ppm. Comparisons to the quantities of these metals present in Los Angeles County and City domestic outfall sewage on which data are available indicate that the concentration of copper in the discharge exceeds the 50% reduction concentration for copper, is equal to that for zinc, and is less than that for cadmium and lead.

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## Mytilids from the Black Sea

Dr. Vida C. Kenk
Department of Biology, California State University, San Jose, California 95114

Mytilus edulis Linné and Brachidontes minimus (Poli) were collected in Odessa, U.S.S.R., and Mamaia, Romania, in August, 1972. The anatomy and distribution of B. minimus have been studied; this species has not been reported previously from the Black Sea.

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## Sidelights on Some Malacologists

Dr. A. Myra Keen
Department of Geology, Stanford University, Stanford, California 94305

(The complete text of this paper appears on pages 37-40.)

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## A Study Trip to Japan

Mr. Robert R. Talmadge
Curator of Natural History, College of the Redwoods, Eureka, California 95501

For three weeks during August, 1973, an intensive study was made in Japan on a few families of marine Mollusca which are used

for food and which are represented by several species on our Pacific Coast. While there, I renewed old friendships, met persons with whom I had been in correspondence, and added new friends. The major research collections, private and institutional, Recent and fossil, were opened to me for study, not only in the Tokyo area, but also in Sapporo, Hokkaido. Field work was carried out at Abashiri on the Sea of Okhotsk, home of the "whelk fleet" operating in northern waters.

Although only a fraction of the specimens observed could be brought back to America for additional study, a considerable amount of information was obtained on some buccinids, neptunids and haliotids.

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Excerpts from and Comments on: "Stanford Contributions to Malacology -- An Evaluation and Appreciation" by Dr. S. Stillman Berry (originally presented to the Stanford meeting of the American Malacological Union, Pacific Division, July 15, 1955)

Dr. A. Myra Keen
Department of Geology, Stanford University,
Stanford, California 94305

Dr. Berry's paper was an after-dinner address that at the time it was delivered received a standing ovation. Unfortunately, no details about its content or its place on the program were mentioned in the Annual Report for that year. Its length -- 26 typewritten pages -- has militated against full publication up to now, although as a historical document it has much merit. It is, belatedly, summarized here, with the hope that it may later be published.

Berry points out that there has been, over the years, a steady flow of papers on malacology from various departments of Stanford University, covering a wide range of topics. A bibliography of some 100 titles that he had compiled shows 60 papers during the first 40 years and 40 papers during the next 25 (up to 1955), either by staff members or by students working on Stanford materials.

The influence of the early professors -- Harold Heath, Walter Fisher, Frank MacFarland, Frank Weymouth, and J. P. Smith -- was far-reaching, and it was reflected in the work of such students as Ralph Arnold, Harold Hannibal, Leo Hertlein, U. S. Grant, H. R. Gale, and Eric Knight Jordan (son of Stanford's first president, David Starr Jordan), to name only some of the better-known students of the first 40 years.

Hopkins Marine Station should be mentioned also for its supporting role in malacological research.

Stanford University Press has long had a tradition of publishing in the field of malacology, beginning with the volumes by I. S. Oldroyd in the 1920s and continuing with a wide variety of books and monographs.

The malacological collections and library of the University have expanded steadily throughout the years, by purchase, expeditions, and gifts. The facility thus has proved increasingly useful to researchers.

The most serious lack remains the need for adequate space that would be fireproof and earthquake-proof and an assured endowment to provide continuous curatorial staffing. Until the collection is properly endowed, it remains in jeopardy.

Such a campaign now is being planned.

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## The Baja California Dash

Mrs. Forrest and Mr. Roy Poorman
Museum Associates, Department of Invertebrate Zoology,
Los Angeles County Museum of Natural History,
Exposition Park, Los Angeles, California 90007

This slide program and commentary dealt with the new Highway 1 in Mexico, which was officially opened for through traffic December 1, 1973.

The discussion started with the earliest days of Europeans in Baja California. Illustrations made by early travelers, particularly monks, were sent back to the courts of Europe. Some of these sketches were shown, including impressions of the plants, animals, towns, and especially the people who traveled the paths and roads of the last four centuries.

The 1065 miles of the road from Tijuana to Cabo San Lucas was reviewed in detail including: the physical structure of the road, accomodations, automotive supplies and repairs, and the varied nature of the landscape as the road crosses and recrosses the peninsula from the Pacific to the Gulf of California. Side trips to important locales were also made. Areas important in the historical development of malacology on the peninsula included: Bahía Todos Santos and Punta Banda, Bahía San Quintín, Bahía de los Angeles, Guerrero Negro, Mulegé, Bahía Concepción, Loreto, region of Bahía Escondido, Bahía Magdalena, Bahía La Paz, Bahía Las Palmas to Los Frailes, San José del Cabo, and Cabo San Lucas.

The peninsula is a fragile land; the plant and animal life are in delicate, precarious balance. Rainfall is very limited. Many of the plants and animals have evolved to a high degree of

specialization. Abrupt, forced environmental changes will mean an end for some of them. While the road was declared built for the commercial development of the land and the people, its proximity to the large population centers of southern California, together with the beauty of the regions opened, will attract thousands of vacationers of the sort who are traditionally very hard on the areas where they pass. Individual restraint and governmental control will be necessary if the environment is to survive unchanged.

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## The Pleistocene Gastropoda of J. J. Rivers

Dr. Jack D. Mount
Department of Earth Sciences, University of California, Riverside 92502

In volumes 3 (no. 5, p. 69-72; no. 6, unnumbered plate) and 12 (no. 2, p. 29 and unnumbered plate) of the Bulletin of the Southern California Academy of Sciences, J. J. Rivers described five new species of Gastropoda from the Lower and Upper Pleistocene of western Los Angeles County, California. Since the brief descriptions are marginally adequate, at best, figures generally unpublished, and most of the types missing, these mollusks have not been well known to modern researchers. Rivers' names are listed below followed by the type locality and formation, repository of the types, suggested modern assignment, synonyms and age range.

Hyalaea tricuspida Rivers, 1904: Santa Monica, Palos Verdes Sand; unfigured holotype apparently lost; CAVOLINIA TELEMUS TRICUSPIDA (RIVERS) [syn.: Cavolina occidentalis Dall, 1908]; Late Pleistocene to Recent.

Eulima raymondi Rivers, 1904: Santa Monica, Palos Verdes Sand; 5 figured and 2 unfigured syntypes apparently lost, 4 unfigured syntypes in the Department of Earth Sciences, University of California, Riverside (UCR); EULIMA RAYMONDI RIVERS [syn.: Strombiformis riversi Bartsch, 1917]; Late Pleistocene.

Chrysodomus arnoldi Rivers, 1904: San Pedro, Palos Verdes Sand; unfigured holotype apparently lost; CALICANTHARUS FORTIS (CARPENTER, 1864); Early Pliocene to Late Pleistocene.

Chrysodomus merriami Rivers, 1904: Santa Monica, Timms Point Silt; unfigured holotype apparently lost; COLUS MERRIAMI (RIVERS) [this may be Tritonofusus riversi Martin, 1914]; Late Pliocene? to Early Pleistocene.

Bathytoma clarkiana Rivers, 1913: San Pedro, Palos Verdes Sand; 2 figured syntypes in the San Diego Natural History Museum, 1 unfigured syntype at UCR; MEGASURCULA CARPENTERIANA (Gabb, 1865); Early Pliocene to Recent.

In addition, a specimen collected by Rivers from the Palos Verdes Sand at Santa Monica, figured in The Nautilus, vol. 20, 1906, pl. 2, fig. 10, as Pleurotoma (Genota) cooperi Arnold, 1903, is now at UCR; MEGASURCULA CARPENTERIANA COOPERI (ARNOLD); Late Pleistocene.

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## Fossil Pholadids (Bivalvia) from the Pacific Coast of North America

Mr. George L. Kennedy
Department of Geology, University of California,
Davis, California 95616

The Pholadidae are a family of the Bivalvia that have a specialized life style and morphology adapted to mechanically boring into hard substrates, such as stiff mud, soft and indurated sedimentary rock, coral, wood, and shell. Three of the four presently-recognized subfamilies (Pholadinae, Martesiinae, Jouannetiinae) mainly inhabit shallow-water marine environments. Members of these subfamilies may occur in deeper than sublittoral waters if current action is strong enough to prevent occlusion of the siphonal entrance by sediment. The Xylophagainae are essentially deep-sea inhabitants, and are only occasionally found in shallower water, particularly in higher latitudes.

Variability in the Pholadidae is great and can be attributed mainly to differences in substrate character. In substrates more difficult to penetrate, the shell will be thicker, shorter in length, more robust, and the anterior concentric ridges will be more tightly spaced; in softer sediments the resulting shell will be thinner, the overall shape will be longer, and the concentric ridges on the anterior slope will be more widely spaced, elevated, and unworn. In addition, in the Martesiinae and Jouannetiinae, there is a confusing two-stage life cycle, in which the juvenile shell changes appearance with addition of a callum and accessory plates around the margins of the shell.

Because of these and other factors, the systematics of the Pholadidae have long been confused. Understanding of the group has been further complicated by paleontologists working with

small samples and often poorly preserved material (i.e., disarticulated specimens lacking accessory plates). Not until 1954 and 1955 when Dr. R. D. Turner monographed the living species of the western Atlantic and eastern Pacific was the stage set for clearing up the many years of accumulated misconceptions and misinformation so prevalent in paleontological literature.

The fossil record of the Pholadidae is poor. In the Cretaceous only three species are known from this coast. They are: Opertochasma clausa (Gabb), Turnus plenus Gabb, and Xylophagella sp. cf. X. elegantula (Meek and Hayden). Paleogene occurrences are even less common but include Opertochasma sp. indet., Martesia meganosensis Clark and Woodford, a recently described subgenus and species of Martesia [Paramartesia tolkieni Kennedy], and possibly two or three forms not assignable to any presently known genus. Penitella first occurs in the Oligocene of California. In the Neogene, the record is more complete, although Zirfaea dentata Gabb is the only common Miocene species. Most of the remaining species still living in the temperate eastern Pacific have fossil records that begin in the Pliocene or Pleistocene. Most of the tropical and subtropical species in the region are unknown in the fossil record, however.

One additional species can now be added to the known pholadids of the eastern Pacific Ocean -- Penitella kamakurensis (Yokoyama). This species was described from Pleistocene and Recent material in Japan, but it also occurs in both the Pleistocene and Recent faunas of the Gulf of Alaska.

For further information see: Kennedy, George L., 1974. West American Cenozoic Pholadidae (Mollusca: Bivalvia). San Diego Soc. Natur. Hist., Memoir 8: 127 pp.; 103 figs.; 1 table; frontis.

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## Miocene Zonation Based on Species of Giant Pectinids from Central and Southern California

Dr. Judith Terry Smith
U. S. Geological Survey, 345 Middlefield Road,
Menlo Park, California 94025

Ten Miocene species of the genera Lyropecten and Vertipecten have restricted chronostratigraphic ranges that define two or more subdivisions of presently recognized molluscan stages. Addicott, 1974 (Journ. of Paleontology, vol. 48, no. 1: 180-194) considered these and other giant pectinid genera to be

characteristic of an approximately 15 million year time span represented by the megafaunal stages "Margaritan," "Temblor," and "Vaqueros." Species of Vertipecten and successive morphologic forms of Lyropecten delineate shorter periods of perhaps 2 million years each, although absolute ages are tentative, owing to the scarcity of radiometrically dated rocks near important fossil localities. Examples of morphologic features that change with time include number and profile of ribs, microsculpture, and prominence of elongate thickenings or nodes on left valves.

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## Late Cenozoic and Recent Naticidae of the Eastern Pacific

Dr. Louie N. Marincovich
Branch of Paleontology and Stratigraphy, U. S. Geological Survey, 345 Middlefield Road, Menlo Park, California 94025

The gastropod family Naticidae is represented in modern seas and Cenozoic sediments worldwide. Areas covered in this study were Recent species in the eastern Pacific from the Arctic Ocean to northern Peru and fossil species from Alaska to southern California. Fifty-seven species were included in the review, of which 30 have fossil records and 13 are extinct.

In order of their importance, the most taxonomically significant features of naticids are umbilical morphology, shell form and sculpture, and opercular sculpture. Radular dentition is generally useful only at the generic level. Under taxonomic criteria developed in this study, the family in this region is divided into nine genera and 13 subgenera. Several genera and species of naticids are restricted to particular marine hydroclimates, making them useful for interpreting past environments.

During the time period considered, naticids were most abundant and diverse in the middle Miocene, during a short warm interval. Contemporaneous species of Oregon and Washington lived in a cooler hydroclimate than those of central and southern California. Several Miocene and Pliocene species are useful as zonal fossils.

Recent eastern Pacific naticids are largely derived from endemic Miocene or older ancestors. One living species is a migrant from the Indo-Pacific, and three have arrived from the North Atlantic. There are at least seven pairs of homologous species between the tropical eastern Pacific and Caribbean faunas.

There is an apparent functional relationship between the shells and opercula of Natica (Stigmaulax) broderipiana Récluz

and N. (S.) elenae Récluz, which has not been described previously in this family.

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## The Early Pleistocene Sequence at California River, Alaska: Geological Setting

Dr. David M. Hopkins, read by Dr. Robert W. Rowland

Paleobiology

Dr. Robert W. Rowland
U. S. Geological Survey, Pacific-Arctic Branch of Marine Geology, 345 Middlefield Road, Menlo Park, California 94025

(No abstract submitted. Paper to be published in full as follows: "An Anvilian (Early Pleistocene) marine fauna of western Seward Peninsula, Alaska," by D. M. Hopkins, R. W. Rowland, R. E. Echols, and P. C. Valentine. Quat. Res. 4 (4) - December 1974)

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## The Ecologic Aspects of Some Fossil Oyster Reefs

Dr. Kiyotaka Chinzei
Geological Institute, University of Tokyo, Tokyo, Japan. (Temporary address: Department of Geology, University of California, Los Angeles, California 90024)

The oyster reefs composed of Crassostrea species are common in the shallow marine deposits from the Upper Cretaceous to Recent. Observations have been made on the Neogene and Quaternary oysters of Japan and on a reef in the Upper Miocene of California.

The reef begins with the first oysters settling on hard substrates. Succeeding individuals grow attached to the shells of the preceding generation. As a result, the small colonies composed of several generations develop into a cup-like shape with the individual shells arranged radially. The formation of reefs of wide lateral extent are regarded as the result of development and mergence of these cup-like colonies, indicated from their radial internal structure and the cup-like projections at the basal surface of the reef.

The population density varies from 20 to more than 500 per square meter, and tends to increase as the colony expands. The form and size of the reefs and the population densities are affected by their containing sediments. In sandstone facies the reefs are smaller, relatively thin, and are composed of

cup-like colonies, while in mudstone facies they are usually much greater both in thickness and lateral extent, with the size of individuals relatively smaller.

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## The Dynamics of Planktonic Dispersal of Shallow Water Invertebrates and its Significance to Paleontology

Dr. William J. Zinsmeister
Institute of Polar Studies, Ohio State University,
Columbus, Ohio 43210

Dispersal of planktonic organisms is completely controlled by currents. Dispersal can only be in the direction of current flow, i.e., currents act as one-way corridors of dispersal. Since transport is parallel to circulation, these corridors of dispersal also act as barriers.

Many benthonic invertebrates are characterized by a pelagic larval stage. The length of this stage varies from a few hours to as long as 9 months. Therefore, many shallow water invertebrates have the capability of bridging great distances. The anomalous distribution of Recent mollusks along the coast of Central America and in the Hawaiian Islands serves to illustrate the importance of currents in marine biogeography.

Indo-Pacific mollusks occasionally occur on the islands off the coast of Central America. There are no similar occurrences of Eastern Pacific species in the Central Pacific. The North Equatorial Countercurrent transports Indo-Pacific species eastward from the Line Islands and also acts as a barrier to the westward dispersal of Panamic species. The principal mechanism for the populating of the intertidal and subtidal habitats of the Hawaiian Islands is by drifting pelagic larvae from the western Indo-Pacific. The removal of the island stepping stones by the rise of sea level at the end of the Pleistocene is responsible for the high number of endemic species. The disappearance of these islands created a barrier to certain members of the molluscan fauna that have a short pelagic larval stage. The isolation of the Hawaiian populations from the parent populations caused them to drift apart genetically. Those taxa with long pelagic larval stages were not affected by the removal of the Pleistocene island stepping stones and have retained their identity with the western Indo-Pacific.

There are numerous examples of anomalous occurrences of marine organisms in the fossil record, some of which might be explained by the dispersal of benthonic organisms during their pelagic larval stage.

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## Characteristics of Bathyal Mollusk Faunas in the Pacific Coast Tertiary

Mrs. Carole S. Hickman
Department of Geology, Stanford University,
Stanford, California 94305

(The complete text of this paper appears on pages 41-50.)

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## The Eastern Pacific Odostomia -- A Progress Report

Mr. Patrick I. LaFollette
Museum Associate, Department of Invertebrate Zoology,
Los Angeles County Museum of Natural History,
Exposition Park, Los Angeles, California 90007

The need for systematic revision of the eastern Pacific species of the family Pyramidellidae is recognized by everyone who has attempted working with these minute ectoparasitic gastropods. The availability of adequate material for such a revision in the Department of Invertebrate Zoology of the Los Angeles County Museum of Natural History -- several thousand lots containing perhaps 15,000 specimens -- served as a stimulus for undertaking this long overdue project. Thus far I have concentrated on the genus Odostomia, and careful study of large numbers of specimens has proved informative. The authors of most of the approximately 250 nominate species apparently ignored intraspecific variability, and nearly half of their taxa were described from single specimens, another 20% from two to five specimens. Hypothesized host specificity may have been the rationale for the proposal of so many species. Recent feeding studies do not support this hypothesis, and I have found a number of hosts for several species. Based on this observation and on morphological studies completed, I estimate that about 80% of the names now available will be relegated to synonymy.

The valid species of "Odostomia" are separable into several genera, but correct generic assignment is made difficult by inadequate descriptions and lack of published figures of the type species of many genera.

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The Predatory Behavior in the Oyster-Boring Snail (*Urosalpinx cinerea*), a Sea Grant-funded Motion Picture by Dr. Melvin R. Carriker; Introduced by Mrs. Beatrice L. Burch, 234 Kuuhoa Place, Kailua, Oahu, Hawaii 96734

(No abstract submitted)

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## A Review of the Genus *Muricopsis*

Dr. George E. Radwin
Department of Invertebrate Zoology, Natural History Museum, Balboa Park, P. O. Box 1390, San Diego, California 92212

The genus *Muricopsis*, the type genus of the muricid subfamily Muricopsinae, has seventeen recognized species and a worldwide distribution. It may be distinguished from other muricopsine genera by the strongly denticulate inner surface of the ovate or lenticular aperture and by the pustulose inner apertural lip. In addition, the protoconch generally consists of one or two sharply tabulate whorls, in some instances with the whorl-angulation marked by a spiral ridge; in a few cases the protoconch may be more or less typically muricoid, consisting of 1 to 2 1/2 convex whorls.

The radular dentition is muricopsine, with many transverse, three-across rows of teeth, each with a single rachidian tooth, flanked on each side by a single sickle-shaped lateral tooth. As in other muricopsine genera, the rachidian resembles that of many ocenebrine forms but differs in a) the greater depth of the tooth, b) the general lack of denticles between each lateral cusp and the adjacent base-end, c) the presence of a single point at the lower corners of the base, instead of the pair of points of ocenebrine dentition, and d) the independence of the intermediate cusps relative to the laterals, rather than appended to or coalescent with the lateral cusps, as in most ocenebrine dentitions. The radular dentition of *Muricopsis* shows the most clear-cut muricopsine features in that denticulation -- occasionally present in the dentition of some of the species of *Favartia* and *Murexiella* -- is rarely, if ever, exhibited.

The species herein assigned to *Muricopsis* seem to be derived from two or three lines that are so closely related they could not be separated, at the present time, at any higher than a subgeneric level. The species, grouped geographically, are:

WESTERN ATLANTIC: oxytatus M. Smith; nicocheanus Pilsbry; sp. nov. A; schrammi Crosse; muricoides C. B. Adams; rosea Reeve.

EASTERN PACIFIC: armatus A. Adams; jaliscoensis Radwin & D'Attilio; pauxillus A. Adams; sp. nov. B; zeteki Hertlein & Strong.

WEST INDO-PACIFIC: bombayanus Melvill; cuspidatus Sowerby; brazieri Angas; purpurispina Ponder.

EASTERN ATLANTIC: blainvillei Payraudeau; cristatus Brocchi; angolensis Odhner.

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## The Typhine Shell: Theme, Development, and Elaboration

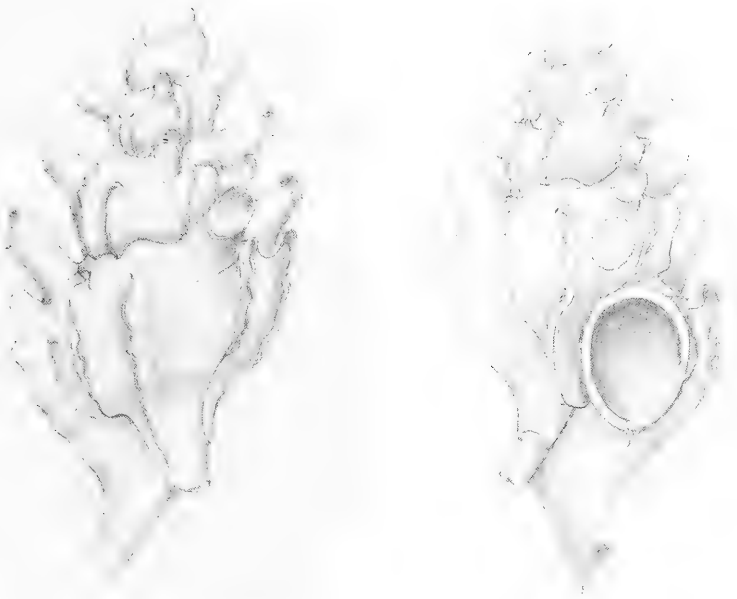
Mr. Anthony D'Attilio
Department of Invertebrate Zoology, Natural History Museum, Balboa Park, P. O. Box 1390, San Diego, California 92212

The purpose of this study is to examine structural elements in the morphology of the typhine shell as revealed in its growth between one varix and the next. The study was done by preparing illustrations using a light microscope with a camera-lucida attachment.

In following the growth of the shell intervarical area from its basic, simple form to those species showing what is apparently a high degree of complexity, one might demonstrate, by the very simple theme and its more elaborate variations, possible relationships within this muricid subfamily. The relationships were not sought for phylogenetic indications, and the trends they seem to show are by no means unequivocal. However, it is possible that some facts relating to this aspect may eventually be drawn from this study.

All previous classifications of this subfamily, based entirely on the position and number of tubes, omit other important characters that are useful for generic classification. These other characters are found in every intervarical space, excluding those found only around the apertural region, which were not studied.

The following figure is an example of the kind of illustration being prepared in this study.



Typhina bivaricata Verco

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## Comments on Some North Pacific Neptunids

Mr. Robert R. Talmadge
Curator of Natural History, College of the Redwoods,
Eureka, California 95507

The "North Pacific" (here used in the broad sense to include not only the Pacific Ocean, but also the Bering Sea, the Sea of Okhotsk, and the Aleutian and Kurile Platforms) appears to be the center of the speciation and distribution of the neptunids as a majority of the described species are recorded from these waters. The paucity of material, both shells in series and soft parts for anatomical comparison, the often ambiguous original descriptions, lack of figures, and many apparent synonyms have created some taxonomic problems.

Data obtained in a recent study of some major private and institutional collections in Japan, plus field studies conducted

at marine stations and fishing fleets, strongly indicate that some of the problems are the result of geographic races or subspecies. It was also noted that species originally recorded from American faunal lists based on eastern Bering Sea collections became more abundant in the western Bering Sea and were common in parts of the Sea of Okhotsk, the eastern Bering Sea specimens evidently representing northeastern populations of Asiatic species.

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1974 High School Science Fair Winners on Mollusks in Hawaii, read by Beatrice L. Burch, 236 Kuuhoa Place, Kailua, Oahu, Hawaii 96734

## Feedback Mechanisms Involved in the Development of Embryos of the Snail, Planorbarius corneus.

Laura Shishido
Aiea, Hawaii

Planorbarius corneus is a reddish brown snail of many freshwater streams of Oahu. It is a scavenger and is hermaphroditic, producing egg masses with approximately ten jelly-covered eggs. Embryos go through three growth stages. Snail size varies with population size.

Mature snails secrete a growth depressant into the water, while snail embryos secrete a growth stimulant. Production site of these growth-regulating substances is the head of the snail. Tests on embryos were conducted using various concentrations of snail head and snail embryo extracts. Embryos and mature snails both produce the two substances. Embryos secrete more embryo substance, while mature snails secrete more snail head substance.

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## Influence of Parasites on the Reproduction of Host Snails

Janice Kubota
Aiea, Hawaii

The parasite Philophthalmus gralli affects the number and growth rate of offspring of the host snails Tarebia mauiensis and T. newcombi. Offspring from infected snails grew more slowly than those from uninfected snails. Application of snail head extract to infected snails increased the number of offspring and resulted in a higher percentage of infestation. The extract may speed up the development of the parasites.

## Effects of Foreign Substances on the Development of Snail Embryos

Darryl T. Hiyama
Aiea, Hawaii

The development of freshly laid egg masses of Planorbarius corneus was observed in 1, 50 and 500 microgram/liter solutions of iodine, potassium iodide, potassium chloride, thyroxine and triiodothyronine. In most cases the effects of these substances were temporary.

## The Biology and Ecology of Northern California Intertidal Gastropods: The State of Our Knowledge

Mr. James T. Carlton
Department of Geology, University of California,
Davis, California 95616

(The complete text of this paper appears on pages 51-58.)

## Nudibranch Life Cycles: The Importance of Year-round Studies in New England

Dr. M. Patricia Morse
Marine Science Institute, Northeastern University,
Nahant, Massachusetts 01908

Records of the occurrence of nudibranchs along the New England coast appear to reflect the extreme weather patterns of the region. Field courses and collections during summer sessions at marine laboratories are often the sources for reports of breeding cycles, egg deposition, and predator-prey relationships. With year-round operating facilities at the Northeastern University Marine Science Institute, we have discovered there are numerous species that are found only in the winter months and deposit egg masses during this season. Temperature records at the laboratory range from $-1^{\circ}$ to $20^{\circ}$C during a yearly cycle.

Several species that have been collected in the winter are Coryphella salmonacea, Coryphella pellucida and Dendronotus robustus. In addition, C. salmonacea was found to have direct development. The other two species have free-swimming veliger stages. Two new species of opisthobranchs have been described

from Nahant, Okenia ascidicola Morse (Nudibranchia) and Unela nahantensis Doe (Acochlidioidea). The latter is an interstitial species and is the first named from New England.

Several species of nudibranchs have been found to utilize different prey during the year. Coryphella verrucosa feeds on the star tunicate, Botryllus schlosseri, as well as on hydroids, and C. salmonacea alternates between the tunicate Amorecium sp. and the hydroid Sarsia mirabilis.

(Contribution number 33 from the Northeastern University Marine Science Institute)

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## The Biology of Thyonicola americana, Parasitic in Holothuroideans of the genus Eupentacta

Mr. Loren Wright
Department of Zoology, University of California,
Berkeley, California 94720

Thyonicola americana Tikasingh, 1961, is a gastropod parasitic in the body cavity of the holothuroideans Eupentacta quinquesemita and E. pseudoquinquesemita. It is attached to the outer surface of the last third of the gut and covered by host peritoneum. Specimens were collected at several sites in the San Juan Islands, Washington. The overall incidence of infection was 41%, and the average number of parasites per infected host was 6.3, with a range of one to several hundred. Most of the individuals were less than 2 mm, a few slightly longer, and several 25 mm or longer. Most of the larger individuals contained many larvae-filled capsules. The veliger shell has a flared aperture; the velum is apparently highly modified for penetration of the host gut.

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## A Subtidal Predator-Prey System: Flabellinopsis iodinea (Nudibranchia) and Its Hydroid Prey

Mr. Christopher L. Kitting
Department of Population & Environmental Biology,
University of California, Irvine, California 92664

The nudibranch Flabellinopsis iodinea (Cooper) selectively preys on the hydroid Eudendrium ramosum (Linnaeus) at Dana Point, California. Localized cohorts of these species were surveyed from September, 1973, through May, 1974. Quantitative

observations and numerous series of underwater photographs were used to determine predation rates and the reproduction, growth, and seasonal density changes of both species in situ. Each predator cohort displayed pronounced egg-laying and recruitment of juveniles during November, after which the adult size classes declined. Juveniles grew in size although some disappeared before maturing and laying eggs in February. Again, settlement of juveniles occurred near the time of egg-laying, though settlement did not occur in all cohorts. In spite of the parallel life histories, prey availability differed between cohorts and remained abundant throughout the study period. Comparing net hydroid regeneration rates to predation rates and frequencies, the highly productive prey is not normally a limitation on the predator population. This system may provide an example in which specialization may maximize efficiency in ingesting the prey, thus enabling rapid growth to maturity within a limited life span. The resulting segregation of predators into distinct areas of suitably dense prey may account for some of the tremendous speciation within the diverse group of nudibranch mollusks.

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## Nudibranch Radular Morphology and Prey Specificity

Mr. Hans Bertsch
Donner Laboratory and Department of Zoology,
University of California, Berkeley, California 94720

Specific radular teeth shapes are correlated with particular prey. Scanning electron microscopy is useful to illustrate the functional morphology of nudibranch radulae. Continuing research on this topic may provide information on phylogenetic relationships among the nudibranchs.

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## The Classification of Euthyneurous Gastropods At Higher Categorical Levels

Dr. Michael T. Ghiselin
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University of California,
P. O. Box 247, Bodega Bay, California 94923

Older classification systems for euthyneurous gastropods had two subclasses, Pulmonata and Opisthobranchia, with about two and four orders respectively. Subsequently, due to uncertain-

ties about relationships and the raising of categorical ranks, the tendency has been to dismember the two subclasses and substitute a non-hierarchical listing of up to 14 orders. Enough is known about the relationships among these orders, however, to construct a phylogenetic system. To insure monophyly it is desirable that the ancestral stock of derived taxa be placed with their descendants. Efforts should be made to retain recognized taxa and change rank and taxonomic position only where necessary. It is proposed that: 1) Pulmonata be reinstated and include the Soleolifera; 2) the Opisthobranchia be divided into four superorders; 3) a superorder Tectibranchia include the orders Entomotaeniata, Acochlidioidea and Cephalaspidea; 4) a superorder Anaspidea include the orders Aplysioidea and Sacoglossa; 5) the Pteropoda be reinstated as a superorder; 6) a superorder equivalent to Thiele's order Acoela contain the orders Notaspidea, Holohepatica (with suborder Doridoidea) and Cladohepatica (with suborders Dendronotoidea, Arminoidea and Eolidioidea); 7) the organisms allied to Runcina and Philinoglossa be placed in the Cephalaspidea.

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Many Phases of Melo (Melocorona) amphora ([Lightfoot], 1786)

Mr. Frank Abbottsmith
Western Australian Shell Club

(No abstract submitted)

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Progress in Protecting the Marine Environment, 1974

Dr. Eugene Coan
The Sierra Club, 1050 Mills Tower,
220 Bush Street, San Francisco, California 94104

The past year has been one of erosion of gains made in previous years. Water pollution control efforts have lagged for lack of funding. The ocean dumping regulation program has not been vigorously enforced. The administration has delayed the coastal zone management and marine sanctuaries programs and sabotaged land planning legislation. Broad-scale use of DDT has begun again in the Pacific Northwest, and oil tanker standards remain weak. Marine mammals, particularly whales, remain in trouble.

Congress has strengthened the Endangered Species Act. International discussions have begun to update the Law of the

Seas, although agreement will not come easily.

We face a continuing uphill effort to defend marine resources against short-range decisions.

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## Dredging off Florida's East Coast

Mr. Kirk W. Anders
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North Carolina 28480

(No abstract submitted)

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## A Collecting Trip to Alaska

Dr. James H. McLean
Department of Invertebrate Zoology, Los Angeles County Museum of Natural History, Exposition Park,
Los Angeles, California 90007

(No abstract submitted)

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## Cephalopoda: A Survey of Relationships and Biology
(Banquet Address)

Dr. Clyde F. E. Roper
Division of Mollusks, United States National Museum, Smithsonian Institution, Washington, D. C. 20560

(No abstract submitted)

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## Sidelights on Some Malacologists

Dr. A. Myra Keen
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Only a few months after I had come into malacology seriously, I was leafing through some old sheet music of mine and was astonished to see the name of a man I could recognize as a malacologist -- yet here he was being credited with an arrangement of the Wedding March from Lohengrin. Could there be, I wondered, two men named George Washington Tryon? It turns out, of course, that besides being a malacologist, whose Manual of Conchology was of immense help to me even then, he was a musician of some attainment. Ever since then I have been keeping watch for these unexpected glimpses of malacologists that one might encounter in casual reading or in connections quite other than the study of mollusks.

The next one turned out to be somewhat in reverse -- a famous person whom one would not expect ever to be doing anything with mollusks. In the Stanford collection I came across a drawer of fossils with the label, "Collected by the noted Hungarian patriot, Louis Kossuth." The name Kossuth was vaguely familiar to me, but what was a collection of his doing at Stanford? I don't know the full answer to that yet. Our records show only that it was donated to Stanford by a Mrs. Stinson of Palo Alto in 1914, which had been more than 20 years before the time I came upon this puzzle. Kossuth, as I found on further reading, not only was a noted figure in Hungary but had suffered political defeat and then

George Washington Tryon

exile. In 1860 he went to Italy, and he died at Turin in 1894. Evidently in that last 30 years of his life he became interested in the abundant nearby fossils and must have exchanged with collectors in the United States. But he had been dead 20 years when this lot of material came to Stanford.

Third was an account I came across in an old issue of Popular Science Monthly, published in 1909, written by a Stanford geology graduate, Robert Van Vleck Anderson, about a trip he had made to Japan. A friend of Ralph Arnold, he was later to collaborate with Arnold on paleontological reports for the U. S. Geological Survey (Arnold had dedicated Pecten vanvlecki to him in 1907). On this trip to Japan, he had walked across one of the islands in the southern part of the chain. In a remote village, he was shown a manuscript record that one family had kept, dating back hundreds of years. A Japanese friend who was with him translated parts of it, especially the record of the first arrival of foreigners on those shores: a Portuguese merchant ship had landed on Kyushu Island in August, 1544. Through a Chinese interpreter, the Japanese had been able to talk with the voyagers, but they soon found them uncultured because they drank their tea from bowls or mugs instead of small cups. However, the Portuguese had some primitive guns, an invention utterly new to the Japanese, one that greatly impressed them. Comparing the Japanese narrative of this meeting with one later published by Ferdinand Pinto, who had been on the Portuguese ship, is fascinating, and I wish it were appropriate here to go into more detail about it, especially how strange and uncouth the Europeans looked to Japanese eyes.

George Willett's name is well known to West Coast collectors, though many of you may not have had the chance to meet him (he died in 1945). He was a very large man, a retired policeman who looked the part -- tall, barrel-chested, with a deep bass voice. In his later years he was a curator at Los Angeles County Museum. Birds were his specialty, but he also had a sizable mollusk collection. In the Audubon Magazine for January, 1970, I found one of my gems -- a quotation from an account written in 1912 by Dr. Alfred Baily when the U. S. Department of Agriculture had a Biological Survey party visiting the Hawaiian Island Group. They had stopped at Necker Island. Baily says, "A great ground swell was running when we attempted to land, and we were unable to get a boat against the steep rocks, but George Willett succeeded in getting ashore by swimming. He rode a white-crested wave against the cliff and was left dangling as the waters surged away." The writer who was quoting this was there again in the late 1960s and said of himself: "I looked at the pounding surf and could see George Willett riding his wave. I decided a rubber raft was a better way.... The landing area was a 20-foot-long lava ledge 18 feet above the sea." Apparently it was on this 1912 trip that George Willett became interested in shells. His companions found it amusing to watch him shake the trees to bring down the

showy little tree-snails, Achatinella.

George Willett

My latest unexpected find had to do with a man who was regarded by his contemporaries as little short of mad -- Constantine Samuel Schmalz Rafinesque. We on the West Coast do not have much occasion to deal with his work, though he did name a few marine genera, for example, Fusinus, Tylodina, and Armina. He is better known to students of the Unionidae in the mid-continent. He was born in Constantinople, and he early became an avid student of natural history. He had his first trip to North America in 1802 at the age of 17. Later, he became a professor at Transylvania University, Lexington, Kentucky. He was fluent in several languages and began publishing as early as 1809. Finding himself in a region where nearly every plant an animal was yet to be formally described, he was almost overwhelmed at the richness of the natural world. He travelled as extensively as he could and collected everything he could get his hands on, feverishly writing descriptions of what he saw and illustrating his papers with drawings that left his successors baffled. There's a classic story of how he spent the night at the Audubon home and was given a bunk in the loft. Later the family was roused by a great commotion up there, and Audubon climbed the ladder only to find Rafinesque flailing around with what was left of Audubon's violin and shouting, "Look, look! All these wonderful bats, and every one of them is a new species!" Besides his contributions to malacology, he left one heritage to future historians. In a book published last year I found another gem. The book, The Rocks Begin to Speak, deals with the meaning of Indian pictographs, and its author says, ... "Perhaps the most valuable translation of Indian symbols appeared in 1836 in a document known as the "Red Score" of the Delaware Indians. This was a painted record or tally of the most notable events in the history of this people. The preservation of the material and its first published account is due to the efforts of Constantine Rafinesque. A friend of his, a medical doctor, had been given the document in gratitude for his work, and he gave it to Rafinesque. Not being able to translate the songs that went

Constantine Rafinesque

with the paintings, Rafinesque studied the Delaware language. His translation in 1836 is now credited as being the first recognition that Indian pictography was based upon their sign language, a very important insight. Rafinesque died in Philadelphia in 1840 in abject poverty and was buried in a pauper's grave. Years later, in 1919, a marker was erected, and 84 years after his death, when the cemetery was being turned into a park, his remains were taken up and reinterred on the campus of Transylvania University, where he is now honored as one of its most famous professors.

This paper may seem rather a series of anecdotes strung together on a slender thread, but that thread is what I really want to point out. All of these malacologists were open-eyed and open-minded. They did not become so intent on some small aspect of their work that they were oblivious to the rest of their world. They were alert to new experiences and new ideas. Tryon found time for both his music and his work at the Academy of Sciences in Philadelphia. Kossuth did not sit idle after his great defeat and waste those last 30 years of his life, but took up, among his other interests, the study of the fossils that he saw in the rocks near his new home. Willett broadened his horizons so that he was able to see not only the birds overhead but the snails underfoot. Anderson and Rafinesque were not so absorbed in their study of the natural world that they overlooked the people in that world, people who also had a worthwhile story to tell. All of these men searched, though perhaps not consciously, for meaning behind the tasks of the day, and thus they enriched not only their own lives but the lives of countless others.

# Characteristics of Bathyal Mollusk Faunas in the Pacific Coast Tertiary

Carole S. Hickman[1]
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## INTRODUCTION

A paleoecological question of persistent interest when dealing with a fossil mollusk assemblage is the depth at which the component species lived. Traditional methods of determining depth all rely on compilations of depth ranges of modern genera, with the implicit assumption that these depth ranges have remained constant over geologic time. Paleobathymetric determinations may also be based on the depth ranges of living species that are considered "morphological analogs" of fossil species, assuming that the analogy holds at the physiological level. These assumptions become increasingly untenable as one goes back through the geologic record and evolutionary time. Furthermore, the methodology is insufficiently rigorous to distinguish deep-water assemblages from shallow cold-water assemblages containing bathymetrically wide-ranging forms that respond primarily to temperature.

An alternative approach to paleobathymetric interpretation derives from substantiation of the hypothesis that the percent composition of mollusk species in major taxonomic groups is different in modern mollusk faunas of different depth zones. The differences, hereafter referred to as differences in taxonomic structure, can be recognized in the fossil record back at least 40 million years, or into the Eocene. Modern faunal taxonomic structure not only provides a key to paleobathymetric interpretation but also frees us from static assumptions to ask evolutionary questions about distributional patterns and about the roles and modes of participation of mollusks in communities over geologic time.

Changes in taxonomic structure with depth assume biological significance through the correlation between feeding type and taxonomy in mollusks. Although the correlation is not equally good for all higher molluscan taxa (or genera, for that matter) there are sufficient data in the literature to facilitate interpretations of certain changes in taxonomic structure in terms of a shift in the mode of participation of mollusks in trophic structure with depth. When appropriate data are available, it is especially useful to refine this approach to produce estimates of the percent composition of individuals or of biomass, both within mollusk groups and across other groups of organisms. This allows recognition of the importance of mollusks and their characteristic feeding patterns relative to

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other animals, as well as a better indication of the relative importance of feeding modes within and among mollusk groups as these change in composition with depth.

## DEFINING MOLLUSCAN TAXONOMIC STRUCTURE

Figures 1 and 2 summarize the generalized taxonomic structure of bivalve and gastropod faunas in shallow water, the bathyal zone, and the abyssal zone. Data on the abyssal fauna are extracted from Clarke's (1962) catalog of the abyssal mollusk fauna of the world and Knudsen's (1970) catalog of abyssal bivalves of the world. Data on the bathyal fauna are compiled from Dall, 1886 and 1889 (Western Atlantic); Dall, 1908 (Pacific); Dell, 1956 (New Zealand); Knudsen, 1967 (Indo-West Pacific); Okutani, 1968 (Japan); and Keen, 1971 (Tropical West America). Shallow-water structure is summarized primarily from Keen (1971) combined with smaller regional faunas from a variety of latitudes.

No attempt has been made to define ranges in percent species composition of major taxonomic groups in different depth zones, particularly since data on the world abyssal fauna constitute a single sample. Percent species compositions for bathyal faunas were compiled separately and averaged to produce a summary profile, and a similar procedure was used for the shallow-water profiles. In this form the figures present an average standard against which fossil assemblages from unknown depth can be compared.

In the following discussion, I will focus on further characterization and interpretation of the taxonomic structure of bathyal mollusk faunas, with emphasis on bathyal faunas in the Pacific Coast Tertiary.

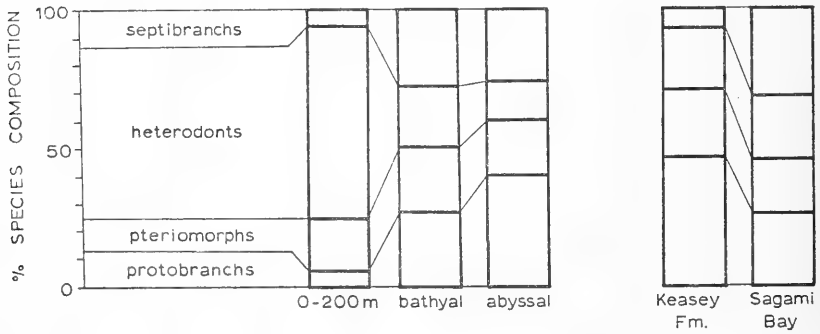


Figure 1. Percent species composition of major taxonomic bivalve groups in different depth zones

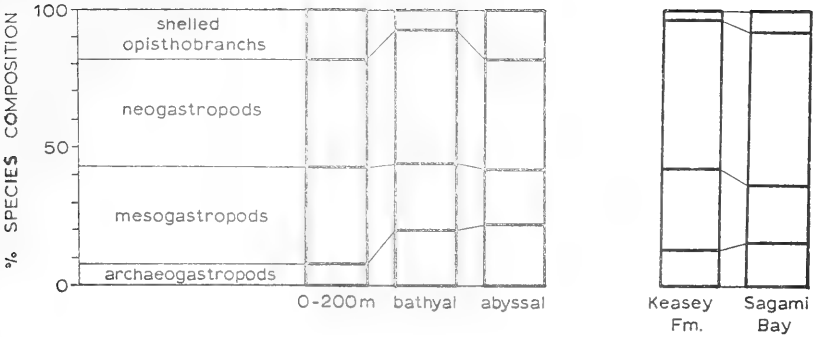


Figure 2. Percent species composition of major taxonomic gastropod groups in different depth zones

## BATHYAL MOLLUSK FAUNAS

Figure 3 illustrates the distribution around the rim of the North Pacific of fossil mollusk assemblages exhibiting bathyal molluscan taxonomic structure. Most of these assemblages occur in formations of narrowly restricted outcrop, and remains are scattered, occurring at low density. In the Pacific Northwest, however, deep-water sediments crop out over unusually broad areas, including, for example, up to 2700 meters (9,000 feet) of continuous Paleogene section in the southern Olympic Peninsula in Washington. Material is sparsely distributed, but intensive collecting increases diversity. The mollusk fauna of the Paleogene Keasey formation in Oregon (approximately 40 million years) has yielded over 100 species, and the bivalve and gastropod faunas of the formation are characterized structurally in Figures 1 and 2.

Before interpreting the taxonomic structure data, it is perhaps appropriate to review some of the physical characteristics of the modern bathyal environment. Physiographically the bathyal zone coincides with the continental slope, characterized by its steep inclination (3-6°) and narrow width (10-35 km). Bathymetrically it extends from a mean depth of 200 meters to 2000 meters and thermally from the 11°C isotherm down to the 4°C isotherm. Substrates are predominantly fine: silts, muds, and oozes. Of particular importance in interpreting taxonomic structural trends is the fact that the bathyal zone is dark, lying completely beneath the euphotic zone.

In the following discussion, emphasis is placed on relating changes in taxonomic structure to changes in feeding mode, strongly implicating light as the ultimate physical control. However, the underlying causes of changes in species

Figure 3. Distribution of fossil Cenozoic bathyal mollusk assemblages in the North Pacific

composition and in the proportional representation of higher molluscan taxa along depth gradients are complexly related to a multiplicity of physical and biotic factors. The relative influence of physical parameters to which organisms respond directly (e.g., temperature, salinity, substrate) is not known; and the effects of some of these parameters, particularly substrate type, are partially masked by comparing the molluscan taxonomic structure of the more homogeneous environment of the sampled bathyal zone with the taxonomic structure of shallow-water faunas from a broad spectrum of physical environments. Knudsen (1970) has found that the abyssal bivalve fauna has relatively little in common with the antarctic and arctic shallow-water faunas of comparable thermal regime. There are also some major structural differences in shallow- and deep-water assemblages developed on similar substrate types, but it is not sufficient to evaluate the importance of individual factors in isolation. Knowledge of deep-water faunas is insufficient to delimit communities, further hampering comparisons of parallel biological units in deep and shallow water. The taxonomic structure of the molluscan component must evolve in relation to as yet undefined complex biotic interactions, which also change in character along depth gradients.

## BIVALVE TRENDS

One of the most striking features of taxonomic structure of modern bivalve faunas in Figure 1 is the trend toward

greater equitability of species in major taxa in the bathyal zone. This equitability maximum appears both in the composite bathyal diagram and in the diagram of the bathyal bivalve fauna of Sagami Bay. Data from Sagami Bay (Okutani, 1968) have been treated separately because of some striking similarities at both higher and lower taxonomic levels between this fauna and the Paleogene Keasey formation fauna (Hickman, 1972).

Protobranchs

One of the most obvious changes with depth is an increase in the proportion of protobranch species, suggesting an increase in the relative importance of deposit feeding. The reversal of relative prominence in filter feeding and deposit feeding with depth has been documented previously (e.g., Ockelmann, 1958; Clarke, 1962), although the assumption that deposit feeding predominates in the deep sea is suspect. In addition to large numbers of protobranch species, individuals often occur in bathyal samples with high density and frequency. This is particularly true of the protobranch species in the Keasey formation, which comprise an atypically high proportion of the bivalve fauna.

Septibranchs

Equally striking in modern faunas is the increase in the proportion of septibranch species, in this case indicating an increase in the percentage of carnivorous species. Septibranchs comprise 36% and 32% respectively of the two bathyal bivalve faunas most recently documented (Okutani, 1968; and Knudsen, 1967). They comprise only 24% of the known world abyssal fauna and 5% or less of the shallow-water fauna. Data from Okutani (1968) suggest that septibranchs are widespread and numerous in the bathyal zone of Sagami Bay. Of the nine bivalve species that occur with highest frequency in sampling at bathyal depths in the bay, three are septibranchs and two of these occur at the highest densities recorded for bivalves in the bay.

Septibranchs may also contribute substantially to bivalve biomass in the bathyal zone in some parts of the world. Knudsen (1967) has stated that carnivores are generally large in size relative to other bivalve species sampled from the bathyal zone in the Indo-West Pacific.

While the number of deposit-feeding species continues to increase with depth, the proportion of carnivores, which I use here in a broad sense to include all forms deriving major sustenance from living animal tissue, reaches a maximum in the bathyal zone through a wide variety of adaptations in a variety of higher taxa and even genera that are not carnivorous in shallow water. This carnivory theme will recur throughout the following discussion.

A major difference between modern and Tertiary bathyal bivalve faunas is the paucity of septibranch species in the

Tertiary and correspondingly higher proportion of protobranchs. These data suggest that adaptive radiation of septibranchs and their rise to importance as bathyal carnivores in some parts of the world bathyal zone may be a relatively recent event.

The proportion of heterodont and pteriomorph species in Tertiary bathyal faunas are comparable to proportions in modern bathyal faunas, providing the major criteria for bathyal paleobathymetric interpretation.

Heterodonts

A major trend in bivalve taxonomic structure is the rapid decline with depth in the proportion of heterodont species, accompanied by a shift in the proportional representation of heterodont families. This trend may be interpreted as a decline in the feasibility of suspension feeding as a mode of life, which in turn is related to a reduction in the abundance of suspended food below the euphotic zone.

The most abundant heterodont superfamilies in shallow water, the Veneracea and Tellinacea, are virtually absent from the bathyal zone. Many of the heterodonts that do occur in the bathyal zone exhibit special adaptations to deep water. The Lucinidae and Thyasiridae are exceptional examples of heterodont families adapted for filter-feeding in relatively food-poor environments, having specialized progressively toward the acceptance of larger particles (Purchon, 1968). Bernard (1972) has described the anatomical modifications associated with macrophagy in Thyasira. The abundant polychaete and arthropod remains he observes in gut contents suggest another potential example of carnivory, although it is not known if meiobenthonic organisms are ingested alive, as in the septibranchs. One of the common faunal assemblages in deep-water mollusk faunas of the Pacific Northwest Tertiary contains two of these modified heterodonts. It is a low diversity assemblage that is dominated numerically by species of Lucinoma, Thyasira, and Solemya, with different species present in the assemblage at different points in time.

Pteriomorphs

The proportion of pteriomorphs increases slightly in the bathyal zone and represents a shift from predominantly shallow-water epifaunal taxa such as the Mytilidae, Ostreidae, and Arcidae to thin-shelled deep-water carnivorous Pectinidae and Propeamussidae, and predominantly deep-water groups such as the Limopsidae and giant limas of the genus Acesta. Carnivory in bathyal pectinids and propeamussids has been documented by Knudsen (1967), who observed that crustaceans comprised the predominant stomach contents in seven species and that detritus was not present in stomach contents. Carnivory in the Pectinidae appears to be restricted to deep-water species.

Thin-shelled pectinids and propeamussids often occur at high density in the most fine-grained Tertiary bathyal facies, and the genus Acesta, because of its large size, is one of the

striking components of a number of Tertiary bathyal faunas.

## GASTROPOD TRENDS

### Archaeogastropods

The proportion of archaeogastropod species increases with depth, with a disproportionate increase in species in the family Trochidae. One of the striking features common to modern and fossil mollusk faunas in the North Pacific is an assemblage type that is numerically dominated by a species of large trochid, most commonly of the genus Bathybembix or an allied genus. Data from Okutani (1968) show that Bathybembix aeola (Watson) occurs at the highest densities of any of the more than 200 mollusk species in the bathyal fauna of Sagami Bay.

Living representatives of the Pleurotomariidae are primarily bathyal in their distribution, although they provide a good example of a family that has occupied a much broader range of depths during its geologic history. Their presence in Tertiary assemblages with shallow-water taxonomic structural features demonstrates the danger inherent in assumptions based on modern bathymetric distributions.

An example of bathyal endemism over geologic time occurs in the homalopomatid genus Phanerolepida. The sole living species is restricted to the Japanese bathyal fauna, while Neogene species in the Western Pacific and Paleogene species in the Eastern Pacific (Hickman, 1972) all occur in faunas exhibiting deep-water taxonomic structure.

Modifications in the feeding habits of deep-water archaeogastropods are largely unexplored, but the predominantly herbivorous algal-grazing or scraping habit of the order must be modified below the level of light penetration where algae do not occur. In the past, deep-water archaeogastropods have been regarded as deposit feeders, and enlargement of the gut relative to the greater volume of material that must be processed was noted early by Dall (1890). More recent evidence suggests at least some modifications in the direction of carnivory. Yonge (1973) raises the question of nutrition in pleurotomariid gastropods and cites evidence that these large archaeogastropods have made a partial change to a carnivorous diet that includes sponges. Pleurotomariids may also be necrophagous: Matsumoto, Kataoka, & Sekido (1972) observed a live specimen of Mikadotrochus beyrichii (Hilgendorf) ingesting the flesh of the Japanese horse mackerel in the laboratory. Clench & Turner (1960) report "what appeared to be worm tubes filling the posterior end of the intestine in several deep-water species" of the genus Calliostoma, suggesting other instances of carnivory.

### Mesogastropods

The proportion of mesogastropod species declines with increasing depth, until in the abyssal zone they are outnumbered

by archaeogastropod species. In shallow water, where the order is best represented, herbivorous forms predominate. At bathyal depths, carnivorous mesogastropod groups predominate in both Recent and Tertiary faunas, representing such families as the Cassididae, Epitoniidae, Naticidae, and Cymatiidae. In Paleogene faunas in the Pacific Northwest, many of the mesogastropod species are striking in their large size, although they tend to occur at low density and frequency. An exception is the high frequency and density characterizing populations of small naticid gastropods. Drilled shells of a wide variety of mollusk species attest to naticid predation and are common in the Keasey formation, an observation contrary to those of Dall (1890) and Knudsen (1970) for the underlying abyssal zone that signs of predation on mollusks are rare.

Neogastropods

Neogastropods achieve maximum representation by percent species composition in bathyal gastropod faunas. Perhaps the most striking characteristic of the neogastropod component of bathyal faunas is that more than half of the species belong to the family Turridae. This is one of the most useful identifying features of Paleogene bathyal faunas in the Pacific Northwest. Species are striking in their adult sizes, which are large for the family, and in their high frequency of occurrence and high population densities. Several assemblages in the Keasey and Lincoln Creek formations in Oregon and Washington are dominated in terms of percent composition of individuals by species of turrids, and an individual assemblage may contain up to seven turrid species.

Although the feeding habits and diets of turrids have not been studied and are difficult to observe, the radular and accompanying functional morphological adaptations for active predation are well known and universal in the family. Bathyal turrids are usually primitive, non-toxoglossate species, but their high within-assemblage diversity suggests highly specialized, if not prey-specific, feeding habits.

## SCAPHOPOD TRENDS

A final characteristic trend in taxonomic structure along depth gradients is the increase in the proportion of scaphopod species in the total shell-bearing mollusk fauna. Scaphopod species comprise 0.5% of shallow-water faunas, increasing to 6% and 7% respectively in modern bathyal and abyssal faunas. Paleogene bathyal faunas in the Pacific Northwest contain assemblages that are numerically dominated by scaphopod species, suggesting high population densities.

## SUMMARY AND CONCLUSIONS

Determination of percent composition of mollusk species in major taxonomic groups provides a means of characterizing mollusk faunas of different depth zones. It also provides a means of determining paleobathymetry for fossil faunas more

accurately than through methods relying on the depth ranges of modern genera and implicit assumptions of physiological constancy over geologic time.

Although changes in molluscan taxonomic structure with depth and over time can be correlated with changes of undoubted trophic significance, the generalizations that are possible at this level of investigation are limited and sometimes rendered ambiguous by lack of information about specific habitats and the total species composition and biotic interactions within these habitats. For example, the predominance of carnivorous species and individuals in many mollusk groups within the bathyal zone is an exciting observation, but one which raises a whole host of specific questions about physical and biotic controls and about specific roles and modes of ecological interaction.

With the ability to recognize and characterize bathyal mollusk faunas on the basis of taxonomic structure comes the possibility for other forms of comparison of fossil and modern bathyal mollusk faunas: comparisons of morphological variability in species populations, comparisons of diversity along depth gradients, and comparisons of standing crop, population densities, and patterning. Some of these comparisons must be approached indirectly and by creative approximation because of the impossibility of using comparable sampling techniques for modern and fossil faunas; but the potential does exist for more refined exploration of features of the Cenozoic evolution of the deep-water mollusk fauna.

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# The Biology and Ecology of Northern California Intertidal Gastropods: The State of Our Knowledge

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In preparation for a chapter of the revised edition of Light's Manual: Intertidal Invertebrates of the Central California Coast (3d ed., Univ. Calif. Press [in press]), I undertook a review of the taxonomy, distribution, ecology, and biology of the northern California intertidal shelled gastropods, compiling available data for approximately 190 species from the Oregon border to Point Conception (Carlton & Roth, 1974). Here the state of our knowledge on a few topics will be considered, with emphasis throughout on conspicuous gaps and common misconceptions.

The prosobranchs have an intertidal fauna of approximately 170 species in this region, comprising about 80 mesogastropods, 48 archaeogastropods, and 42 neogastropods. Most of these are well-known systematically; that is, the chances of identifying a species one encounters are good. The majority of species were described before 1875. Three workers alone, Philip P. Carpenter, Augustus A. Gould, and William H. Dall, named more than 70 recognized species. Since 1920 few new taxa have been recognized in the northern California intertidal fauna. To be expected are discoveries among the microgastropods, especially interstitial and cryptic species, range extensions of southern species during "warm-water" years, and recently introduced species.

Of the 162 endemic prosobranchs, fewer than 20 percent have been the subject of published investigations on their biology or ecology, and, of these, more than 80 percent of the publications have been issued since 1960, or only within the last 14 years.

There remains, however, a data base perhaps equal in volume (and less certainly in quality) to that which has been published, embodied in graduate theses (both master's and doctorate) and student reports on file at marine stations, though the value of the latter in particular must be carefully weighed in each instance. Moreover, many field collectors and biologists possess a vast knowledge on such aspects as habitats, behavior, feeding, and symbiotic associations which they will never put in writing and which they do not intend to publish.

Unfortunately, museum labels tend to be a poor source of habitat and ecological data. Collectors have been admonished for years to write down "the habitat" on labels, but 1,000 labels all saying "under rocks" accompanying 1,000 lots, tell us nothing more than what we might have suspected in the first place. The information lost in not recording more immediate, detailed observations is of large magnitude indeed. What is "well-known"

to everyone, except of course to the zoologist trying to compile such information -- where to find an animal or what it eats -- is of little use if not written down.

Despite the preponderance of mesogastropods, a good deal of what we do know concerns only three archaeogastropod families: the Haliotidae (Haliotis), the Trochidae (Tegula), and the Acmaeidae (Acmaea, Notoacmea, Collisella, and Lottia). Recent competitive interest in halioticulture has spurred a number of investigations into reproduction, growth, and feeding, little of which has been or will likely be published. Available are Cox's general review (1962) (preceded by papers by Williamson, Edwards, Thomson, Bonnot, and others), the fine work by Owen, McLean & Meyer (1971) on hybridization, and some 20 to 30 papers on various aspects of the biology of the red and black abalones, Haliotis rufescens Swainson and H. cracherodii Leach. Unblessed by any extensive published accounts are our other two species, H. wallalensis Stearns and H. kamtschatkana kamtschatkana Jonas, of which we know little concerning California populations.

The limpets (or acmaeas) have received long attention, including work by Test (1945, 1946), Shotwell (1950a, 1950b), Fritchman (1961-1962), McLean's still largely unpublished Ph.D. thesis (1966), and Wolcott's recently published doctorate on physiological ecology and zonation (1973). An important contribution in the form of 20 papers on the Acmaeidae appeared as a supplement to The Veliger (Abbott, et al., 1968). There are 17 intertidal species in northern California, no longer hiding comfortably under one all-encompassing generic name. (Systematists should sympathize with the problems that other zoologists encounter in seeking to grasp limpet nomenclature; not only is Notoacmea not spelled "Notoacmaea," but neither is N. scutum (Rathke) a name of Eschscholtz any longer, situations incomprehensible to those not appreciating the subtleties of international nomenclatural tranquility.) With more than 45 published papers on the biology and ecology of the Acmaeidae of our northern coast, no one has yet been moved to synthesize or analyze this large and detailed body of information. Collisella digitalis (Rathke) alone has had no fewer than 16 published papers devoted to it, all but one since 1964. And, while Collisella limatula (Carpenter), C. scabra (Gould), C. pelta (Rathke), and Lottia gigantea Sowerby have all been studied to varying degrees, we remain with mere scraps of information on no fewer than 10 of 17 species. We know almost nothing, for example, about Acmaea mitra (Rathke), Collisella instabilis (Gould), Notoacmea fenestrata (Reeve), and N. paleacea (Gould), each not nearly as uncommon as some may think. And at least one limpet should have interested at least as many investigators as has C. digitalis; this is Collisella pelta, a eurytopic species whose wide geographic range and broad intertidal distribution should lend itself well to studies on adaptive "strategies," intertidal zonation, genetic variation, behavioral ecology, and larval ecology. Jobe (1968) recorded four varieties: a brown form, a black form on the fucoid alga Pelvetia, a black form on

mussels, and a green form. McLean (1966) recognized additional associations, on Postelsia, on Egregia -- the C. pelta here resembling Notoacmea insessa (Hinds) -- and on the coralline alga Lithothamnion at the outer edge of exposed rocky reefs. And there are still others -- specimens upon Tegula, varieties of a myriad of colors on the surf-grass Phyllospadix, and a variety on Laminaria. No other limpet in our fauna presents such a wide range of morphological and, apparently, physiological plasticity.

Some misconceptions have crept into limpet lore, and the case of the little black limpet Collisella asmi (Middendorff) provides an example. Collisella asmi has long been characterized as being stenotopic on the black turban snail, Tegula funebralis (A. Adams), but a careful examination of the literature reveals reliable records of its occurrence upon four species of Tegula (both living and hermit-crab occupied), and other records have it on Acanthina spirata (Blainville), on other limpets, on the sponge Halichondria panicea (Pallas), and even on rocks. More importantly, however, it is clear that at least some workers have been misled to believe that any small dark limpet on Tegula funebralis is C. asmi, but as McLean (1966) pointed out and as has been recently studied by Beth Brewer at the Bodega Marine Laboratory (The Veliger, 1975), other species of limpets are often more common on many Tegula populations, including Collisella strigatella and C. pelta. Work published on C. asmi in The Veliger supplements on both Acmaea and Tegula show strong internal evidence (such as shell length/height graphs) that at least two and possibly three or more species of limpets were actually under study, all identified only as "C. asmi." The record of C. asmi from the sponge Halichondria is of interest; while it may be a misidentification, Long (1968) found sponge spicules in the stomach of a limpet, unexpected in a family considered largely herbivorous.

Another misconception may be readily dispatched, one brought to light again by Thomas' (1973) table on limpet homing. In 1934, Frank Richardson described the diurnal movements of Lottia gigantea and Acmaea persona. Richardson's A. persona, however, is Collisella digitalis. This, in fact, was pointed out by Villee & Groody (1940), but many subsequent workers appear to have failed to notice this. Similarly, the Acmaea persona of Wells (1917), of Keep & Baily (1935: 172; fig. 144), and of all of Keep's previous books, is also C. digitalis; Moskalev's (1970) inclusion of Richardson's A. persona in the chresonymy[1] of "Collisella radiata (Eschscholtz)" [ = N. persona] is thus also in error. Further, Wells' work on Acmaea scabra refers to Collisella limatula; his A. spectrum is C. scabra; and his A. patina is Notoacmea scutum. We do not often enough point out that names we use today occasionally refer to different animals than they did in the past.

1. A list of references under a species name, as opposed to a true synonymy.

Our knowledge of the trochid genus Tegula is largely limited to Tegula funebralis. Tegula brunnea (Philippi), T. montereyi (Kiener), and T. pulligo (Gmelin) have been mostly ignored. Much of this information appears in 19 papers in another Veliger supplement (Abbott, et al., 1964) (a few papers of which also consider T. brunnea), with additional work by Peter Frank (1965), Robert Paine (1971), and others. Of our other trochids, such as Calliostoma, Lirularia, and Homalopoma, we know almost nothing.

It would seem, then, almost unnecessary to state that we lack even the most basic knowledge of the biology and ecology of most of our common and conspicuous gastropods, yet not a few students and even instructors at marine stations who have had an interest in molluscan biology have puzzled over "adequate" problems for a summer's work at the seashore. Of such animals as the Fissurellidae, Lirularia (one species of which, L. funiculata (Carpenter), is common on old beer cans on the mudflats of Bodega Harbor, California), Lacuna, Alvinia, Barleeia, the Caecidae, Cerithidea, the introduced Batillaria, Bittium, Cerithiopsis, Velutina, Erato, Trivia, Ocenebra, Mitrella, Amphissa, and Epitonium, we have almost no understanding of reproduction, life history, feeding, physiology, or ecology. Instead, we perhaps too easily pronounce upon the biology of local species based on work done on different species of the same genera, or, for introduced forms, on the same species as it occurs elsewhere in the world. We may speak of what an animal eats, or when it reproduces, but feeding and reproduction often remain uninvestigated locally. An example concerns the thaidid Acanthina spirata. Mature Acanthina have a spine on the base of the outer lip. Since Robert Paine's (1966) work on the function of the spine in Acanthina, no one has been moved to reinvestigate the matter. This situation has been accentuated perhaps by the brief summary of Paine's work in Between Pacific Tides (Ricketts & Calvin, 1968). Paine concluded that the spine may function largely for support rather than for prey penetration; however, he studied two species of Acanthina and one Neorapana from the Gulf of California, and not Acanthina spirata. The MacGinities (1949) provided a five-stage account of the use of the spine in A. spirata to wedge open and eat a barnacle, which Paine believed to be "apparently unsupported by data." And, according to Glynn (1965), Hewatt's thesis (1934) also provides a detailed description of the use of the spine in A. spirata to enter not only barnacles but also the periwinkle Littorina scutulata Gould. The manner of use of the spine in Acanthina thus is by no means resolved. We have relied perhaps too much on a study which was designed to answer a different question.

Life spans are almost entirely unknown, and there appear to be no more than a dozen statements in the literature on the life spans of a few of our gastropods. Parasitism and other symbiotic associations, especially as these concern "protozoans" and

smaller metazoans, go virtually uninvestigated. We are largely unaware of the significance of predation by vertebrates, including intertidal fish and birds. And too often unemphasized -- especially to students undertaking investigations -- is that a good deal of what we do know is based upon research done at marine stations in the middle of summer, at low tide, during the day. The extrapolations and generalizations about the lives of intertidal organisms derived from such limited data are remarkable indeed.

Our knowledge of introduced species also deserves comment. While comprising less than one percent of the gastropod fauna in this region, most of these are "ecologically dominant" where they occur in bays and estuaries. The species concerned have been listed elsewhere (Hanna, 1966; Carlton, 1974). What effect they may have had or are having upon the endemic fauna is unknown. We have successfully identified most of the introduced gastropods. However, the Atlantic Crepidula plana Say has gone largely unnoticed in San Francisco Bay, where it is abundant, despite its introduction there in the last century, a situation partially resulting from general taxonomic confusion of several native Crepidulas. Introduced Odostomia have gone unnoticed, though one or more species are doubtless present, and the taxonomy of a few introduced species has been remarkably tangled up, such as Batillaria attramentaria (Sowerby), a horn snail introduced from Japan and occurring in astronomical numbers in various coastal estuaries. It has gone under such names as B. zonalis (Bruguière), a different species that has not been introduced, B. cumingi (Crosse) (a junior synonym of B. attramentaria), and B. multiformis (Lischke), another probable junior synonym.

The introduction of Ilyanassa obsoleta (Say) from the Atlantic into San Francisco Bay about 1900 leads us somewhat obliquely into a consideration of depleted and endangered species in our fauna, a subject which has also received little attention. Once the horn snail Cerithidea californica Haldeman was apparently abundant on the mudflats of San Francisco Bay, a habitat now occupied largely by Ilyanassa obsoleta. The two species' diets include microfloral deposits, I. obsoleta, however, possessing a much broader trophic range. I am investigating the original distribution of Cerithidea in San Francisco Bay and the possibilities of competition between C. californica and I. obsoleta. The endemic brackish-water hydrobiid Tryonia imitator (Pilsbry), once widely distributed and not uncommon in estuaries from Sonoma County, California, southward, suffered a more certain fate of competitive exclusion, but by a somewhat larger eurytope, Homo sapiens. And what data, besides anecdotal accounts, exist of the depletion of some of our abalones, of the owl limpet, Lottia gigantea, or of the giant keyhole limpet, Megathura crenulata?

The shelled opisthobranch fauna is represented by eight species of cephalaspideans, one notaspidean (Tylodina), and an

undetermined number of pyramidellids (Iselica, Odostomia, and Turbonilla). There seems to be little consensus as to why cephalaspideans are sporadically abundant intertidally, with opinions ranging from reproductive inshore aggregations to accidental washing ashore of larvae. Snails as common and as widely known as Rictaxis punctocaelatus (Carpenter), Bulla gouldiana Pilsbry, and Tylodina fungina Gabb seem not to have been the subject of any investigations. Roller's contribution (1971) marks one of the few recent efforts to re-investigate Acteocina morphology and systematics. The difficulty in applying names to many species of Odostomia may in part be why few workers have become interested in the biology of these ectoparasites, species of which may be encountered intertidally on sabellid polychaetes, vermetid mollusks, Mytilus, and, of course, in numerous other associations.

Local intertidal pulmonates number three or four species, depending upon where one assigns the little slug Onchidella borealis Dall. We have the benefit of extensive European work on Ovatella myosotis (Draparnaud) (formerly Phytia setifer Cooper) but it and its mesogastropod associate Assiminea have not been the subject of any investigations on the Pacific coast. Yonge (1958, 1960) has contributed the only substantial observations on Williamia peltoides (Carpenter) and Trimusculus reticulatus (Sowerby).

Despite some trends in biology, including what I shall call ecological megathinking, it will long remain worthwhile to gather and publish basic natural history data. We do not need to wait for the publication of extensive monographic treatments of individual species. We need to know distributions, behavior, feeding, and many other aspects of the biology of our intertidal fauna in the face of ever-increasing human pressures on many habitats. Contributions, however brief, to our knowledge of the intertidal fauna are vital, and amateur and professional workers alike must not be deterred by the mistaken belief that only in exhaustive investigation lies the understanding -- and thus the key to our appreciation -- of nature.

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PROGRESS REPORT FROM WINNER OF
1973-1974 WSM STUDENT RESEARCH GRANT

# The Effects of Particle Size and Concentration on the Feeding Behavior of the Vermetid Petaloconchus keenae Hadfield and Kay, 1972

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The majority of members of the gastropod family Vermetidae appear to be capable of two methods of suspension feeding: use of the mucus-covered gill filaments as particle-collecting surfaces; and the use of external, pedally-derived, mucus secretions that function as nets or traps for suspended material. Morton (1965) considers this the primitive or generalized feeding condition for the Vermetidae. My study concerns the adaptive advantages of the dual nature of this vermetid feeding habit.

Vermetid gastropods inhabit midlittoral to shallow sublittoral regions where they are subject to fluctuating concentrations of suspended material. Having two feeding mechanisms that operate within different ranges of particle concentration would enable the organisms to feed efficiently under varied conditions. Moreover, the range of particle sizes efficiently handled may be different for the two feeding methods. Thus, size and concentration of suspended materials may have simultaneous effects on feeding behavior. This hypothesis is testable using the Hawaiian vermetid Petaloconchus keenae Hadfield and Kay, 1972, which is capable of both mucus trap and ctenidial feeding (Hadfield, et al., 1972).

The study has two facets, laboratory calibration and field correlation. The laboratory calibration consists of the exposure of the organisms to gradients of particle sizes and concentrations. This will determine whether one feeding mechanism is preferred over the other within different particle size ranges and at low or high concentrations of suspended matter. Polyacrylamide beads of four size classes ranging from 300 μm to 10 μm will be used to establish size and concentration regimes. Efficiencies of capture for the two mechanisms can then be easily established by measuring the bead uptake per unit time and per weight of mucus expended. Uptake of particulate and dissolved organic matter by the respective feeding methods will be determined by use of a carbon-nitrogen-hydrogen gas chromatographic analyzer. Having established the carbon-nitrogen content of mucus used in each feeding mechanism, one can determine the amount of adsorbed carbon and nitrogen from pedal and ctenidial mucus under different feeding regimes and from field samples.

Field correlation employs populations of Petaloconchus from

two sites in Kaneohe Bay, Oahu, Hawaii. Populations on Checker Reef, a coralline-algal encrusted patch reef, are distributed horizontally on the coral rubble substrate where wave action is moderate. Organisms inhabiting the sheltered South Dock wall of Mokuoloe (Coconut) Island are distributed on a vertical rock substrate where wave action is slight. Observations of feeding behavior and measurements of sediment load (weight of "microseston," after Banse, Falls & Hobson, 1963) and particle size throughout the tidal cycle will serve to clarify the relevance of this work to the organisms' distribution and adaptive strategy.

(read by James T. Carlton)

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## LIST OF EXHIBITS AT THE 1974 MEETING

Beatrice L. Burch, Exhibits Chairperson

Santa Barbara Malacological Society -- 1973 Shell Show

Southwestern Malacological Society -- Selected Marine Mollusks and Tellinidae from the Puerto Peñasco area, Sonora, Mexico

Beatrice L. Burch -- Projects on Mollusks in U. S. Sea Grant Programs

Rose Burch -- Shell Stamps and Shells

Eugene Coan -- Marine Conservation Literature from the Sierra Club

Wesley Farmer -- Selected Nudibranch Drawings

Darryl T. Hiyama -- Effects of Foreign Substances on the Development of Snail Embryos (see abstract on p. 31)

Janice Kubota -- Influence of Parasites on the Reproduction of Host Snails (see abstract on p. 30)

Patrick LaFollette -- Pyramidellid Shells (with microscope)

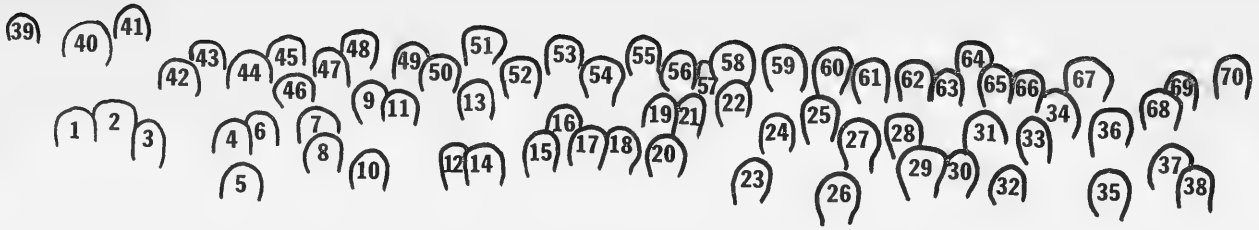
James H. McLean -- Photo Portraits from the 1973 WSM Meeting

William & Lois Pitt -- Fossil Shells from the Kettleman Hills, California

Mrs. Richard Russell -- World Wide Olividae

Laura Shishido -- Feedback Mechanisms Involved in the Development of Embryos of the Snail, Planorbarius corneus (see abstract on p. 30)

Winnifred Wagg -- Decorated Cookies (eaten at last coffee break!)



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4. Clyde Roper
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6. Patricia Morse
7. Barbara Good
8. Stillman Berry
9. Betty Phillips
10. Bert Draper
11. Jody Woolsey
12. Winnifred Wagg
13. Kiotaka Chinzei
14. George Radwin
15. Sharon Van de Velde
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17. Myra Keen
18. Martha Dippell
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23. Twila Bratcher
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58. Loren Wright
59. Hans Bertsch
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61. John Allen
62. Clifford Martin
63. Frank Abbottsmith
64. Steven Long
65. Robert Rowland
66. Merton Goldsmith
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Those attending not in picture: Kirk Anders, Ellen Brennan, William Bledsoe, Ford Bratcher, Jack Brookshire, Don Cadien, Victor Chakowa, Margaret Chevonnes, Mr. & Mrs. Stephen Crane, Thelma Crow, Margaret Cunningham, Anthony D'Attilio, Lois Goldsmith, Ruth Greenberg, Mr. & Mrs. Robert Janowsky, Veronica Parker Johns, Christopher Kitting, Marjorie Neiswanger, Ruth Newby, Karen Norman, Selma Raskin, Donald J. Reish, Helen Rodgers, Louise Russell, Natalie Russell, James Smith, Robert Talmadge, Mr. & Mrs. E. E. Wahrenbrock

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175 E. First St.
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Conchological Club of Southern California
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, first Monday of every month, 7:30 p.m.)

Hawaiian Malacological Society
P. O. Box 10391
Honolulu, Hawaii 96816
(Meets first Wednesday of every month, 7:30 p.m. First United Methodist Church, 1020 S. Beretania Street)

Long Beach Shell Club
600 Long Beach Boulevard (YMCA Building)
Long Beach, California 90812
(Meets second Sunday of every month except July, 2:00 p.m.)

Northern California Malacozoological Club
c/o Mr. Glenn Burghardt
14453 Nassau Road
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(Meets third Friday of each month, various places)

Oregon Society of Conchologists
2233 S. E. 53rd Avenue
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(Meets first Sunday of each month at 1:30 p.m. in private homes)

Pacific Northwest Shell Club
c/o Miss Ann Smiley
Route 1, 2405 N. E. 279 Street
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(Meets third Sunday of each month at 2:00 p.m., various places)

Pacific Shell Club
Los Angeles County Museum of Natural History
900 Exposition Boulevard
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(Meets in Museum Lounge, first Sunday of each month at 1:30 p.m., October through June)

San Diego Shell Club
P. O. Box 1390
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(Meets third Thursday of every month, San Diego Museum of Natural History, Balboa Park)

Santa Barbara Malacological Society
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(Meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol, Santa Barbara)

Southwestern Malacological Society
c/o Mrs. Carol Skoglund
3846 E. Highland Avenue
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(Meets third Wednesdays, September through May, 7:30 p.m., Room 163, Life Science Building, Arizona State University, Tempe)

Yucaipa Shell Club
Mousley Museum of Natural History
Bryant Street and Panorama Avenue
Yucaipa, California 92399
(Meets third Sunday of every month except August, 2:00 p.m.)

# THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT

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Joint Meeting With

## The American Malacological Union

San Diego, California
June 22-26, 1975

**Volume 8**

The Western Society of Malacologists

Annual Report

Volume 8

Joint Meeting With

The American Malacological Union

San Diego, California

June 22-26, 1975

Issued: NOV 1 1975

The Annual Report of the Western Society of Malacologists is based on its yearly meeting. Distribution of the Annual Report is free to regular and student members who are, at the time of issue, in good standing. Membership dues are $5.00 for regular members and $2.00 for students. Others of a regular member's family may join for an additional $1.00; each family receives only one Annual Report.

Correspondence regarding membership and orders for additional or back copies of the Annual Report or other publications should be addressed to the Treasurer, Mr. Merton Goldsmith, 1622 No. 10th Street, Phoenix, Arizona 85006.

When longer papers are included in the Annual Report or other of the Society's publications, they are reviewed by two members of the Editorial Board in addition to the Editor.



## Special Notice Concerning this Volume

This year, as the result of a joint meeting with the American Malacological Union, members of the WSM and the AMU elected to publish the resulting abstracts and papers solely in the Bulletin of the American Malacological Union. The latter is distributed with the brief WSM Annual Report to members of the Western Society of Malacologists.

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# NOTICE OF THE NINTH ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The ninth annual meeting of the Western Society of Malacologists will be held from June 23 to 27, 1976, on the Asilomar State Conference Grounds, Pacific Grove, California. The program will feature contributed papers, symposia, displays, a shell auction, and field trips.

Inquiries about the meeting should be made prior to May 15, 1976, and should be addressed to the Society's Secretary, Mr. Clifton Martin, 324 Kennedy Lane, Oceanside, California 92054. Applications for membership should be sent to the Treasurer, Mr. Merton Goldsmith, 1622 No. 10th Street, Phoenix, Arizona 85006. Dues are $5.00 for regular members, $1.00 for additional family members, and $2.00 for students. Regular and student members receive the Annual Report of the Society.

NOTICE CONCERNING OCCASIONAL PAPER 1
OF THE
WESTERN SOCIETY OF MALACOLOGISTS

Occasional Paper 1, "Sea Shells of Tropical West America": Additions and Corrections to 1975, by A. Myra Keen and Eugene Coan, was made available at the eighth annual meeting of the Western Society of Malacologists. Copies may be ordered by libraries and individuals at $2.50, postpaid. Orders with payment checks should be sent to Merton J. Goldsmith, W.S.M. Treasurer, 1622 North 20th Street, Phoenix, Arizona 85006.

Those who have copies of this Occasional Paper may wish to annotate them with the following further corrections and additions that have come to light since the date of publication. (The first page numbers refer to the Occasional Paper, the second page numbers, in parentheses, to "Sea Shells of Tropical West America".)

Page 8: Add as no. 262a (page 116): Vesicomya (Archivesica) suavis Dall, 1913. Gulf of California, depth 1,345 m.

Page 9: Add as no. 381a (page 162): Ventricolaria lavezzarii (Fischer-Piette, 1975). Peru (?). [Exact locality unknown; allocated to Venus by Fischer-Piette]. [Note also: Fischer-Piette, on the basis of his study of illustrations, places no. 381 in the synonymy of the Caribbean V. rigida (Dillwyn, 1817)].

Page 9, insert as a new entry after "168, #397": The synonymy of no. 438 (page 182) should be rearranged as follows: Petricola oblonga and P. solidula Sowerby, 1834; Venerupis foliacea Deshayes, 1853; P. solidula Sowerby, 1854.

Page 14, insert as a new entry after "371, #225a": 371, #227. Ranges from Venado Island, Panamá, to El Rubio, Peru [Shasky, 1975].

Page 22: No. 835 (page 467) ranges south to Panamá [Bertsch, 1975].

Page 24, insert as a new entry after "478, #875": 438, #875a. Polinices (Polinices) hacketti Marincovich, 1975. Height, 64 mm; diameter, 52 mm. Range: Galápagos Islands, intertidal zone.

Page 32: Add as synonym for no. 1086 (page 552): Purpura callosa Sowerby, 1834 (non Lamarck, 1822).

Page 35: In the 10th line from bottom, read, for "Nassarius, s. s.": Nassarius, subgenus Phrontis.

Page 35: In the 6th line from the bottom, add as synonym: Nassa ciniscula beltrani Mari, 1928 [fide W. O. Cernohorsky, in litt.].

Page 39, insert as a new entry after "759, #1837": 762, #1846. Ranges south to Punta Ancón, Ecuador [Shasky, 1975].

Page 43, 3d line from bottom: Delete "and figure 1 of Color Plate XX."
2d line from bottom: change "illustrate" to "illustrates."

Page 46, Pl. XX: Delete this entry. The illustration was correctly labeled in the first place.

Page 55, add above 3d line from bottom a new entry: 1004, line 2 of the Mörch 1859-61 entry should read: "(July, 1860)" [not 1890].

Page 56, add new bibliographic entry after Bertsch, 1973b:
Bertsch, Hans. 1975. New data on Thyca callista. The Veliger, vol. 18, no. 1, pp. 99-100, 1 text-fig. (July 1).

Page 59, add new bibliographic entry after Fischer-Piette, 1973:
Fischer-Piette, Édouard, 1975. Révision des Venerinae, s. s. Mém. Mus. Nat. d'Hist. Nat., n.s., Ser. A, vol. 93, 64 pp., 8 pls.

Page 62, add new bibliographic entry after Marincovich, 1973b:
Marincovich, Louie, Jr. 1975. New Tertiary and Recent Naticidae from the Eastern Pacific (Mollusca: Gastropoda). The Veliger, vol. 18, no. 2, pp. 168-173, 2 pls., 3 text-figs. (Oct. 1)

Page 64, add new bibliographic entry after Roth, 1971:
Roth, Barry, and Eugene V. Coan, 1971. Marginellidae ... from the Galápagos Islands and Cocos Island. Proc. Calif. Acad. Sci., ser. 4, vol. 37, no. 23, pp. 575-584, 5 text-figs. (Nov. 23)

Page 64, add new bibliographic entry after Shasky, 1973:
Shasky, Donald R. 1975. Range extensions for two tropical West American gastropods. The Veliger, vol. 18, no. 2, p. 217. (Oct. 1)

## PROGRAM

Sunday, June 22

10:00 - 1:00 -- Registration

12:00 - 1:00 -- Lunch

1:00 - 4:00 -- Session 1 -- Dedicated to William Healey Dall

Albert Johnson, San Diego State University -- "Welcome"

* Joseph Rosewater, U. S. National Museum of Natural History -- "William Healey Dall; The legacy he left for malacology"

* Wendell P. Woodring, U. S. National Museum of Natural History -- "Personal reminiscences of William Healey Dall"

Joshua L. Baily, Jr., San Diego Natural History Museum -- "Recollections of William Healey Dall based on correspondence"

* Richard S. Houbrick, Smithsonian Oceanographic Sorting Center -- "Preliminary revision of supraspecific taxa in the Cerithiinae Fleming, 1822 (Cerithiidae: Prosobranchia)

* Gary McDonald, Moss Landing Marine Laboratories -- "Cerberilla mosslandica McDonald & Nybakken, 1975, a new nudibranch from Monterey Bay, California, with comments on other enigmatic or undescribed species from California"

* Alan Solem, Field Museum of Natural History -- "Oreohelicid land snails of the Salmon River Valley, Idaho"

Gale G. Sphon, Los Angeles County Museum of Natural History -- "The Mitridae of the Galápagos"

* Donald R. Moore, Rosenstiel School of Marine and Atmospheric Science, University of Miami -- "Is Meioceras living in the Indo-Pacific (Gastropoda: Caecidae)"

* Artie L. Metcalf, University of Texas, El Paso -- "Ashmunellas of the San Andrés and Organ Mountains, New Mexico, and Franklin Mountains, Texas"

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* Paper or abstract in AMU Bulletin

* Christopher L. Kitting, Hopkins Marine Station, Stanford University -- "The impact of mollusks feeding on some West Indian gorgonians"

5:30 - 8:00 -- Luau-style dinner sponsored by the San Diego Shell Club

8:00 - 8:30 -- Evening program

Kirk Anders, Shells of the Seas, Inc. -- "A collecting trip to Honduras"

Robert Robertson, Academy of Natural Sciences, Philadelphia -- "Some American malacologists and currents in malacology"

Merton J. Goldsmith, Southwestern Malacological Society -- "Call me Juan"

Bob Schoening, San Diego Shell Club -- "A preview of Auction items"

Monday, June 23

7:30 - 9:00 -- Breakfast

9:00 - 12:00 -- Session 2

* Bertram C. Draper, Los Angeles County Museum of Natural History -- "An overview of the family Caecidae on the Pacific Coast of the Americas"

* Hans Bertsch, University of California, Berkeley -- "On some species of Discodoris and the use of the radula in nudibranch taxonomy"

* Thomas R. Waller, U. S. National Museum of Natural History -- "The origin of foliated-calcite shell microstructure in the subclass Pteriomorpha (Mollusca: Bivalvia)"

* Alan Solem, Field Museum of Natural History, and Clyde F. E. Roper, U. S. National Museum of Natural History -- "Structures of Recent cephalopod radulae"

* George E. Radwin, San Diego Natural History Museum -- "A review of the genus Aspella (Gastropoda: Muricidae)"

* Gordon A. Robilliard, Woodward-Clyde Consultants -- "The nudibranch Dendronotus frondosus: Is it one species or four?"

* Robert R. Talmadge, California Academy of Sciences -- "Notes on Fusitriton"

* James H. McLean, Los Angeles County Museum of Natural History -- "A new genus and species of Monoplacophora from the continental shelf of southern California"

* Virginia O. Maes, Academy of Natural Sciences, Philadelphia -- "The genus Pilsbryspira: Its position in history and the family Turridae"

* Thomas Backman, Lockheed Ocean Laboratory -- "Grazing effects on algae caused by limpets and littorines"

12:00 - 1:00 -- Lunch

1:00 - 4:30 -- Session 3 -- Eastern Pacific-Western Atlantic faunal affinities

* Emily H. Vokes, Tulane University -- "Geologic history of the Panamic region"

* Harold E. Vokes, Tulane University -- "Atlantic ancestors of the East Pacific fauna"

* C. O. van Regteren Altena, Teyler Stichting -- "The marine mollusks of Surinam (Dutch Guiana)"

* A. Myra Keen, Stanford University -- "Pacific outposts of the Tertiary Caribbean province"

* Donald R. Shasky, San Diego Natural History Museum -- "Marine mollusks of Panama Bay"

* Joseph Rosewater, National Museum of Natural History -- "Some results of the National Museum of Natural History-Smithsonian Tropical Institute Survey of Panama, 1971-1975"

* Anthony D'Attilio, San Diego Natural History Museum -- "Recent and fossil Typhinae of the New World"

* Robert Robertson, Academy of Natural Sciences, Philadelphia -- "Faunal affinities of the Architectonicidae in the Eastern Pacific"

* William E. Old, Jr., American Museum of Natural History -- "Living Conus of the New World, with special reference to 'twin species'"

* K. Elaine Hoagland Davis, Lehigh University -- "Patterns of evolution and niche partitioning in North American Crepidula"

* Emily H. Vokes, Tulane University -- "Eastern Pacific-Western Atlantic faunal affinities -- Muricinae and Muricopsinae"

6:00 - 8:00 -- Chuckwagon-style dinner sponsored by the Conchological Club of Southern California

8:00 - 10:00 - Simultaneous meetings of the WSM Executive Board and the AMU Council

8:00 - 10:00 - Evening Program

* Leroy Poorman, Los Angeles County Natural History Museum -- "The life and times of S. Stillman Berry"

Lillian B. Davenport, Jersey Cape Shell Club -- "Our first year"

Isabelle Welch, The Shell Cabinet -- "Freshwater collecting at Windsor Locks"

Tuesday, June 24

7:30 - 9:00 -- Breakfast

9:00 - 12:00 -- Session 4

* Clyde F. E. Roper & Michael J. Sweeney, U. S. National Museum of Natural History -- "The pelagic octopod, Ocythoe tuberculata Rafinesque, 1814"

S. Stillman Berry, Redlands, California -- "Remarks on Ocythoe"

* George M. Davis, Academy of Natural Sciences, Philadelphia -- "Origin of Asian 'Hydrobiidae' in time and space"

* James T. Carlton, University of California, Davis -- "Comments on cosmopolitanism"

* Peter U. Rodda, California Academy of Sciences -- "Evolutionary rates in gastropods"

* Hal Lewis & George M. Davis, Academy of Natural Sciences, Philadelphia -- "Evolutionary relationships between the three orders of the prosobranch gastropods"

* Joseph Vagvolgyi & Thomas Broderidge, Staten Island Community College -- "Body size, dispersal, and the origin of the Pacific land snail fauna"

* George Hemingway, Scripps Institution of Oceanography -- "Functional morphology of feeding in Acanthina spirata (Gastropoda: Prosobranchia)"

12:00 - 1:00 -- Lunch

1:00 - 2:00 -- Group photograph

2:00 - 5:00 -- Session 5

* Barry Roth, California Academy of Sciences -- "Preliminary analysis of the land mollusk faunas of the islands of southern California and northern Baja California"

* Peter N. D'Eliscu, University of Santa Clara -- "Metal and pesticide contamination and concentration in mollusks of the Lake Tahoe Basin"

* James T. Carlton, University of California, Davis -- "Extinct and endangered populations of the endemic mudsnail, Cerithidea californica, in northern California"

R. Tucker Abbott, Delaware Museum of Natural History -- "American Seashells: Supplement and Third Edition"

* A. Myra Keen, Stanford University -- "Another check-list plan?"

* Richard L. Reeder & Walter B. Miller, University of Arizona -- "Karyotype studies in Ashmunella (Pulmonata: Polygyridae)"

* Noorullah Babrakzai, Oscar G. Ward, & Walter B. Miller, University of Arizona -- "The introduction of Giemsa and centromeric banding techniques in molluscan cytotaxonomy"

5:00 - 8:00 -- Dinner

8:00 - 10:00 -- Auction

8:00 - 10:00 -- Meeting of Council of Systematic Malacologists

Wednesday, June 25

7:30 - 9:00 -- Breakfast

9:00 - 12:00 -- Session 6

James T. Carlton, University of California, Davis -- Presentation of WSM Student Award -- See p. 18 herein.

* James Nybakken, Moss Landing Marine Laboratories -- "Abundance, diversity and temporal variability of an intertidal nudibranch population"

* Gary L. Pace, E. J. Szuch, & R. W. Dapson, University of Michigan -- SCUBA-assisted studies of freshwater snails"

* Thomas R. Waller, National Museum of Natural History -- "The living habits of Pteriomorphian bivalves: A motion picture study"

* Gregory P. Daly, San Diego State University -- "The effects of the reproductive cycle on seasonal growth trends in the owl limpet, Lottia gigantea"

* Charles M. Courtney, Marco Applied Marine Ecology Station -- "Mangrove and seawall oyster communities, Marco Island, Florida"

* David Shonman, Moss Landing Marine Laboratories -- "An analysis of feeding of two species of benthic opisthobranchs"

* David R. Lindberg, California Academy of Sciences -- "The homing depression of the limpet, Collisella scabra (Gould, 1846)"

* Edward J. Petuch, University of Wisconsin -- "The Verdesian province: A new West African molluscan faunal province"

* Joseph P. E. Morrison, National Museum of Natural History -- "Relict freshwater mussels from two continents"

12:00 - 1:00 -- Lunch

1:00 - 3:00 -- Session 7

* Joseph C. Britton, Texas Christian University -- "Shallow-water marine mollusks of the Swan Islands, Honduras"

* David H. Stansbery, Ohio State University -- "The naiad mollusks of the Rockcastle River of the Cumberland Plateau of eastern Kentucky"

* Carl C. Christensen & Walter B. Miller, University of Arizona -- "Preliminary observations on *Rabdotus* in Baja California"

* Eugene V. Coan, California Academy of Sciences -- "The availability of taxa proposed in the *Minutes of the Conchological Club of Southern California*"

* M. Bowie Kotrla, Trinity University -- "New geographical location for *Philophthalmus* sp. in thiarid snails and waterfowl in Texas"

* Noorullah Babrakzai & Walter B. Miller, University of Arizona -- "Karyotypic comparison between Helminthoglyptidae and Bradybaenidae (Gastropods: Pulmonata)"

* Glenn A. Long, Baltimore Museum of Art -- "*Spondylus*: The red shell"

* Harold D. Murray, Trinity University -- "*Melanoides tuberculatus* (Müller), Las Moras Creek, Bracketville, Texas"

3:00 - 5:00 -- AMU Business meeting

5:00 - 10:00 -- Cocktails and banquet

Sam Hinton, University of California, San Diego -- "The taxonomy of common names"

Thursday, June 26

7:30 - 9:00 -- Breakfast

9:00 - 10:00 -- WSM General Business Meeting

## SUMMARY OF MINUTES OF THE EXECUTIVE BOARD MEETING AND THE ANNUAL BUSINESS MEETING

(Complete minutes of both meetings are contained in the records of the Secretary of the Society and will be available at the ninth annual meeting.)

The meetings were presided over by the President, Dr. George E. Radwin.

The Minutes from the 1974 meeting as written in the Secretary's book and summarized in the Annual Report were approved.

Dr. James Nybakken reported that reservations have been made to hold the ninth annual meeting at Asilomar, California, June 23-26, 1976.

James Carlton, Chairman of the Committee on Student Grants, reported that an award of $500 was given this year to Judith Ann Christensen of the Department of Biological Sciences of the University of Arizona.

Dr. James H. McLean, Chairman of the Nominating Committee, nominated the following members for next year's officers:

| | |
|---|---|
| President | Dr. James Nybakken |
| 1st Vice President | Helen DuShane |
| 2nd Vice President | Dr. Peter N. D'Eliscu |
| Secretary | Clifton L. Martin |
| Treasurer | Merton J. Goldsmith |
| Members-at-Large | Dr. Louie Marincovich |
| | Carol Skoglund |

These nominees were elected by unanimous ballot.

Bertram C. Draper, Treasurer of the Society, reported a treasury balance of $2,149.30. (This did not include advance registration fees or expenses of the eighth annual meeting.)

The Board members approved these proposals:

(1) That a publication be issued jointly with the American Malacological Union containing abstracts and papers from the joint meeting. That an Annual Report in abbreviated form, containing list of abstracts and papers, membership list, financial report, etc., will also be published. Members of the WSM will receive copies of both publications.

(2) That no scholarship award shall be given in 1976 but an award of $500 shall be given the following year.

(3) That all sales receipts for our special publication, Occasional Paper 1, be held in reserve to finance publication of future papers.

(4) That the Editor shall have the power to regulate the price of back-issues of The Echo and the Annual Report to comply with costs of publication, etc.

(5) That a sum of $50 shall be given to the Historian to purchase pictures and other documents for the Historian's Book.

TREASURER'S REPORT
September 12, 1975

| | | | |
|---|---|---|---|
| **Income** | | | |
| Dues for 1973 (1 Regular) | | 2.50 | |
| Dues for 1974 (15 " ) | | 75.00 | |
| Dues for 1975 (178 ", 30 Family, 16 Student) | | 952.00 | |
| Dues for 1976 (3 Regular) | | 15.00 | 1044.50 |
| Sales of publications | | | |
| Back issues of the Echo (28) | | 70.00 | |
| Annual Reports,'74,'75 (13) | | 67.50 | |
| Occasional Paper #1 (126) | | 307.11 | 444.61 |
| Interest on Savings Account | | 57.90 | |
| 1975 Shell Auction | | 1155.05 | |
| Reprints from Annual Report | | 92.77 | |
| Old AMUPD Bank Account transferred to WSM | | 16.00 | 1321.72 |
| From WSM/AMU Conference to help cover increase in costs of 1975 publications necessitated by the joint conference | | 500.00 | |
| Surplus of conference income over expenses | | .74 | 500.74 | 3311.57 |
| **Disbursements** | | | |
| 1974 Annual Report | | | |
| Typing | 265.42 | | |
| Press work & binding | 579.18 | | |
| Handling & mailing | 175.17 | 1019.77 | 1019.77 |
| Occasional Paper #1 | | 399.66 | |
| AMU membership dues | | 6.00 | |
| Historian's expenses | | 20.85 | |
| Group photos for Historian & Annual Report | | 3.00 | |
| Secretary's expenses | | 63.46 | |
| Editor's misc. expenses | | 11.45 | |
| Student Award Chairman's expense allowance | | 50.00 | |
| Treasurer's expenses | | 60.49 | |
| Advance deposit at Asilomar for 1976 Conference | | 100.00 | 714.91 |
| Total disbursements | | | 1734.68 |
| Year net increase | | | $1576.89 |

## Financial Report on WSM/AMU Joint Conference

### Receipts

| | | | |
|---|---|---|---|
| Registrations 237 @ 10.00 | 2370.00 | | |
| Housing 137 @ 32.00 | 4384.00 | | |
| Meals 134 tickets @ 18.00 | 2412.00 | | |
| Banquet 189 " @ 6.65 | 1256.85 | | |
| Group photos 112 @ 2.00 | 224.00 | | |
| Happy Hour receipts | 77.00 | 10,723.85 | |
| Total receipts | | | 10,723.85 |

### Expenditures

| | | | |
|---|---|---|---|
| Refunds of advance registrations | 50.00 | 50.00 | |
| Payment to San Diego State University | | | |
| Meals and banquet | 3626.45 | | |
| Housing | 4352.00 | | |
| Aztec Center use | 1150.00 | | |
| Parking stickers | 216.00 | 9344.45 | |
| Table favors | 29.75 | | |
| Group photos | 228.24 | | |
| Happy Hour supplies | 53.04 | | |
| Misc. expenses | 131.99 | | |
| Secretary's " | 255.61 | | |
| Treasurer's " | 130.03 | | |
| Increase in publication cost | 500.00 | 1328.66 | |
| Total expenditures | | | 10,723.11 |
| Net surplus of receipts over expenditures | | | .74 |

### Financial Standing

| | | |
|---|---|---|
| Balance, August 7, 1974 | | |
| Checking account | 964.81 | |
| Savings account | 1265.67 | |
| | 2230.48 | 2230.48 |
| Net increase for 1975 | 1576.89 | 1576.89 |
| Balance, September 12, 1975 | | |
| Checking account | 2483.80 | |
| Savings account | 1323.57 | |
| | 3807.37 | 3807.37 |
| Reserved funds | | |
| For 1975 Student Grant | 500.00 | |
| For Publications | 800.00 | |
| | 1300.00 | |

Submitted:

Bertram C. Draper, Treasurer

# REPORT OF THE COMMITTEE ON STUDENT GRANTS, 1974-1975

**Committee Members:**

Mr. James T. Carlton (University of California, Davis), Chairman
Dr. Eugene V. Coan (California Academy of Sciences)
Dr. Vida C. Kenk (San José State University)
Dr. James W. Nybakken (Moss Landing Marine Laboratories)
Dr. Peter U. Rodda (California Academy of Sciences)
Dr. Judith T. Smith (United States Geological Survey)

Since 1972, the WSM has awarded a student research grant in malacology. The award is announced through a poster distributed to about 200 institutions in the western United States, encouraging applicants in the fields of systematics, biology, ecology, paleontology, and anthropology.

In 1972, Mr. Carl Stiefbold, of the Department of Biology, Portland State University, was awarded a grant of $250 for a research project entitled, "The role of neurosecretion in the transformation of the rock-boring clam, Penitella penita, from the working-asexual form to the resting-sexual form." In 1973, Ms. Carol N. Hopper of the Department of Zoology, University of Hawaii, was awarded $250 for the research project, "The effects of particle size and concentration on the feeding behavior of the vermetid Petaloconchus keenae Hadfield & Kay, 1972." No grant was awarded in 1974.

A grant of $500 was offered for the academic year 1975-1976, and applications were received from students in British Columbia, Washington, Oregon, California, and Arizona. The grant was awarded to Mrs. Judith A. Christensen of the Department of Zoology, University of Arizona, for a project entitled, "Electrophoresis studies of selected species of the genus Rabdotus, a Baja California land snail."

The WSM will award a Student Research Grant of $500 biannually, with the next award to be offered for the academic year 1977-1978. In intervening years, the Committee will encourage student participation in the WSM through posters and letters announcing the annual meeting and encouraging students to present papers or attend the meeting.

1973-74 WSM STUDENT RESEARCH GRANT

PROGRESS REPORT

# The Effects of Particle Size and Concentration on the Feeding Behavior of the Vermetid Snail *Petaloconchus keenae* Hadfield & Kay, 1972

Carol N. Hopper
Department of Zoology, University of Hawaii
Honolulu, HI 96822

The generalized (primitive) feeding condition for the gastropod family Vermetidae entails two methods of suspension feeding: use of the mucus-covered ctenidial filaments as particle-collecting surfaces; and use of external, pedal mucus secretions which serve as nets or traps for suspended material. Vermetid gastropods inhabit midlittoral to shallow sublittoral regions, and such habitats are subject to intermittent water movement and fluctuating concentrations of ungraded suspended matter. The dual nature of this feeding habit might be expected to be of adaptive value under such variable conditions. Having two feeding mechanisms which operate under different current intensities and within different ranges of particle size and concentration may enable the organisms to feed efficiently under a variety of conditions. This hypothesis was tested using the Hawaiian vermetid *Petaloconchus keenae* Hadfield & Kay, 1972, which epitomizes this generalized feeding condition.

Organisms with an average aperture diameter of 3.2 mm were collected from two sites in Kaneohe Bay, Oahu, Hawaii. Populations from Checker Reef are distributed horizontally in the coral rubble substrate, and wave action here is moderate. Organisms inhabiting the sheltered South Dock wall of Coconut Island are distributed vertically, and wave action here is slight. The capabilities of their respective feeding mechanisms were evaluated by exposing the organisms to different regimes of particle size, particle concentration, and current speed. Polyacrylamide beads of four size classes ranging from 10 $\mu$ to 300 $\mu$ were used to establish concentrations from less than 1 particle/ml to 1500 particles/ml. Cultures of the diatom *Dunaliella tertiolecta* ($0.5 \times 10^6$ cells/ml) represented the organic counterpart of 10 $\mu$ size polyacrylamide beads. The animals were placed on a screen platform in a 600ml beaker. Currents of varying speeds (0.7-1.0 cm/sec. and 1.4-2.6 cm/sec.) were created using a magnetic stirring plate and rod in the beaker below the screen. All observations were made with a dissecting microscope, and observational trials ranged from 10 to 60 minutes in length. Individual feeding events were recorded with a twenty-channel event recorder.

In 54 feeding trials, four animals (two from each collection site) were found to exhibit three means of particle capture. First, ctenidial feeding involves consolidation of suspended material in the mucus on the gill filaments. Particles collected from the inhalant respiratory current by this passive means are passed out of the mantle cavity via a ciliated tract on the right side of the mantle cavity. Single particles can be passed in this fashion, as well as consolidated boluses of up to 1mm in diameter. Such collections are ingested as they emerge from the mantle cavity, or as they collect on the mesopodial pad immediately in front of the mouth. This feeding mechanism was of universal occurrence in feeding trials. Little relationship appears to exist between current speed and ctenidial bolus frequency, implying that the filtration rate maintained by the gills is not greatly affected by the speed of the external water current. Frequency of bolus production increases, however, with increasing particle concentration, reaching highest frequencies (up to 32 boluses/hour) for the smaller particle sizes ($< 150\ \mu$). There is also an indication that production frequency is reduced during feeding trials in which mucus string feeding also occurs.

Second, the secretion of mucus strings or traps is enacted by a pair of highly extensible pedal tentacles which lie on either side of the mesopodial pad beneath the mouth. The pedal mucus gland opens between the tentacles; its secretions are drawn down ciliated grooves on the inner sides of the pedal tentacles. Droplets of mucus are flicked off the tentacle ends to form long strings (up to 4 cm) which are distributed by water currents. Spinning may take place continuously throughout a feeding trial, the strings periodically being retrieved by the action of the jaws and radula. Long strings are often lost when contact to the head, foot or shell edge is broken; recovery is also hampered by larger particle sizes ($> 300\ \mu$). In addition to the formation of long mucus strings, the pedal tentacles may secrete a series of short mucus strings extending from the shell edge to the head, foot and operculum, creating an effective web over both incurrent and excurrent apertures. Mucus string feeding, in both forms, appears capable of handling the largest and smallest size ranges of particles. This mechanism has occurred in filtered sea water, in concentrations of polyacrylamide beads up to 1000 particles/ml, and in a diatom culture of concentration 0.5 x $10^6$ cells/ml. It has also been observed in both still and fast moving water.

The third means of capture of particulate matter is by the mesopodial pad of the foot, which is facilitated by secretions from the pedal gland, most obviously via the pedal tentacles, though some direct secretion may occur. Of nearly universal occurrence is the painting of the mesopodial pad and foot edge by the pedal tentacles. Particles which lodge on these surfaces are adsorbed to the mucus coating and consolidated by ciliary tracts. These boluses may reach sizes of 1 mm in diameter. Ingestion may be immediate, or following consolidation with ctenidial boluses or mucus strings. No consistent relationship seems to exist between frequency of bolus accumulation and current speed, particle size or concentration.

Table I summarizes the occurrence of these three feeding behaviors. Each of the mechanisms is reported under all (or nearly all) of the feeding regimes. The capabilities of these methods do not appear to be severely limited by the independent variables treated here: current speed, particle size, or particle concentration. This implies that more adaptive than two (or more) feeding mechanisms which operate differentially under different conditions are multiple mechanisms which function over a wide spectrum of environmental situations. The relative efficiency of this feeding strategy and the environmental conditions under which it persists are being studied currently.

This work was supported by the 1973-1974 Western Society of Malacologists student research grant. The event recorder was loaned by the National Marine Fisheries Service.

Table I

Petaloconchus Feeding Behavior Under Regimes of Varying Particle Size and Concentration

| Particle size-concentration regime | # trials/ regime | # individuals tested/regime | Occurrence of feeding methods/regime* M.S.F. | M.P. | C.T. |
|---|---|---|---|---|---|
| 150-300μ | | | | | |
| 0.5-1/ml | 4 | 2 | yes | yes | yes |
| 16/ml | 2 | 1 | yes | yes | yes |
| 94/ml | 2 | 1 | no | yes | yes |
| 75-150μ | | | | | |
| 24/ml | 4 | 3 | yes | yes | yes |
| 160/ml | 4 | 2 | yes | yes | yes |
| 216/ml | 1 | 1 | no | yes | yes |
| 500/ml | 6 | 4 | yes | yes | yes |
| 1500/ml | 1 | 1 | no feeding possible | | |
| 37-75μ | | | | | |
| 68/ml | 2 | 1 | no | yes | yes |
| 750/ml | 5 | 3 | yes | yes | yes |
| 10-37μ | | | | | |
| 100/ml | 5 | 2 | yes | yes | yes |
| 1000/ml | 7 | 3 | yes | yes | yes |
| Dunaliella | | | | | |
| 10μ | | | | | |
| $0.5 \times 10^6$/ml | 6 | 3 | yes | yes | yes |
| Filtered seawater | 5 | 2 | yes | yes | yes |

*M.S.F.=mucus string feeding; M.P.=mesopodial pad feeding; C.T.=ctenidial feeding

## LIST OF EXHIBITS AT THE 1975 MEETING

Clifford Martin, chairman

R. Tucker Abbott -- American Malacologists: Past and Present

Phillip Clover -- Marginellidae and the Cypraeid Genus Zoila

Barbara Good -- Marine Mollusks of San Diego

A. M. Frias-Martins -- Photographs of Micromollusca of the Azores

James Lance & David K. Mulliner -- Outstanding Nudibranch Photographs

Bill & Lois Pitt -- Fossil Mollusks from Costa Rica

Don & Jeanne Pisor -- Growth Series

Leroy & Forrest Poorman -- Giants of Their Species

Donald R. Shasky -- Tropical West American Cancellariidae

Southwestern Malacological Society -- Learning to See

1. Unidentified
2. Unidentified
3. Unidentified
4. Norval Brewer
5. William L. Woods
6. Mae Dean Richart
7. Brett Morrison
8. Wendell O. Gregg
9. Merton J. Goldsmith
10. Blanche Brewer
11. Carl C. Christensen
12. William Minkel
13. Jan Greenberg
14. Hollis Q. Boone
15. Gary L. Pace
16. Joshua L. Baily
17. Bruce H. Fowler
18. Hal Lewis
19. Walter B. Miller
20. Judith Christensen
21. Wesley M. Farmer
22. Louise Lewis
23. Beth Brewer
24. Joseph P. E. Morrison
25. Chuck Courtney
26. Jerry Harasewych
27. Edgar J. Hailey
28. Ruth H. Fair
29. Richard Reeder
30. Russell H. Jensen
31. Helen DuShane
32. Roland Taylor
33. Tim Chapman
34. Harold Vokes
35. James Carlton
36. Jerry Landye
37. Peter D'Eliscu
38. H. Wallace Roberts
39. Kay Taylor
40. George Hemingway
41. Glenn Long
42. George M. Davis
43. Charlotte Johnson
44. Barry Roth
45. Charles L. Powell
46. Emily Vokes
47. Vida Carmen Kenk
48. Lucinda Draper
49. Fred G. Hochberg
50. Eugene V. Coan
51. Elaine Hoagland-Davis
52. Artie Metcalf
53. James H. McLean
54. Clyde F. E. Roper
55. Clifton L. Martin
56. Harold D. Murray
57. Albert Taxson
58. Ingrid Roper
59. Hans Bertsch
60. Adlai B. Wheel, Sr.
61. W. L. Pratt
62. Elois Crum
63. Harald A. Rehder
64. Wendell P. Woodring
65. Anna Paine
66. Anne Taxson
67. Lois C. Rehder
68. Mary Rosewater
69. Bertram C. Draper
70. Suzanne Pratt
71. Irene Wheel
72. Joseph Rosewater
73. S. Stillman Berry
74. Louie Marincovich
75. Rose A. Burch
76. Rose D'Attilio
77. Sally Bennett
78. Roy Poorman
79. Jo Ramsaran
80. Anthony D'Attilio
81. Jeanne S. Whiteside
82. Ivan E. Thompson
83. Constance Boone
84. Bill Pitt
85. Bernadine Hughes
86. Myra Keen
87. Joyce Gemmell
88. Henry Bagdon
89. Rhoda Webb
90. Agnes Thompson
91. Bill Gemmell
92. George Radwin
93. Lois Pitt
94. John Webb
95. Hyacinth B. Rowe
96. Beatrice L. Burch
97. William Bledsoe
98. Marjorie Neiswanger
99. Patricia Bagdon
100. Esther Parodiz
101. Carole Hertz
102. Carol Skoglund
103. Juan J. Parodiz
104. Vera Schieler
105. Lorrie Hudson
106. Donald A. Moore
107. Gale G. Sphon
108. Roy L. Hudson
109. Twila Bratcher
110. Jean Cate
111. Helen King
112. Ruth Waters
113. Billee Dilworth
114. Forrest Poorman
115. Virginia O. Maes
116. Ruth Purdy
117. Edith Abbott
118. Myra Taylor
119. Tom Rice
120. Juliette Compitello
121. Joyce Clover
122. Viola Perrault
123. David Bickel
124. Margaret S. Cunningham
125. Dee S. Dundee
126. Ben Purdy
127. Marian S. Hubbard
128. Phillip W. Clover
129. Elsie Marshall
130. Norma Dexter
131. Edwin Roworth
132. H. Wayne Holiman
133. Barbara Chaney
134. Salle Crittenden
135. Paul Jennewein
136. G. Alan Solem
137. Wilma G. Young
138. Veronica P. Johns
139. William K. Emerson
140. Richard M. Kurz
141. Jody Woolsey
142. William Old, Jr.
143. Dorothy Raeihle
144. Joseph Vagvolgyi
145. Kirk Anders
146. Ursula Shasky
147. Unidentified
148. Paul O. Hughes
149. Robert Robertson
150. Judy Terry Smith
151. Robert R. Talmadge
152. Ed Petuch
153. Don Shasky
154. George Kennedy
155. Clifford A. Martin
156. Joseph DuShane
157. Audrey Holiman
158. Bayle Greenberg
159. Crawford N. Cate (& Robaire)
160. Dave Mulliner
161. E. P. Chace
162. Ruth Greenberg

Also Attending but Not in Photograph
(or Among Unidentified Therein)

R. Tucker Abbott
Noorullah Babrakzai
Nooshie Babrakzai
Tom Backman
Joe Bibbey
Mrs. William Bledsoe
Carla Bratcher
Ford Bratcher
Jack Breese
Joseph Britton
Pat Brophy
Don Cadien
Kathy Cadien
Barbara Chaney
Henry Chaney
Arthur Clarke
Phillip Crane
Phyllis Crane
Susanne Cummings
John D'Aiuto
Mary D'Aiuto
Greg Daly
Lillian B. Davenport
Richard Dilworth
Dorothea Franzen
Lois Goldsmith
Barbara Good
Frank E. Good
Ernie Haigh
George Hanselman
Sam Hinton
Mrs. Sam Hinton
Richard S. Houbrick
Todd Hutcheon
Ursula Jacobson
Albert Johnson
Nona Johnson
Carol Jones
June King
Christopher L. Kitting
Florence Kuczynski
Patrick LaFollette
Lauren Lewis
Olive Lewis
Steven Long
Emile A. Malek
Kathy Marshall
Gary McDonald
George Mendenhall
Nola Michel
David Montgomery
Cynthia Moore
Dorothy Morrison
Margaret Mulliner
Stephen Newswanger
Bette Nybakken
James Nybakken
Rich Peckham
Andrea Purdue
Mrs. George Radwin
Grace Louise Richard
Carol Roberts
Gordon Robilliard
Peter Rodda
Kate St. Jean
Maria Salamanca
S. Helen Salamanca
Bob Schoening
David Schonman
Eva Schroeder
Martin Schuler
Evelyn Schumaker
Eunice Seay
Jim Seay
Lula Siekman
David H. Stansbery
Katherine Stewart
Thomas Waller
Gladys Weber
Isabelle Welch
Ruth White
H. D. Young
M. E. Young

# EXECUTIVE BOARD AND COMMITTEE MEMBERS, 1974-1975

## OFFICERS

| | |
|---|---|
| President | Dr. George E. Radwin |
| 1st Vice President | Dr. James W. Nybakken |
| 2nd Vice President | Mrs. Helen DuShane |
| Secretary | Mr. Clifton Martin |
| Treasurer | Mr. Bertram C. Draper |
| Members-at-Large | Mr. Glenn Burghardt |
| | Mr. Steven Long |
| Three most recent Past Presidents | Dr. James H. McLean |
| | Mrs. Twila Bratcher |
| | Mrs. Beatrice L. Burch |
| Mentor-Parliamentarian* | Dr. A. Myra Keen |

## STANDING COMMITTEES

| | |
|---|---|
| Auditing* | Mrs. Helen DuShane, Chairman |
| | Mr. Merton J. Goldsmith |
| | Mrs. Edith M. Abbott |
| Nominating | Dr. James H. McLean, Chairman |
| | Mrs. Twila Bratcher |
| | Mrs. Beatrice L. Burch |

## MEETING COMMITTEES

| | |
|---|---|
| Auction | Mr. Robert Schoening & members of the Southwestern Malacological Society |
| Exhibits | Mr. Clifford Martin, Chairman |
| | Mr. Loyal J. Bibbey |
| | Mrs. Jeanne Pisor |
| Historian | Mrs. Bernadine Hughes |
| Hospitality & Refreshments | Mr. & Mrs. Roland Taylor |
| | Mrs. Barbara Good |
| | Mrs. Margaret Mulliner |
| | Mr. James Seay; Mr. Loyal J. Bibbey |
| Registration | Mr. & Mrs. Bertram Draper |
| | Mr. Clifton Martin |
| | Mrs. Blanche Brewer |
| Student Grants | Mr. James T. Carlton, Chairman |
| (see page 18 for list of committee members) | |
| Photograph | Mr. David K. Mulliner |
| Editor | Dr. Eugene V. Coan |
| (see page 2 for list of Editorial Board members) | |
| Banquet Favors | Mrs. Gertrude Wahrenbrock & the Yucaipa Shell Club |
| Program Coordination | Dr. Donald R. Shasky |
| Publicity | Mrs. Prudence Hutsching |
| Audio-Visual | Mr. Leroy Poorman |
| | Mr. James T. Carlton |
| | Mr. Hans Bertsch |

* Appointed by Past President

Abbott, Mrs. Edith M.
1264 W. Cienega Ave.
San Dimas, CA 91773

Abbott, Dr. R. Tucker
P. O. Box 4208
Greenville, DE 19807

Adams, Mr. Elmo W.
747 Winchester Dr.
Burlingame, CA 94010

Addicott, Dr. Warren O.
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(Meets twice a month: second Wednesday at 9:30 a.m. in members' homes, and last Wednesday at 7:30 p.m. in the CARD office on Rio Linda Avenue)

Conchological Club of Southern California
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, first Monday of every month, unless a holiday, 7:30 p.m.)

Guam Shell Club
P. O. Box 2933
Agana, Guam 96910
(Meets at U. S. O., Piti, Guam, on the first and third Tuesday of each month at 7:30 p.m.)

Hawaiian Malacological Society
P. O. Box 10391
Honolulu, Hawaii 96816
(Meets first Wednesday of every month, 7:30 p.m. First United Methodist Church, 1020 S. Beretania Street)

Long Beach Shell Club
600 Long Beach Boulevard (YMCA Building)
Long Beach, California 90812
(Meets second Sunday of every month except July, 2:00 p.m.)

Northern California Malacozoological Club
c/o Mrs. John S. Crittenden (Salle S.)
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(Meets third Friday of each month, various places)

Oregon Society of Conchologists
2545 N. E. 15th Avenue
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(Meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card)

Pacific Northwest Shell Club
c/o Miss Ann Smiley
Route 1, 2405 N. E. 279th Street
Ridgefield, Washington 98642
(Meets third Sunday of each month at 2:00 p.m., various places)

Pacific Shell Club
Los Angeles County Museum of Natural History
900 Exposition Boulevard
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(Meets in Museum Lounge, first Sunday of each month at 1:30 p.m., October through June)

San Diego Shell Club
P. O. Box 1390
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(Meets third Thursday of every month, San Diego Museum of Natural History, Balboa Park)

Santa Barbara Malacological Society
P. O. Box 30191
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(Meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol, Santa Barbara)

Southwestern Malacological Society
c/o Mrs. Carol Skoglund
3846 E. Highland Avenue
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(Meets third Wednesdays, September through May, 7:30 p.m., 1601 West Indian School Road, in auxiliary rooms of the Asbury U. M. Church)

Yucaipa Shell Club
Mousley Museum of Natural History
Bryant Street and Panorama Avenue
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(Meets third Sunday of every month except August, 2:00 p.m.)


BOUND BY
HW

# THE WESTERN SOCIETY OF MALACOLOGISTS

ANNUAL REPORT

Pacific Grove, California

June 23-26, 1976

**Volume 9**

The Western Society of Malacologists

Annual Report

Volume 9

Pacific Grove, California

June 23-26, 1976

Issued: OCT 12 1976

The Annual Report of the Western Society of Malacologists is based on its yearly meeting. Distribution of the Annual Report is free to regular and student members who are, at the time of issue, in good standing. Membership dues are $5.00 for regular members and $2.00 for students. Others of a regular member's family may join for an additional $1.00; each family receives only one Annual Report.

The Western Society of Malacologists has issued two Occasional Papers -- No. 1, "'Sea Shells of Tropical West America': Additions and Corrections to 1975" by A. Myra Keen and Eugene Coan; and No. 2, "A Catalogue of Collations of Works of Malacological Importance," by George E. Radwin and Eugene Coan. Each is available for $2.50.

Correspondence regarding membership and orders for additional or back issues of the Annual Report or for either of the Occasional Papers should be addressed to the current Treasurer, Mr. Merton Goldsmith, 1622 No. 20th Street, Phoenix, Arizona 85006.

When longer papers are included in the Annual Report or other of the Society's publications, they are reviewed by two members of the Editorial Board in addition to the Editor.

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PROGRAM SUMMARY

Wednesday, June 23rd

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6:00 - 7:30 - Dinner
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Thursday, June 24th

7:30 - 8:30 - Breakfast
8:30 - 11:30 - Symposium on Limpets - Session I
James T. Carlton, Chairman
11:30 - 1:00 - Lunch Break
1:00 - 1:30 - Group Photograph
1:30 - 5:15 - Limpet Symposium - Session II
6:00 - 7:30 - Dinner
7:30 - 8:15 - Executive Board Meeting
7:30 - 9:00 - Shell Auction

Friday, June 25th

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8:45 - 11:30 - Contributed Papers - Session I
11:30 - 1:00 - Lunch Break
1:00 - 5:00 - Contributed Papers - Session II
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7:30 - 9:00 - Slide Show, "The 1975 Marine Communities Expedition to Chile," by Dr. James H. McLean

Saturday, June 26th

7:30 - 8:30 - Breakfast
8:30 - 11:30 - Contributed Papers - Session III
11:30 - 1:00 - Lunch Break
1:00 - 2:30 - Contributed Papers - Session IV
3:00 - 4:00 - Business Meeting
6:00 - 9:00 - Banquet - Dr. Ralph Buchsbaum, "Some Unusual Invertebrates I Have Known"

## NOTICE OF THE TENTH ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The tenth annual meeting of the Western Society of Malacologists will be held June 15 to 18, 1977, at Kellogg West, Center for Continuing Education, California State Polytechnic University, Pomona, California. The program will include contributed papers, symposia, exhibits, and study workshops on molluscan subjects.

Inquiries about the meeting should be directed by May 15 to Mrs. Jo Ramsaran, Secretary, 807 North Road, San Bernardino, California 92404.

Applications for membership should be sent to Mr. Merton Goldsmith, Treasurer, 1622 N. 20th Street, Phoenix, Arizona 85006. Dues are: regular membership - $5.00; additional family members - $1.00 per person; student membership - $2.00. Regular and student members will receive the Annual Report of the Society.

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## NOTICE OF THE 1977 W.S.M. STUDENT RESEARCH GRANT

The Western Society of Malacologists will award a grant of $500 to an upper division undergraduate (junior or senior) or graduate (first or second year) student for the academic year 1977-1978. The grant is offered to initiate or further research concerned with some aspect of molluscan biology, ecology, systematics, paleontology, anthropology, or related fields. Grant funds may be applied to any aspect of the research, including purchase of materials, obtaining or copying literature, transportation, or publication costs.

Students must be registered in a part- or full-time status at a college, university, or marine or field station. The completed application and research proposal must be accompanied by an outline of the student's academic background and by a letter from a faculty member, instructor, advisor, museum curator, or other professional scientist supervising or knowing of the student's work. The grant recipient would agree to present, if possible, the results of the research to the Society at its eleventh annual meeting in the summer of 1978.

Applications and accompanying materials will be accepted no later than May 6, 1977.

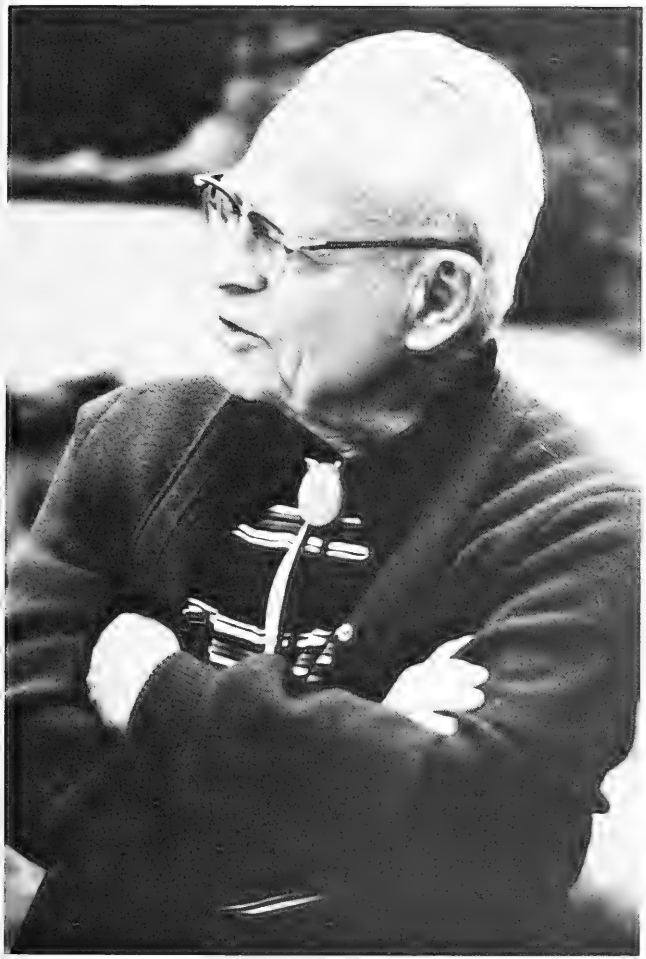
Application forms may be obtained by writing:

Mr. James T. Carlton
Chairman, W.S.M. Committee on Student Grants
Department of Geology
University of California at Davis
Davis, California 95616

## Allyn Goodwin Smith (1893-1976)

The passing of Allyn G. Smith on 18 August, 1976, marked the loss of a much admired malacologist, an impressive source of knowledge in our field. Born in Hartford, Connecticut, Allyn moved with his family in 1908 to Redlands, California, where he acquired an interest in natural history. While on vacation with his parents, Allyn attended a lecture on mollusks given in 1910 by Professor Josiah Keep. Keep evidently recognized Allyn's keen ability, and the two of them made several collecting trips together. This was all that was needed to steer Allyn in the direction of conchology. Returning to Redlands, he made the acquaintance of S. Stillman Berry, who became his mentor and was undoubtedly responsible for his early and continuing interests in the chitons and land snails.

Allyn graduated from high school in Redlands, and obtained a B.S. degree in electrical engineering from the University of California at Berkeley in 1916. He worked 32 years for the Pacific Telephone and Telegraph Company, where he became Administrative Superintendent of Personnel. However, Allyn's true love was malacology, and his retirement from P. T. & T. in 1955 allowed him to work full time at the California Academy of Sciences, where he had served as a Research Associate in Conchology since 1939. He held the positions of Research Malacologist and Executive Assistant to the Director from 1956-1960. In 1960, he accepted an appointment as Associate Curator of the Department of Invertebrate Zoology, and in 1963, one as Chairman of the Department. During this time at the Academy, Allyn was primarily responsible for developing one of the largest wet preserved invertebrate research collections in the western United States. He retired from these duties in 1972 and served actively as Research Associate in Malacology associated with the Department of Geology until his death.



Among his many affiliations, Allyn was a charter member, editorial board member, and president of the Institute of Malacology [Malacologia]; charter member, director, vice-president, and member of the editorial board of the California Malacozoological Society [The Veliger]; honorary life member of the Conchological Club of Southern California, which he joined in 1917 along with Emery Chace, William Golisch, and Tom Oldroyd, the first men allowed to join the previously all woman's club; charter member and past president of the American Malacological Union; and charter member of the Western Society of Malacologists.

Allyn was a respected authority on the Polyplacophora (chitons) and the west American land snails, but his knowledge and interests were broad, extending to all aspects of malacology. He maintained a private collection approaching 13,000 carefully curated lots of principally west North American mollusks. Allyn loved to share his knowledge, and the use of his private collection and library benefited many. He was always willing to help the neophyte as well as the professional worker, and many students of west coast malacology owe much to the guidance and advice he generously gave. Since his first article appeared in 1917, over 100 professional papers by him have been published or are in press. These articles deal with a variety of molluscan subjects and include the description of several new taxa. Perhaps he will be best remembered by the scientific community for his work (with Mackenzie Gordon) on Monterey Bay mollusks published in 1948 (Calif. Acad. Sci., Proc. (4) 26(8): 147-245); the Amphineura section of the Treatise on Invertebrate Paleontology (R. C. Moore, ed., 1960. Part I, Mollusca 1, pp. 41-76); and various papers dealing with the Galápagos land snail fauna.

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Photos courtesy of California Academy of Sciences (p. 8) and James H. McLean (p. 9)

SUMMARY OF MINUTES, EXECUTIVE BOARD
AND ANNUAL BUSINESS MEETINGS

June 24 & 26, 1976

(The complete minutes of these meetings are contained in the records of the Secretary of the Society and will be available at the tenth annual meeting.)

The meetings were presided over by the President, Dr. James Nybakken.

Minutes of last year's meetings as contained in the Secretary's book and summarized in the Annual Report were approved.

The Treasurer, Merton J. Goldsmith, reported a total balance of savings account and checking account of $2,522.62 and a total membership of 191. He also reported registrations for the present meeting at 114 and auction and raffle receipts of $373.91.

Dr. George Radwin, Chairman of the Nominating Committee, nominated the following members for 1976-1977 officers:

| | |
|---|---|
| President: | Mrs. Helen DuShane |
| 1st Vice President: | Dr. Peter N. D'Eliscu |
| 2nd Vice President: | Mr. Barry Roth |
| Secretary: | Mrs. Jo Ramsaran |
| Treasurer: | Mr. Merton J. Goldsmith |
| Members-at-Large: | Mr. James T. Carlton |
| | Mr. Leroy Poorman |

The nominees were elected by unanimous ballot.

Helen DuShane reported that arrangements have been made to hold the tenth annual meeting at Kellogg West (Center for Continuing Education), California State Polytechnic University, Pomona, California, June 15-18, 1977.

The following actions were approved:

(1) To allow for additional expenses connected with the Student Grant Program for increased costs of postage and advertising.

(2) To publish Occasional Paper 2, a key to collations of major molluscan works, by George E. Radwin and Eugene V. Coan.

(3) To give the Historian $50.00 to purchase pictures and documents for our records and to allow an additional sum to purchase a new book.

(4) To reinstate the WSM membership in the American Malacological Union.

TREASURER'S CONSOLIDATED REPORT

August 1, 1976

| | | | |
|---|---|---|---|
| Total deposits, September 12, 1975 | | | $3807.37 |
| Income | | | |
| Dues | 837.00 | | |
| Publications | 406.22 | | |
| Interest | 76.22 | | |
| Shell auction | 376.91 | 1687.75 | |
| Disbursements | | | |
| Publications | 1776.47 | | |
| Student award | 500.00 | | |
| Conference '77 | 100.00 | | |
| Conference '76 | 308.22 | | |
| Miscellaneous | 347.66 | 3032.35 | |
| Year net expense | | | 1344.60 |
| | | | $2462.77 |

| | | | |
|---|---|---|---|
| August 1, 1976 | Undeposited check | 5.00 | |
| | Checking account balance | 1066.58 | |
| | Savings account balance | 1391.19 | $2462.77 |

Respectfully submitted:

Merton J. Goldsmith, Treasurer

# SYMPOSIUM ON LIMPETS

## Introduction

James T. Carlton, Chairman

The gathering of biologists at Pacific Grove on June 24, 1976, to present papers and discuss the biology of northeastern Pacific Acmaeidae came at a time when interest by biologists and ecologists in limpets had never been greater. This was originally conceived as a small morning session of a few papers, but inquiry along the coast revealed a great many workers engaged in the study of limpets. Many of those at the symposium had never met nor knew of each other's work prior to the organization of the meeting.

Speakers were invited to present short papers on their work on limpets without restriction as to topic, and 50 to 75 attendees heard the results of biological, ecological, physiological, genetic, and biogeographic studies. Lindberg, in two papers, turned to the fossil record and biogeographic patterns for distinctly new conclusions on the phylogenetic relationships of the Acmaeidae. Questions on limpet genetics and gene exchange were addressed by Murphy and Gresham on limpet enzyme patterns, by Chapin on chromosomes, and by Turner on race formation, all topics which have received virtually no previous attention.

The biology and physiology of Collisella strigatella by Hoffman; Notoacmea scutum and C. digitalis by Phillips, Seapy, and Tarr; and Notoacmea paleacea by Fishlyn and Morgan were dealt with in six papers. The tiny limpet N. paleacea, the subject of only brief literature mention, now promises to be as well known as many other species; the surprising discoveries of a second shell notch by Fishlyn (following the discovery of one notch by Yonge (1962)*) and of adult limpets on the green alga Ulva by Horgan, are of special note. Escape and avoidance responses of limpets to predators were discussed by Phillips and by Yensen, in a continuing and probing interest (Phillips, 1975a, 1975b, 1976)* by biologists on limpet-starfish (and other predator) interactions. Stenotopic marine plant limpets, never before studied as a separate group, were analyzed for their Neogene host and spatial distributional patterns by Carlton and by Lindberg.

Presented here are abstracts of the 14 papers given, supplemented by a bibliography of about 100 papers dealing in whole or in large part with Pacific coast limpets.

Twenty-four species (see bibliography) of acmaeas in six genera (Acmaea, Collisella, Notoacmea, Tectura, Problacmaea, and Lottia) occur along the Pacific Coast from Alaska to Baja California. For many decades all of these, except Lottia, were assigned to the single genus Acmaea, and it may be said that attempts to reassign many well known species to other genera have met, in some biological and ecological quarters, with objection if not resistance. While supraspecific systematic work on our limpets is by no means completed with such reassignments, the trend away from an all-encompassing genus for distinct groups of closely-related species appears to be a valid one.

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* See bibliography at end of symposium.

# Pacific Coast Acmaeidae: A Brief History of Biological and Systematic Studies

James T. Carlton
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Four major periods of systematic and taxonomic work on Pacific Coast limpets may be recognized. The first, from 1833-1857, included the description of 12 still recognized species. In 1857, Philip P. Carpenter published the first review of west coast limpets, followed by papers in 1864 and 1866, and then by a lengthy review by Dall in 1871. Dall continued contributing to limpet taxonomy for 56 years, until 1927. In 1891-1892 Pilsbry produced the limpet sections of the Manual of Conchology. The contributions of Carpenter, Dall, and Pilsbry in the years 1857 to 1927 constitute a broad second period. (The work of applying names to most of the 24 species of limpets on the Pacific Coast was completed by 1872, due to the efforts of Eschscholtz and Rathke in 1833, Sowerby, Hinds, Gould, Middendorff, and Reeve in the next 22 years, Carpenter in 1864, and Dall in 1871. Only three species remained to be named: in 1879 Dall added Collisella apicina; in 1945 Test described Collisella conus; and in 1960 Berry named Notoacmea gabatella).

A third and shorter period embraces the work of Avery Grant (Test) at Berkeley and Michigan from 1933 to 1946, which included the production of a largely unpublished doctorate and three papers on the taxonomy, ecology, and evolution of acmaeids. A fourth period opened 16 years ago, in 1960, when, coincidentally, two new limpet names were proposed: Fritchman described Acmaea paradigitalis (for what Grant and others had taken to be perhaps a hybrid of Acmaea pelta and Acmaea digitalis) and Berry named N. gabatella. Six years later, McLean completed the first revision of the acmaeids since Grant's work of the 1930's, and demonstrated that Fritchman's species was in fact strigatella Carpenter, 1864. In 1969, McLean introduced for general usage as full generic names Collisella and Notoacmea, subdividing at a generic level those limpets which had been encompassed in most literature under the single name Acmaea.

In contrast to these four periods of taxonomic and systematic work, studies on the biology and ecology of limpets waited a good many more years. Prior to Test's 1945 paper, only the subject of limpet homing had received any attention. Morris Wells' 1917 paper on limpet homing, and, earlier, Fisher's magnificent work (1904) on the anatomy of Lottia, seem to mark the first real interest in limpet biology on the Pacific Coast. Richardson in 1934 and Villee and Groody in 1940 returned to the question of homing behavior and movement. After Test's 1945 and 1946 papers, only a few papers appeared in the next decade: those of Shotwell (1950a, 1950b) on shell volume and vertical zonation in Oregon, Segal (1956a and 1956b) on the biology of Collisella limatula, and Abbott (1956) on Lottia. By the close of the 1950's, a total of about 12 papers on some aspect of the biology or ecology of Pacific Coast limpets had appeared since the first species was described in 1833.

Since the publication in 1961 of Fritchman's 4-part series on the reproductive cycles of California limpets, based upon Ph.D. work at Berkeley in 1953, a relative flood of limpet work has appeared. In the

1960's, over 30 papers appeared, nearly three times the number which had appeared in the last 100 years. A major contribution in the form of 20 papers appeared in 1968 as a supplement to the Veliger (Abbott, et al., 1968), constituting the work of students at Hopkins Marine Station. Since 1970, more than 20 additional papers have been issued, and this decade will likely represent the production of more limpet work than any previous period. Two broad periods of biological work thus stand out: one prior to, and one since, 1960. This latter period is responsible for the production of more than 80% of the work on Pacific Coast limpets.

Despite the preponderance of work on certain species (e.g., Collisella digitalis, C. scabra, and C. limatula), we are left with an understanding of limpet biology in only a broad sense, as our knowledge about any one species remains largely unsynthesized.

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## Cenozoic Phylogeny and Zoogeography of the Acmaeidae in the Eastern Pacific

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In the Eastern Pacific the family Acmaeidae is represented by 49 Recent species which have been assigned to between two and seven genera, depending on the taxonomic scheme adopted. Previous generic assignments have mostly been made on the basis of radular and gill characters. Shell morphology has not been considered useful, as shell surface characters are readily altered by environmental conditions. However, reliance on radular and gill characters has restricted workers to Recent species in determining generic assignments, and the Cenozoic Eastern Pacific species could be only questionably assigned to genera, with little revealed about the family's phylogeny. We have thus been left with a family whose present distributions, radular characters, shell morphology, and gill characters suggest an interesting and complex evolution, but we have lacked methods to clearly establish relationships and understand this evolution.

In a study of the shell microstructure of world-wide acmaeids, Copeland MacClintock found that 59 Recent and fossil species were divisible into six basic groups, and he showed that shell structure could be studied in fossil specimens retaining original shell material. In my study, current knowledge of radular and gill morphology are being correlated with his findings on shell structure, with supraspecific groupings based on all three sets of characters.

Four of the groups of West American species made in the present study correspond to genera recognized today -- Tectura, Collisella, Lottia, and Scurria. In two cases my groupings differ from existing generic units, this because of differences in shell structure between the type species of the genera and Eastern Pacific species which have been placed in them.

Only three of MacClintock's six basic shell structure types are found in the Eastern Pacific. Members of the first shell structure group may possess one of two types of gill morphologies -- either a ctenidium only, or both a partial branchial cordon and a ctenidium. Within this first

shell structure group, four generic units based on radular characters, chiefly the number of rudimentary marginal teeth (uncini), are found in the ctenidium-only subgroup -- (1) "Genus A," with two pairs of uncini in each row, species of which have been included in the genus Patelloida; (2) "Genus B," which lacks uncini and species of which have been included in the genus Notoacmea; (3) Collisella, which has a single pair of uncini; and (4) Tectura, which lacks uncini and has a simplified basal plate. The subgroup with a partial branchial cordon and a ctenidium contains only the monotypic genus Lottia, whose radula bears a single pair of uncini. The members of the second shell structure group possess only one type of gill morphology -- a full branchial cordon and a ctenidium. The genus Scurria belongs here, and its radula bears a single pair of uncini on each row. The third shell structure group is represented in the Eastern Pacific only by Paleogene species whose radular and gill morphologies will probably never be known.

The earliest fossil acmaeid limpets occur in North Africa and southern Europe, and this suggests that the family originated in the ancient Tethys Sea. Early in its evolution the stock was divided in two by Late Mesozoic tectonic activity, one part in the Eastern and one in the Western Tethyan. The majority of the Eastern Pacific species are believed to be derived from the Western Tethyan stock, and the Western Pacific acmaeids are believed to be derived entirely from the Eastern Tethyan stock. In the Eastern Pacific, the genera Collisella, Tectura, Scurria, and Lottia are considered to be endemic. Genera "A" and "B" are considered to be immigrants from the Western Pacific, "A" by a trans-Pacific route and "B" by moving along the continental margins of the North Pacific. "Genus B," Tectura, and Collisella then moved through Bering Strait into the North Atlantic. Genera "A" and "B" and Collisella also entered the Caribbean prior to the closing of the seaway across Panama.

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## Observations on the Natural History and Morphological Variation of Notoacmea paleacea on Phyllospadix scouleri and P. torreyi in Northern California

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The stenotopic limpet Notoacmea paleacea occurs in Horseshoe Cove, Bodega Bay, California, on the surfgrasses Phyllospadix torreyi and P. scouleri. Adult limpets on P. scouleri, which has broad, flat blades, are significantly ($p < .001$) larger than limpets on P. torreyi, with narrow, oval blades. Limpets on P. scouleri are flatter, however, reflecting their presence in areas of higher wave action. N. paleacea is capable of both forward and reverse locomotion, using the cephalic tentacles to orient itself on the blade; mucus is secreted to aid in attachment. This limpet feeds upon the cortical cells of its host. It occurs not only on the surfgrass blades, but also on the stems. The seastar Leptasterias preys upon N. paleacea in the Phyllospadix beds. Sessile epizoics on the shell include algae, protozoans, hydroids, sponges, and bryozoans.

The shell of N. paleacea varies in texture of ribbing, strength of marginal crenulations, and shape in cross-section (sides parallel, ventrally skirted out, or ventrally ingrown). Limpets found on P. torreyi also

exhibit a saddled margin, conforming to the oval shape blade. Limpets vary in development of anterolateral notches -- from no notches to both right and left notches. The presence of a left notch has not been previously described. Notches are used for cleansing and respiratory currents, gamete release, and cephalic tentacle extension. A preliminary study of limpets from along the Pacific Coast was also undertaken; south of Point Conception, Santa Barbara County, shells appear to be longer, narrower, and taller than those from Central and Northern California. These southern limpets also show the saddle shape of Horseshoe Cove limpets occurring on P. torreyi. Two-notched limpets occur along the entire coast.

Adaptations of N. paleacea include: the utilization of notches in order to maintain continued cleansing currents and tentacle extension without raising the shell from the blade; orientation of the shell on the blade so that the posterior slope faces wave impact; mucus secretion for attachment; movement to lower blade surfaces to avoid desiccation on blades exposed to air at low tide; and possession of a flatter shell in areas of higher wave energy.

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## Population Studies of the Stenotopic Limpet Notoacmea paleacea on its Sea Grass Host, Phyllospadix torreyi

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Notoacmea paleacea is a common animal of the intertidal Phyllospadix beds in Monterey Bay, California, yet the sizes and seasonal fluctuations, and the relation of these numbers to Phyllospadix, have not been previously studied.

A mapped portion of the Phyllospadix beds on the eastern exposure of Soquel Point, Santa Cruz County, California, was sampled five times between May, 1975, and February, 1976. Three collections of P. torreyi were harvested from random 625 $cm^2$ quadrats and N. paleacea stripped from the blades. Blade lengths and dry weights were recorded. All N. paleacea were counted and shell dimensions were recorded for the first 100 individuals counted.

As N. paleacea increased in length to 7.25 mm, height also increased steadily to a maximum of 3.0 mm. Width increased as length increased until a maximum width range of 1.5-2.0 mm was established for all limpets over 3.5 mm long. Width of P. torreyi blades never exceeded 2.0 mm in the collections. Length/width-height relationships of 14 N. paleacea found at the study site adhering to and grazing on the green alga, Ulva, were closely similar to those limpets on P. torreyi and suggest that at least width in these limpets is genetically controlled.

Size classes and densities of N. paleacea were plotted over time to determine growth rates and seasonality of recruitment. It was found that the largest number of N. paleacea juveniles (less than 2.5 mm) appeared in the May sample, with the highest overall densities appearing in the October collections. Densities progressively decreased while large numbers of limpets making up size class "fronts" increased in size through the last sample date.

It is concluded that N. paleacea spawns all year as exhibited by the presence of juveniles in all collections, but the major recruitment of juveniles seems to occur in the spring. It can be hypothesized that large, adult limpets are lost in large numbers during the winter months (possibly victims of Phyllospadix erosion resulting from the increased wave action and/or the decreasing ability of large limpets to withstand surf.) This loss increases the amount of substrate available for spawned juveniles.

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## Intertidal Distribution and Movement in Collisella strigatella

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Collisella strigatella inhabits rocky high intertidal regions in central California. The vertical distribution of this species was determined by quadrat sampling on north and south facing substrates. Distributions for the overlapping species C. digitalis and C. scabra were also determined. Collisella strigatella occurs slightly lower than the other two species and appeared to be polymodal and possibly bimodal. A downward shift of all three species occurred on the south substrate as compared to the north substrate, presumably as a response to increased stresses from temperature and desiccation. The ability of the three species to tolerate desiccation and high temperatures was tested. Of the three, C. strigatella was least able to tolerate stress conditions. I hypothesize that the lower distribution limits for high intertidal limpets may be controlled by a physical factor, submergence, rather than biological factors. The lower limits of C. digitalis and C. scabra correspond to a tidal level submerged once during a tidal cycle, while the lower limit for C. strigatella corresponds to a level submerged twice during a tidal cycle.

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## Electrophoretic Evidence that Competition Affects Gene Frequencies in the Acmaeidae

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At least nine of the 17 species of intertidal acmaeid limpets on the central Californian coast share electrophoretically identical alleles at a leucine aminopeptidase (Lap) locus. Using starch gel electrophoresis, the strongest staining (and in most cases the only detectable) Lap isozymes in these species show an unusual banding pattern of two, three, or four bands per individual. This pattern may be explained by proposing two polymeric enzymes that share a common polymorphic subunit as well as having different monomorphoric subunits. There appears to be an interspecific total of eight alleles for the polymorphic subunit. Various acmaeid species have from two to eight of these alleles.

Collisella asmi, C. instabilis, and Notoacmea insessa, species that do not ordinarily exist in close association with large populations of other species of limpets, tend to have a broad range of these alleles with

the mean electrophoretic mobilities of their alleles near the middle of the eight allele spectrum. Six other species that regularly coexist in various combinations tend to have fewer alleles with mean allelic mobilities that are separated along the spectrum of alleles. Furthermore, populations of Collisella pelta, C. digitalis, and C. scabra collected from mixed species assemblages exhibit greater interspecific gene differences than do populations of the same species collected from unispecific assemblages.

These results can be explained by "genetic feedback" if it is assumed that similar Lap genotypes have similar utilities for micro-niches or a limiting resource regardless of the species of the individual limpet. "Genetic feedback" refers to the effects of selection acting on two or more species in such a way as to make stable coexistence more likely.

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## Enzyme Variation in Collisella digitalis

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Horizontal starch gel electrophoresis was used to survey genetic variability at 23 enzyme loci in 284 individuals of Collisella digitalis from three intertidal zones at a single site on Bodega Head, Sonoma County, California. Allelic variation was found at all loci. The expected frequency of heterozygous loci per individual, assuming Hardy-Weinberg equilibrium, is 0.241±.048. However, the observed average heterozygosity per locus for the total sample or for each of the three subpopulations is only about half the expected value (0.121±.025). No significant differences in allelic or genotypic frequencies between the three intertidal habitats sampled were observed. The surprisingly large discrepancy between the observed and expected heterozygosities cannot easily be explained by selection against heterozygotes in view of the high level of polymorphism observed. Since C. digitalis has a lengthy planktonic larval phase, there is great potential for dispersal and minimal probability of larval settlement in parental populations. Even within small geographic areas, populations of C. digitalis differ in spawning period and frequency. It is possible that population boundaries are determined by spawning periodicity rather than local proximity. Thus, the sample of C. digitalis studied may have included individuals from several genetically different subpopulations. The deficiency of heterozygotes would then be due to the Walhund effect.

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## Karyotypes of the Family Acmaeidae

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Some acmaeid species may have arisen sympatrically, geographic isolation appearing unlikely in certain cases. Chromosomal rearrangements may be a possible isolating mechanism leading to the eventual reproductive isolation necessary for speciation to occur. Establishing the karyotypes

of the Acmaeidae may indicate such an isolating mechanism and may provide further information on the phylogenetic relationships of this family. This work is now in progress using spermatocyte metaphase nuclei. A haploid count of 10 has tentatively been made for the species Collisella pelta, C. digitalis, Notoacmea scutum, and N. fenestrata in Oregon. This differs from a count of 9 made by Nishikawa on six Japanese acmaeids. Spermatocytes and possibly fertilized oöcytes will be examined to substantiate these tentative findings and to further characterize the karyotypes.

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## Possible Evidence and Mechanisms of Geographic Race Formation in Collisella digitalis

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Limpets represent ideal subjects for examining species formation in a group that has a potential for great vagility during its planktonic larval stage. The assumption that classic allopatric speciation could not occur in such an animal has been examined.

A biometric index involving the radula was used for comparison between and within populations of Collisella digitalis north and south of Monterey Bay, California. The only significant difference was for that between two populations; differences within populations were not significant.

Temperature and salinity data were analyzed to see if hydrographic barriers to dispersal across Monterey Bay could be identified, but these tests were inconclusive. The possibility that current patterns in Monterey Bay could act synergetically with the sandy shoreline to prevent larval migration across the bay was also analyzed using drift card studies. The development of circular eddies in the northern and southern extremes of the bay, as well as a powerful current bypassing the coast north of the bay, may act to prevent movement of limpet larvae across the bay, perhaps allowing race formation to occur. However, the effects of different substrates (sandstone and serpentine) at the two localities may also be responsible for the radular differences.

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## Volume Regulation in Two Species of Intertidal Limpets, Notoacmea scutum and Collisella digitalis

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The capacity to regulate body volume has recently been suggested as an important aspect of the ability of soft-bodied osmoconforming marine animals to withstand osmotic stress. Two species of intertidal acmaeid limpets, Collisella digitalis and Notoacmea scutum, which have been shown to differ in their tolerance of osmotic stress, were compared in their ability to regulate water content using two qualitative methods and two quantitative approaches.

The two limpets were found to be osmoconformers over the range 500 to 1500 mOs/l but showed a possible slight tendency to hyporegulate chloride and sodium in the hemolymph. In weight and tissue hydration changes following a change in the osmotic pressure of the medium, C. digitalis did not vary as widely as did N. scutum in either measurement, and so appears to have better control over body volume. This correlates well with a previous finding that C. digitalis is able to tolerate a wider range of osmotic pressure than is N. scutum. Application of the two quantitative methods confirmed this conclusion.

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## Morphological Adaptation in Notoacmea scutum to the Middle Intertidal Zone

Roger R. Seapy
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Previous investigations on two species of west coast Acmaeidae (Collisella limatula and C. strigatella) showed that the higher intertidal members of each population exhibited a greater amount of extra-visceral space relative to soft part (body) volume beneath the shell than did the lower intertidal members. A population of Notoacmea scutum occurring in a boulder field at Point Piedras Blancas, central California, was studied in May 1975 to determine if this relationship could also be demonstrated for this species of limpet. Individuals on the seaward-facing slopes of the boulders were examined separately from those on the shoreward-facing slopes. In both cases, extra-visceral space relative to body volume increased with tidal height between +0.5 ft and +3.5 ft above datum, although the animals from the shoreward sides of the boulders had a greater extra-visceral space to body volume ratio above +2.0 ft than did animals from seaward sides. The latter result suggests that desiccation stress was greater on the shoreward (east-facing) sides of the boulders.

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## Avoidance of Predatory Starfish by Notoacmea scutum

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The limpet Notoacmea scutum responds to predatory asteroids with two kinds of defensive behavior. An escape response is elicited when a limpet is actually contacted by a predatory starfish. In the escape response, the limpet moves directly away from the point of contact. In contrast, an avoidance response is elicited by waterborne chemicals diffusing from a distant starfish. In the presence of this starfish "scent," the limpet's primary response is to move up a vertical surface. Although this avoidance response is definite and strong, it is also quite subtle and flexible. Light, the direction of water-flow, the concentration of scent, and the species of starfish all affect the final, integrated behavior. The distance chemoreceptors that trigger avoidance behavior and the contact chemoreceptors that trigger escape behavior are both located on the mantle margin, where photoreceptors and tactile receptors are also present.

The mantle margin of Notoacmea scutum bears a large number of small, sensory tentacles which were examined using the scanning electron microscope. Most of the surface of the mantle tentacles is covered with pigmented epithelial cells. The free surface of these cells consists of a dense packing of microvilli. The tip of each tentacle is conspicuously crowned with a dense cap of cilia, and in addition, many smaller clusters of cilia are scattered along the length of the tentacle. Most of the cilia are 6-8 μ long and are organized into stiff, cohesive tufts. Smaller numbers of cilia with lengths that differ markedly from the average are also regularly present. Rows of short, truncated cilia are often seen, as well as extremely long, flexible cilia, which may be as much as 20 μ long. All of the cilia on the mantle tentacles are essentially non-motile, and all are presumed to be sensory in function.

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## Unusual Defense Behaviors of Limpets in the Northern Gulf of California

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The defense behaviors of the limpets Collisella strigatella, C. stanfordiana, and C. strongiana have been studied. Collisella strigatella raises its shell high above the substrate (mushrooming), twists its shell (rocking), and crawls rapidly (running) when touched by the predatory sun star, Heliaster kubiniji. Near the northern limit of its range C. strigatella has been reported to simply clamp to the substrate. Collisella stanfordiana clamps to the substrate when a narrow shadow crosses the shell margin, indicating the presence of photoreceptors in the mantle and a possible defense response to avian predators. Collisella strongiana covers its shell with its mantle when touched by the tube feet of H. kubiniji or by the predatory gastropod Morula ferruginosa. This response has not been recorded previously among acmaeid limpets but is fairly common among the keyhole limpets (Fissurellidae) and abalones (Haliotidae).

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## Marine Plant Limpets of the Northeastern Pacific: Patterns of Host Utilization and Comparative Plant-Limpet Distributions

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Eight Recent species of acmaeid limpets in the northeastern Pacific utilize as adults specific types of host plants as primary food sources (Table 1). (Not considered here is Notoacmea gabatella, for which both host and stenotopic nature are speculative.) No limpet is known to utilize as a specific trophic resource any one species of green algae (Chlorophyta). Only the Laminariales of the brown algae, and only the corallines among the red algae, serve as hosts for stenotopic limpets, as do all three species of marine grasses occurring on the Pacific Coast.

Three patterns of comparative plant-limpet distributions are possible: (1) the limpet extends farther than the plant host, (2) the plant host

extends farther than the limpet, or (3) their ranges are coextensive. In the first case, the plant range may be in error, or the plant actually extends no farther, or the limpet may change host. In the second case, the limpet range may be in error, or the limpet actually occurs no farther. Table 2 (in which coralline feeders, whose species-specificity is undetermined, are excluded) provides examples of case 1 (Notoacmea insessa), case 2 (Collisella instabilis, C. alveus, and Notoacmea depicta), and case 3 (Notoacmea paleacea). We may thus predict, for example, that C. instabilis may be found farther south than it is presently recorded. Of further interest is that both limpets occurring on Zostera have the shortest recorded ranges of the acmaeid limpets in the northeastern Pacific; no Zostera limpet occurs between British Columbia and southernmost California.

All of these limpets may eat their host plant, although there is little or no confirmed evidence for this in C. alveus, N. depicta, and C. depicta, and C. instabilis. Collisella instabilis may have the widest trophic range (with the possible exception of some coralline-feeding limpets). Collisella alveus, N. depicta, and C. instabilis of the plant limpets have been the least studied on the Pacific Coast, and, until recently, some confusion still existed as to the host plant of N. depicta.

Marine plant limpets and their host plants provide potential systems for the study of marine coevolution. Of particular interest may be the chemistry of these associations, including the possibility and nature of chemoreception of the host by larval or juvenile limpets, and the determination of whether plant chemistry has resulted in the restriction of stenotopic limpets to certain plant groups.

Sources of Data on Tables

Table 1

For main hosts, McLean (1966), except for N. depicta, Bishop & Bishop (1973) and Carlton (unpublished).

For other plants,

Rigg & Miller, 1949, Calif. Acad. Sci., Proc. (4) 26: 323-351.
Keen & Doty, 1942, Oregon State Univ., Monogr. Studies in Zool. 3, 16 pp.
Burch, 1946, Min. Conch. Conch. Club So. Calif. # 57: 9
McLean, 1966, Ph.D. Thesis, Biol. Sciences, Stanford Univ., 255 pp.
Bishop & Bishop, 1973, J. Conch. 28: 43-54.

Table 2

1. Grant, 1938, in McLean, 1966 (above)
2. McLean, 1966 (above)
3. Fritchman, 1962, Veliger 4: 135
4. Grant & Gale, 1931, San Diego Soc. Natl. Hist., Mem. 1: 1036 pp.
5. Eyerdam, in Burch, 1946, Min. Conch. Club So. Calif. # 57: 8
6. California Academy of Sciences, Dept. Geology collections

For algae, I. Abbott, pers. comm. (1976)

For marine grasses, den Hartog, 1970, "The sea-grasses of the world," Verh. Konink. Neder. Akad. Weten. (3) 59: 275 pp.

Table 1

MARINE PLANT LIMPETS OF WESTERN NORTH AMERICA

| SPECIES | MAIN HOST PLANT | OTHER PLANT SUBSTRATES REPORTED |
|---|---|---|
| COLLISELLA INSTABILIS | Laminaria dentigera (P)<br>Pterygophora californica (P) | Lessoniopsis [littoralis] (P), Washington (Rigg & Miller, 1949)<br>Alaria (P), Oregon (Keen & Doty,19 |
| NOTOACMEA INSESSA | Egregia menziesii (P)<br>Egregia laevigata (P) | "other species of algae" [besides Egregia] (Burch, 1946)<br>Laminaria (P), San Luis Obispo Co. (McLean, 1966) |
| COLLISELLA ALVEUS | Zostera marina (Z) | |
| NOTOACMEA DEPICTA | Zostera marina (Z) | |
| NOTOACMEA PALEACEA | Phyllospadix torreyi (Z)<br>Phyllospadix scouleri (Z) | Halidrys dioica (P) and Corallina spp. (R), San Diego, juveniles, (Bishop & Bishop, 1973) |
| ACMAEA MITRA<br>TECTURA ROSACEA<br>COLLISELLA TRIANGULARIS | All, Corallinaceae (R): Calliarthron, Lithophyllum, Lithothamnium | |

(P) = Phaeophyta, brown algae

(R) = Rhodophyta, red algae

(Z) = Zosteraceae, marine grasses

Table 2

## LIMPET AND HOST PLANT DISTRIBUTIONS, WESTERN NORTH AMERICA

(HOST PLANTS INDENTED)

### LIMPETS ON LAMINARIALES

| | |
|---|---|
| *COLLISELLA INSTABILIS*: | Amchitka Island, Aleutian Islands[1] - San Diego[4] |
| *Laminaria dentigera*: | Komandorskie Islands, USSR - Ensenada, Baja California |
| *Pterygophora californica*: | Vancouver Island, British Columbia - Bahia Rosario, Baja Calif. |
| *NOTOACMEA INSESSA*: | Wrangell, Alaska[1] - Cabo San Lucas, Baja California[3] |
| *Egregia menziesii*: | Dixon Entrance, British Columbia - central California |
| *Egregia laevigata*: | Central California - Punta Eugenio, Baja California |

### LIMPETS ON ZOSTERACEAE

| | |
|---|---|
| *COLLISELLA ALVEUS*: | Sitka, Alaska[2] - Victoria, British Columbia[5] |
| *NOTOACMEA DEPICTA*: | San Pedro[2] - Cabo San Lucas, Baja California[2] |
| *Zostera marina*: | Japan and USSR Pacific Coast; Aleutian Islands - Gulf of California: Altata, Sinaloa |
| *NOTOACMEA PALEACEA*: | Vancouver Island[1] - Cabo San Lucas, Baja California[6] |
| *Phyllospadix torreyi*: | Ucleulet, Vancouver Island - Cabo San Lucas, Baja California |
| *Phyllospadix scouleri*: | Dundas Island, British Columbia - Cabo San Lucas, Baja Calif. |

# Marine Plant Limpets of the Northern Pacific: Neogene Phylogeny and Zoogeography

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Excluding the coralline-feeding limpets, seven Recent and one fossil species of stenotopic marine plant limpets occur in the Northern Pacific Neogene -- Collisella instabilis, C. alveus, C. angusta, Notoacmea insessa, N. paleacea, and a Notoacmea species-complex composed of N. depicta, N. gabatella, and the extinct N. lepisma. Notoacmea insessa is the oldest marine plant limpet found in the fossil record, occurring in the Pliocene of southern California, and it is thought to be derived from a different stock than the other Notoacmeas. Collisella instabilis and N. paleacea first appear in the late Pleistocene of southern California, and their phylogeny is not known. All three species of the Notoacmea-complex first occur in the early Pleistocene of southern California. They are thought to be derived from a common ancestor and to have speciated in the Eastern Pacific after migration of the ancestral stock from the Western Pacific. Collisella alveus, of the northeastern Pacific and the northwest Atlantic, and C. angusta of the northwestern Pacific appear to be cognates. The discontinuous Atlantic and Pacific populations of C. alveus and the allopatric distributions of C. alveus and C. angusta may be due to Pleistocene glaciation.

# A Partial Bibliography of Pacific Coast Acmaeidae

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## INTRODUCTION

Papers dealing solely with one species are listed under that species; papers in the "General References" are also cross-referenced to individual species. This bibliography is not exhaustive, particularly with reference to biochemical and cytological literature. Minor mentions of species are not cited.

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SUBJECT INDEX



SPECIES INDEX

See also: Test, 1946; McLean, 1966, 1969; Carlton, 1974; Brewer, 1975.
Shell: MacClintock, 1967.
Physiology: Ross, 1968 (light responses)
Mantle Cavity Currents: Yonge, 1962
Reproduction: Fritchman, 1961c
Anatomy: Walker, 1968
Ecology: Shotwell, 1950a

▲Collisella conus (Test, 1945)
See: McLean, 1966, 1969
Shell: MacClintock, 1967

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Mantle Cavity Currents: Yonge, 1962
Reproduction: Fritchman, 1961c
Growth: Frank, 1965
Anatomy: Walker, 1968
Ecology: Shotwell, 1950a, 1950b; Glynn, 1965; Haven, 1971, 1973; Wolcott, 1973; Stimson & Black, 1975
Homing: Galbraith, 1965; Villee & Groody, 1940; Richardson, 1934 (as persona); Wells, 1917 (as persona)
Commensals: Johnson, 1968 (amphipod)
Predation: Chapin, 1968 (crab)

▲Collisella instabilis (Gould, 1846)
See: Test, 1945, 1946; McLean, 1966
Shell: MacClintock, 1967
Mantle Cavity Currents: Yonge, 1962

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Mantle Cavity Currents: Yonge, 1962
Reproduction: Fritchman, 1961c
Anatomy: Walker, 1968
Homing: Wells, 1917 (as scabra)
Commensals: Johnson, 1968 (amphipod)
Predation: Chapin, 1968; Phillips, 1975a, 1975b, 1976

▲Collisella ochracea (Dall, 1871)
See: Test, 1945; McLean, 1966, 1969
Mantle Cavity Currents: Yonge, 1962

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Mantle Cavity Currents: Yonge, 1962
Reproduction: Fritchman, 1961c
Growth: Frank, 1965
Anatomy: Walker, 1968
Ecology: Shotwell, 1950a, 1950b; Glynn, 1965; Eaton, 1968 (see C. limatula); Wolcott, 1973; Stimson & Black, 1975
Homing: Villee & Groody, 1940
Commensals: Johnson, 1968 (amphipod)
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Mantle Cavity Currents: Yonge, 1962
Reproduction: Fritchman, 1961c
Anatomy: Walker, 1968
Ecology: Glynn, 1965; Haven, 1971, 1973; Wolcott, 1973; Stimson & Black, 1975
Homing: Wells, 1917 (as spectrum); Villee & Groody, 1940
Commensals: Johnson, 1968 (amphipod)
Predation: Chapin, 1968 (crab)

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Mantle Cavity Currents: Yonge, 1962
Growth: Frank, 1965
Anatomy: Walker, 1968
Ecology: Stimson & Black, 1975

▲Collisella triangularis (Carpenter, 1864)
See: McLean, 1966
Mantle Cavity Currents: Yonge, 1962

▲Notoacmea depicta (Hinds, 1842)
See: McLean, 1966 (Phyllospadix recorded in error as host plant); McLean, 1969; Bishop & Bishop, 1973
Shell: MacClintock, 1967

▲Notoacmea fenestrata (Reeve, 1855)
See: Test, 1945; McLean, 1966, 1969
Shell: MacClintock, 1967
Physiology: Doran & McKenzie, 1972 (respiration)
Reproduction: Fritchman, 1961b

▲Notoacmea gabatella (Berry, 1960)
See: McLean, 1966

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Mantle Cavity Currents: Yonge, 1962
Anatomy: Walker, 1968

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See: McLean, 1966, 1969 (in error on feeding: eats Phyllospadix, not epiphytes); Bishop & Bishop, 1973
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OTHER PAPERS PRESENTED TO THE NINTH ANNUAL
WSM MEETING: TITLES AND ABSTRACTS

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## An Overview of the Opisthobranch Fauna of Guam

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Since spring, 1969, approximately 360 species of opisthobranchs have been collected on Guam. The majority of this collection comes from Bile Bay, on the southwestern area of the island. The order Cephalaspidea is represented by about 70 species, with the Atyidae, represented by 20 species, being the predominant family. The Aglajidae, with 12 species, are the most numerous of those with no external shell. Anaspidea and Notaspidea, with 6 and 10 species respectively, are two orders that seem to be lacking in number of collected species compared to the other common Opisthobranch orders. There are over 70 sacoglossan forms, with the Elysiidae dominating the group with 33 species. The nudibranchs, with 205 species, are most commonly represented by the dorids -- 117 species -- and eolids -- 60 species. The dendronotids, with 7 species, and arminid forms, with only 3 species, are so far the least numerous of the nudibranchs.

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## *Fissurella* of Chile and Peru

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(No abstract submitted)

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## Spine Development of Juveniles in Three Species of Panamic *Hysteroconcha* (Bivalvia: Veneridae)

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Spine development occurs at different size classes in different species of the subgenus *Hysteroconcha*. *Pitar* (*H.*) *multispinosus* (Sowerby, 1851) has its first spine at 4mm. Neither *Pitar* (*H.*) *lupanaria* (Lesson, 1830) nor *Pitar* (*H.*) *roseus* (Broderip & Sowerby, 1829) show this characteristic of the subgenus until they are much larger. *Pitar lupanaria* is a plain, white, slightly quadrate shell with smooth, rolled concentric ribs and no sign of spines at 4 mm. *P. roseus* has slightly raised concentric ribs and is more elongate than the other two species. In the lots examined, *P. lupanaria* produced the first small spines at about 9 mm. In contrast, *P. multispinosus* at the same size had several long spines and most of the characteristics of the adult shell.

Not until 21 mm did P. lupanaria attain comparable spine development. Spine development in P. roseus occurs at the midpoint between that of P. multispinosus and P. lupanaria.

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## Notes on the Bivalve Genus Cyclocardia from the Upper Cenozoic of Southern California

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(No abstract submitted)

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## The Aeolid Nudibranchs of the Hawaiian Islands

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Twenty-two species of aeolid nudibranchs were collected and identified from the Hawaiian Islands. Two of these probably represent undescribed taxa. Of the fourteen species which were observed feeding in the field, five were feeding on hydroids, five on sea anemones, two on stony corals, one on an octocoral, and one on the egg masses of other opisthobranchs.

Four species of the Hawaiian aeolids are circumtropical in their distribution; five are found throughout the Indo-Pacific; and nine are apparently limited to the Pacific Basin. Four species have thus far been found only in the Hawaiian Islands. Thus, the Hawaiian aeolid fauna seemingly has a wider distribution with a lower level of endemism than other Hawaiian taxa which have been studied. The Hawaiian aeolids are closely allied to the aeolid fauna of Japan. Of the twenty-two species encountered, fifteen have also been recorded from Japan.

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# Comparative Anatomical Studies in Europe on the African Achatinidae

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From October 1974 to June 1975, and at the invitation of Dr. Pierre L. G. Benoit, Curator of Invertebrates, an intensive examination was made of the shells and soft parts of the many specimens of the giant African snail family Achatinidae in collections of the Musée Royal de l'Afrique Centrale (MRAC) in Tervuren, Belgium. This project was a sequel to my earlier study at the Museum of Comparative Zoology at Harvard University (Harvard, Mus. Comp. Zool., Bull. 105: 219-291); and, in effect, it was a continuation and an extension of the work on the MRAC collection by Dr. Joseph C. Bequaert in the 1930's (ibid., p. 1-216). In the present undertaking, several thousand dry specimens of the genera Achatina (principally subgenus Achatina), Archachatina, and Callistoplepa in several hundred lots were examined. Seventy-four MRAC alcoholic specimens were dissected and 142 illustrations of their genital tracts drawn to scale. To these were added specimens examined, dissected, and illustrated during visits to other European museums, including thirteen specimens from the Institut Royal des Sciences Naturelles in Bruxelles, nine from the Rijksmuseum in Leiden, and one from the British Museum (Natural History). Dry specimens of uncertain identification from MRAC were compared with specimens in these institutions as well as the Zoölogisch Museum in Amsterdam. The smaller species in other achatinid genera (for example, Limicolaria and its allies) could not be examined because of time limitations, but their study has been projected for the summer of 1977. Total species and subspecies examined anatomically are as follows: 22 in genus Achatina, 10 in genus Archachatina, and 3 in genus Callistoplepa -- nearly all of which were anatomically unknown. There are clearly several new taxa, based on both the soft anatomy and shell morphology. New insight has been provided in the zoogeography of this group.

In the quantity and richness of the alcoholic specimens, and in virtually every other aspect, the MRAC collection of Achatinidae is without question the finest in the world. Among its many fine qualities are the following: (1) a large series of specimens for many species whose natural variability has created confusion in collections having only small series; (2) a broad representation from many localities; (3) the many labels in the handwriting of Dr. Joseph C. Bequaert -- the world authority on this group; (4) the superlative condition of the specimens; (5) the excellent system of housing the specimens; and (6) the fact that all specimens bear their own accession number, greatly reducing confusion and error because of misplaced material.

## Reproductive Biology of Assiminea californica (Mesogastropoda: Rissoacea) in the Salt Marshes of Palo Alto

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San Francisco Bay salt marsh snails, Assiminea californica (Tryon, 1865) are dioecious with no visible sexual dimorphism in the adult animals. The male system consists of a lobed testis, vas deferens made up of several discrete sections, prostate gland, ridged ciliated sperm duct, and penis. The penis is large and dagger-shaped with an annulated nipple-like extension at the tip. The female system consists of a large lobed ovary, oviduct of several sections, seminal receptacle, bursa, and pallial oviduct surrounded by albumen and capsule glands. The oviduct within the albumen gland is enlarged and chamber-like. Reproduction is not seasonal, although they copulate only during moist periods of the month. During favorable periods the eggs hatch immediately upon development but may delay hatching during dry periods. The egg capsule is coated with a thin but very sticky mucous film, and due to mud adhering to the mucus, the egg becomes visibly undetectable. The young hatch as fully developed snails, the veliger stage passing within the egg capsule. The calcified protoconch is not pigmented and consists of one and one-quarter whorls. Fluke infections castrate heavily infected snails, but snails with a lesser infection may have reduced but apparently functional reproductive systems.

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## Some Remarks on Felipe Poey's "Memorias sobre la Historia de la Isla de Cuba"

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(The complete text of this paper appears on pages 55-58)

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## The San Francisco Bay Project: A New Perspective in Taxonomy

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Despite nearly one hundred years of studies of the invertebrate fauna of San Francisco Bay and the Bay Delta, investigators still lack the basic taxonomic tools required to make consistent and accurate identifications of the organisms which they are attempting to study. Yet such correct identifications are essential before any ecological, environmental assessment, or monitoring study may be undertaken. This lack of information has resulted from several causes, including lack of expertise and co-ordinated effort; failure to retain specimens for future reference; scattered, technical, and often unavailable literature; and the lack of a central information and specimen storage and retrieval facility.

The San Francisco Bay Project of the Department of Invertebrate Zoology at the California Academy of Sciences was developed to provide those services most required by investigators, and to disperse information in a way which will maximize usage and permit adoption in a broad spectrum of research efforts. The program is divided into three phases. Phase I is concerned with the development of a complete reference collection of invertebrate organisms from the area, including growth series, color variants, sexual dimorphs, and other forms not covered in typical collections. The department has set up procedures to serve as the central repository for all collections of invertebrates made throughout the Bay and Delta.

Phase II involves the production of a fully cross-referenced bibliography to the Bay and its fauna. The references will be arranged by author, subject, and taxon to provide full accessibility. While primary emphasis will be directed toward taxonomic information, references to physiological, ecological, and other aspects of the life histories of the taxa will be included, as well as relevant papers on the geology, hydrology, and history of the San Francisco Bay-Delta system.

Phase III of the project will compile and disseminate the information through a series of identification manuals to various groups of the fauna. Each manual will provide full background, including illustrated glossary, bibliography, and description of techniques for handling and preparing specimens. The most important character of the manual will be the presentation of a series of distinct, yet complementary keys to the identification of the taxa. The keys will include pictorial, traditional dichotomous, and tabular formats in a manner which makes them useful to both the non-professional and the specialist alike.

Through the development of these services and manuals, professionals and amateurs may obtain all needed taxonomic information at a single source and may utilize the information to whatever extent desired. The San Francisco Bay Project provides a pilot study towards the development of similar programs in other areas of the country, and hopefully it will serve as a standard for regional taxonomic faunal studies.

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## Some Comments on Shell-Boring Pholads

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For several years, I have examined the pholads boring into shells of Haliotis rufescens. I am convinced that authors have been incorrect in synonymizing Navea subglobosa Gray, 1851, with Penitella conradi Valenciennes, 1846. Navea subglobosa is more globose than Penitella conradi and is more common in Haliotis. It never has a callum nor a siphonoplax. It never occurs under a blister on the inside of the shell of Haliotis. Rather, Haliotis secretes a thin, flat patch of chitinous material over it which is almost transparent, and the knobby ends of the shells of N. subglobosa are visible through this patch. Penitella conradi, on the other hand, causes Haliotis to secrete an internal, nacreous blister. The shell of P. conradi is more elongate and has a callum and a siphonoplax. Unlike N. subglobosa, it lacks a condyle. Although N. subglobosa has been regarded as the juvenile of P. conradi, I find no intergrades.

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## Phyllonotus (Gastropoda, Muricidae), a Worldwide Tropical and Subtropical Genus

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Of all muricid genera, few exhibit such large shell size and prominent coloration as Phyllonotus Swainson, 1833 (type species: Murex imperialis Swainson, 1833, non G. Fischer, 1807, =Murex margaritensis Abbott, 1958). Although unquestionably more richly represented in the New World tropics, Phyllonotus is now considered, on the basis of a re-evaluation of world-wide muricid species, to have several species outside the New World.

The shell in Phyllonotus is large, solid, and globose. The inner lip is smooth and expanded anteriorly into a detached, erect inductura. Shells of most species bear three broad spiral brown bands, and the apertural margin is heavily enameled in shades of pink, orange, yellow, or brown, or a combination of two or more of these colors. Radular dentition is typically muricine, with a simple, broad, curved rachidian tooth bearing five prominent cusps. The lateral cusps have broadly concave outer margins; the central cusp is long, obelisk-shaped, and lacks the central, longitudinal highlight of Hexaplex, Chicoreus, and Muricanthus which gives them a triangular cross-section.

There are two different protoconchs: a simple, short, smooth one, as in P. pomum, and a longer, more tapering, pustulose one, as in P. peratus.

In addition to the New World species generally assigned here, our investigation has led us to also assign the West African "Murex" duplex; the Mediterranean "M." trunculus; and the Indo-West Pacific "M." superbus, "M." laciniatus, and "M." venustulus to Phyllonotus.

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## Gastropod Predation of the Bivalve Cyclocardia from the Lomita Marl (Pleistocene) of Southern California

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Although it has been suggested that members of the gastropod families Naticidae and Muricidae preferentially attack the valve margins of certain bivalve mollusks, quantification of this phenomenon has not previously been published. Taylor's attempt showed a preference for the ventral third of the shell rather than for the margin. Specimens of the bivalve Cyclocardia from the Lomita Marl (Pleistocene) of San Pedro, Los Angeles County, California (LACMIP loc. 435) show an unusually high proportion of gastropod bore holes along or near the shell margin. Of 15,104 Cyclocardia valves examined, 3,309 have gastropod bore holes in them, 1,593 in left valves (LV's) and 1,716 in right valves (RV's). The percentage of bored valves is about 22%. If one makes the erroneous assumption that

every animal bored to death was attacked only once, the percentage of bored clams is thus almost 44%.

The differences between naticid and muricid holes are reported to be pronounced. In actuality, however, it was often impossible to determine the gastropod predator, and therefore this distinction was not made.

The size (length) of clams with the greatest number of bore holes was between 2 and 16 mm. The greatest number of holes on, or near, the margin (defined as $\leq$1 mm from the valve edge) is in the 4 to 16 mm size range. Specimens 2 to 4 mm long were bored most frequently in the central region of the valve, probably due to manipulative problems of the gastropod predator with its small prey. The percentage of holes on or near the margin in the 4 to 16 mm size range is 45 to 78% for LV's, and 60 to 73% for RV's. In the range of 4 to 8 and 10 to 12 mm, there is a slight preference (numerically) for RV's (6.7 to 9.5%). There is a slight boring preference for RV's in the 0 to 12 mm size range.

Incomplete bore holes ("failures") were not uncommon, and in the 2 to 14 mm range ran between 3 and 18% (LV's) and 6 to 15% (RV's). Above 14 mm, the rate of "failures" rose sharply, although the total number of bored valves also fell off. Multiple bore hole "failures" were rare, but 8 and 2 RV's had 2 and 3 "failures," respectively, and 13, 3, and 1 LV's had 2, 3, and 4 "failures," respectively. A small proportion of these also had successful holes in them. The greatest proportion of bore hole loci ("failures" only) were, for both LV's and RV's, in the central disc region of the valve, with greatest concentrations approaching the umbones. Only 11 LV and 7 RV loci of "failure" holes were on or near the margin of the valves. This is significant considering the overall high proportion of successful holes in this same region.

In comparison with living populations of Cyclocardia from the eastern Pacific, there seems to be little similarity. Only one lot, of Cyclocardia spurca beebei (Hertlein) from Banderas Bay, Jalisco, Mexico (LACM 38-5), approached the fossil population in showing a high boring rate. Of 110 valves, 29 had gastropod bore holes (26+% of valves). Assuming one bore hole per animal, the boring rate would be 52.7%. Sixteen (55%) of these holes were on or near the margin of the valves.

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## A Cowrie from the Late Pleistocene of Isla Guadalupe, Mexico

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Since 1957, exposures of Pleistocene fossils have been discovered at several points around Isla Guadalupe. Edward Goldberg determined the age of a Guadalupe fossil coral sample supplied by Carl Hubbs to be 120,000 $\pm$ 10,000 years B.P. by radiometric dating, which places the deposit within the Sangamon interglacial stage of the late Pleistocene.

Several fragments and two entire specimens referable to Cypraea (Erosaria) cernica Sowerby, 1870, of the Indo-Pacific represent the only cypraeid known from the Pleistocene of the Island. This occurrence marks the first record of an Indo-Pacific mollusk in the fossil record of the Eastern Pacific. The specimens compare well with published descriptions

and illustrations of C. cernica from Western Australia and Hawaii, and comparison with Recent specimens show no significant differences.

The published range of Cypraea cernica is the entire Indo-Pacific region, including Mauritius Island, Western Australia, New Caledonia, Okinawa, Japan, Hawaii, and the Tuamotu Archipelago. The presence of an Indo-Pacific faunal element on oceanic islands in the tropical Eastern Pacific has long been known, especially for the Cypraeidae and Conidae. A discussion of this phenomenon by William Emerson in 1967 suggested the lack of available niches, especially the paucity of well developed coral reefs, to be important in explaining the comparative lack of Indo-Pacific elements on the continental shelf of the west American mainland. Thus, a hermatypic coral of the genus Pocillopora, also with Indo-Pacific affinities, and found in great abundance in the same deposit might have encouraged the establishment of other Indo-Pacific species on Isla Guadalupe during the late Pleistocene. Although the Recent fauna of Isla Guadalupe is predominantly Californian, the fact that conditions exist for the introduction of Indo-Pacific elements, at least intermittently, is suggested by the presence of the Western Pacific gastropod Morula uva on both Isla Guadalupe and Clipperton Island, as well as Indo-Pacific species in the Guadalupe algal flora.

The occurrence of Indo-Pacific species in the fossil record of the Eastern Pacific points to the necessity of considering the Western Pacific fauna when identifying fossil or Recent specimens, and perhaps a need for overall re-evaluation of the relationships among the Indo-Pacific, Eastern Pacific, and Caribbean faunas.

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## Ecological Observations on Four Tritonid Nudibranchs Occurring in St. Croix, U. S. Virgin Islands

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Aspects of the ecology of four species of Tritonia have been studied at St. Croix in the U. S. Virgin Islands. Tritonia bayeri was found to be very common, but only on the undersides of downed colonies of the gorgonium Briareum asbestinum. A species resembling Tritonia wellsi was found uncommonly on upright colonies of the sea fan Gorgonia ventalina. An unidentified species of Tritonia was found occasionally on toppled colonies of G. ventalina, and a fourth species of Tritonia was very common on downed colonies of gorgonians of the genera Pseudoptera, Eunicea, and Plexaura. Three of the nudibranch species were found on only one gorgonian species, and all four species were specific for where they were found on either attached or unattached gorgonians. Three of the species were found only on colonies that were lying flat on the bottom. Gorgonian colonies that have broken free of their attachment sites are lost to the community, though it may take several months for their complete deterioration. It is postulated that predation by visual predators in the tropics has exerted strong selective pressure on nudibranchs. This has resulted in most species' being negatively phototactic. Tritonia species which are negatively phototactic would be limited to toppled gorgonian colonies, the case with three of the four species studied. This would in turn reduce predation on the

gorgonians utilized as prey until after they are essentially lost from the community. Observations on immature Cyphoma also associated primarily with toppled gorgonians and coral-eating nudibranchs from the Indo-Pacific suggest that this phenomenon of specializing on the "lost" portion of a prey population is widespread among specialized predators on species living in exposed positions.

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## Chromosomal Aberrations in Sonorella virilis (Gastropoda: Pulmonata: Helminthoglyptidae)

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Specimens of Sonorella virilis Pilsbry, 1905, collected during yearly field trips to the South Fork and Reeds Mountain, Chiricahua Mountains, Cochise County, Arizona, were studied cytologically over a period of five years (1971-76). Chromosome spreads were made from the ovotestes of these snails by a technique of colchicine hypotonic squash and staining with lactic acetic orcein.

Only 2 specimens out of 18 seemed to have a haploid number of n=29. The majority (16) had chromosomal aberrations of various kinds. Karyotypes constructed from mitotic metaphase chromosomes of one specimen showed evidence of primary trisomy, a chromosomal fragment and a translocation. Four specimens had translocation heterozygosity indicated by rings or chains of four chromosomes in diakinesis. The remaining 11 specimens had primary trisomy in 2, and translocation heterozygosity and chromosome fragments in 9.

The translocation between 2 bivalents apparently involved a very small chromosomal exchange. It was indicated only by the close association of the 2 bivalents and usually a "bridge" connecting them. The behavior of the normal chromosome and its 2 homologous fragments was quite different compared to normal ones in the same spread. They remained relatively uncoiled in diakinesis. Their association at diakinesis was seen as rings or chains of three elements, or occasionally, 2 elements were observed pairing and the third one behaving as a "univalent." They were also quite separate from the rest of the bivalents on the metaphase plate. The disjunction of these chromosomes was such that 2 chromosomes would go to one pole and one to the other, thus indicating that half of the progeny would have an additional fragment and the other half would have a deficiency.

We hypothesize that somewhere in the past the population of S. virilis was reduced to only a few individuals due to adverse environmental conditions. Chromosomal breakage, reunion and non-disjunction occurred at least in some of the survivors, resulting in translocations, trisomies, and chromosomal fragments. The present population of S. virilis has most likely emerged from these survivors, and therefore, most of the specimens sampled have chromosomal aberrations. The future of these aberrations would depend on their adaptive value. If they are adaptive, then they will be retained, resulting in a karyotype different from the ancestral population.

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## Intraspecific Variations of Some Neptunids

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A number of species of Neptunea exhibit major differences in shell characters in distal populations. Often, these differences are sufficient to warrant subspecific recognition. In some species there are shell characters, chiefly coloration, which have previously been explained as individual, genetic features. Recent studies of these color variations indicate that, at least in some species, they have a loose geographic correlation. For example, the yellow aperture of the southern subspecies of Neptunea pribiloffensis (Dall, 1919), N. p. humboldtiana A.G. Smith, 1971, appears to be restricted to between 40° and 43° N latitude (with the predominant area at about 40° 45' N). Both north and south of these latitudes, the shell has a white exterior and interior.

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## Land Snails of the Spring Mountains, Clark County, Nevada -- A Preliminary Survey

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The Spring Mountains, an isolated forested limestone range, rise from the northern Mohave Desert to an elevation of 3630 meters. The biota contains a high percentage of relictal and precinctive taxa. Three precinctive (P) land snail taxa have been described. Nine native taxa, four of them new records (N) have been collected to date: Vallonia cyclophorella Sterki, Pupilla blandi charlestonensis Pilsbry (P), Vertigo gouldi (Binney), s. lat. (N), Vertigo modesta ingersolli (Cockerell) (N), Discus cronkhitei (Newcomb) (N), Euconulus fulvus (Müller), Vitrina pellucida alaskana Dall, Oreohelix handi handi Pilsbry & Ferriss (P), and Orehohelix handi jaegeri Berry (P). The introduced limacid slug Lehmannia valentiana (Ferussac) was found along one spring run at an old ranch headquarters in the range.

Land snails seem to be largely restricted to the coniferous forest above 2200 meters. Vertigo modesta, Discus cronkhitei, and Euconulus fulvus seem to be restricted to the vicinity of flowing streams; the remaining species are more widely distributed. Vallonia cyclophorella, Discus cronkhitei, and Vitrina pellucida range down to flowing springs within the evergreen woodland at about 1900 meters.

The fauna is depauperate in comparison with faunae of similar habitats in the plateaus of Utah and basin ranges of Arizona, its presumptive sources. Perhaps this is a result of isolation. Interestingly, the fauna of the Spring Range bears no resemblance to a Wisconsin Pleistocene fauna from the Las Vegas Valley, immediately to the east.

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## Preliminary Investigations of Possible Competitive Interactions between Two Mudsnails, Ilyanassa obsoleta and Cerithidea californica

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Ilyanassa obsoleta (Say, 1822), a Western Atlantic mudsnail, was inadvertently introduced into San Francisco Bay between the 1860's and 1910's in shipments of eastern oysters, Crassostrea virginica (Gmelin, 1791), for the then-thriving oyster industry. The decline in numbers of Cerithidea californica (Haldeman, 1840), a native mudsnail, roughly parallels the increase in numbers of Ilyanassa. Field observations of these ecologically similar snails indicate that Cerithidea californica in the presence of Ilyanassa obsoleta occurs in only a restricted portion of the marsh and mudflat habitat. Subsequent investigations on allopatric and sympatric populations of the snails are planned to determine the mechanisms responsible for this niche contraction.

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## A Preliminary Survey of the Northwest American Carditidae

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A review of the Recent species of the northwest American Carditidae has been conducted and tentative synonymies proposed. The family, particularly the genus Cyclocardia, is a difficult group to deal with taxonomically because species display a bewildering degree of morphological variability. Most if not all species brood their young, giving rise to a high potential for genetic isolation. In combination with a northern distribution along the complex Alaskan and Canadian coastlines and a long geological history in the Northern Pacific, this high potential for genetic isolation yields taxonomic complexity not easily resolved. Two species-complexes in particular will require statistical analysis of many specimens from a wide array of stations -- that of Cyclocardia crebricostata (Krause, 1885), centered in the Bering Sea, and that of C. ventricosa (Gould, 1850), distributed from the Gulf of Alaska to central Baja California. C. rjabininae (Scarlato, 1955) is tentatively recognized from the Gulf of Alaska.

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## Some Muricacean Cognate Species of the New World on Both Sides of the Panama Land Bridge

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Geologic evidence suggests that the free interchange of oceanic waters across the slowly rising Panama land bridge was brought to a close between the late Pliocene and early Pleistocene. Some molluscan cognate species occurring on the two sides of Panama have been recognized by those

interested in zoögeography. Dall, in the latter part of the 19th Century, first enumerated a few such species. In the present study, a few species were identified as cognates as an outcome of work done for a book on worldwide Muricidae.

Some cognate pairs show comparatively little morphological change in spite of more than a million years of complete separation. Other species or whole genera have, during the same time, apparently proliferated to a remarkably different degree on the two sides. In addition to the many newly available niches because of the complexity of the eastern Pacific coastline, significant changes in ocean currents may have affected evolution towards extinction or high endemicity.

Cognate species recognized in the present study are:

| WESTERN ATLANTIC | EASTERN PACIFIC |
|---|---|
| Purpura patula | P. patula pansa |
| Stramonita haemastoma | S. biserialis |
| Aspella castor | A. pollux |
| Coralliophila caribaea | C. macleani |
| Calotrophon ostrearum | C. turrita |
| Eupleura caudata etterae | E. triquetra |
| Murex donmoorei | M. recurvirostris |
| Muricopsis oxytatus | M. armatus |
| Muricopsis schrammi | M. zeteki |
| Phyllonotus pomum | P. peratus |
| Phyllonotus margaritensis | P. regius |
| Murexiella hidalgoi | M. radwini |
| Murexiella mcgintyi | M. humilis |
| Murexiella levicula | M. perita |
| Coralliophila dalli | C. santacruzensis |

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## The 1975 Marine Communities Expedition to Chile

James H. McLean
Department of Invertebrate Zoology, Los Angeles County Museum of Natural History, 900 Exposition Blvd., Los Angeles, California 90007

(No abstract submitted)

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## The Letters a Curator Receives!

A. Myra Keen
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Curatorial correspondence obviously includes exchanges of ideas with colleagues, but there is also a continuing flow of requests from individuals whose knowledge of the field is sadly limited. Letters in this category seem most often to be offers of supposed rare or unusual material or requests from school children who want help on a science project -- much free literature and guidance. A form letter might be devised that would be an adequate answer to most of the latter, but a more permanent

solution would seem to be to get the word to teachers that "research" at this level consists in study of books in the local library, not in writing letters to specialists whose time is already mortgaged to the care of the collections under their charge.

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## Regulation of Micrarionta (Xerarionta) kelletti (Forbes) on Santa Catalina Island by the Trematode Dicrocoelium dendriticum (Rudolphi)

Peter Neal D'Eliscu
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The trematode Dicrocoelium dendriticum appears to have both direct and indirect effects on its snail host Micrarionta (Xerarionta) kelletti on Santa Catalina Island. Direct effects of 1° and 2° sporocyst generations and stylet-bearing xiphidiocercariae include mechanical and hystologic disruption of host digestive gland cells and tubules, and destruction of gonadal tissues. Indirect effects include parasitic castration of adults, toxic inhibition of gametogenesis in juveniles and adults, and disruption of carbohydrate and calcium metabolism.

Numbers of host snails in three localities on Catalina Island are closely correlated with incidence of infection, numbers of second intermediate hosts (several ant species), and numbers of definitive hosts (rodents, sheep, and other mammals). The seasonal and geographical incidence of infection is 3-60% for snails, 0-19% for ants, and approximately 50% for rodents.

The introduction of Dicrocoelium to Catalina Island is the first recorded in the western United States. Since this liver and bile duct parasite is known to infect man and many domestic and non-domestic animals, its introduction may effect definitive host populations. Possible economic impact of this introduction on sheep and cattle ranching may be significant, as Dicrocoelium-produced toxins and hepatic stases are often debilitating.

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## Reconnaissance of Mollusk-Bearing Neogene Rocks, Almeria Province, Eastern Andalusia, Spain

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A sequence of dominantly shallow-water marine strata with a composite thickness of more than 500 meters occurs in a late Neogene basin on the Mediterranean coast of Spain about 300 km east of the Straits of Gibraltar. The onshore part of this basin is a linear belt of gently folded upper Miocene and Pliocene strata extending about 100 km along the coast of Almeria Province. Our stratigraphic reconnaissance of this late Neogene basin indicates that several formations can be recognized; each of these is characterized by unique associations of mega-invertebrate fossils. Owing to factors of preservation, pectinids are the most abundant and varied element of the megafauna. Paleoenvironmental analysis of the molluscan and microfaunal assemblages indicates that the basin underwent two cycles of marine deposition; one took place during the late Miocene, the other during the Pliocene.

The sequence of upper Neogene formations of Almeria Province is younger than about 11.5 million years based on a radiometric age determination on volcanic rocks that underlie the oldest known basin sediments. Marine conglomerate with scattered molluscan fossils of late Miocene age occurs at the base of the Neogene sequence. Coral reefs are developed locally on this oldest unit. Stratigraphically higher are bioclastic limestones with giant echinoids of the genus Clypeaster and the orbitoidal foraminifer Heterostegina at the base; stratigraphically higher parts of the limestone contain bivalves including Chlamys and Mytilus. Near the top of the Miocene sequence are deep-water biogenic mudstones with microfossils of latest Miocene age and deep-water sandstones with displaced pectinid-ostreid assemblages of shallow-water, nearshore aspect. A 30-meter gypsum bed occurs in the upper part of this deep-water late Miocene unit.

Pliocene strata are of shallower water aspect than Miocene strata and include relatively little biogenic rock. In addition to a local angular unconformity between the Miocene and Pliocene, microfaunal studies indicate a faunal hiatus across this boundary. In the central part of the basin, the Pliocene includes a mudstone facies characterized by abundant Amusium cristatum (Bronn), Flabellipecten, and the ostreid Pycnodonte. Strandline facies of cross-bedded sands and gravels are characterized by extremely abundant macrofossils including Ostrea edulis Linné, Pecten jacobeus (Linné), and Flabellipecten flabelliformis (Brocchi).

This work results from a U. S. Geological Survey - Government of Spain cooperative marine geology investigative program.

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## Function of Nematocysts in Eolid Nudibranchs

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&
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Eolid nudibranchs have been long known to possess nematocysts, but the source of the nematocysts and their function has been debated for more than a century. The morphology of the cerata, the dorsal appendages of eolids, pertains to nematocyst transport, storage, and function. Much of the evidence regarding the defensive function of nematocysts in eolids has been circumstantial, with no positive proof given that the nematocysts are functionally defensive. In order to resolve this question, the eolid Phidiana crassicornis (formerly Hermissenda) was fed to shiner perch, Cymatogaster aggregata, a fish known to feed in areas where Phidiana occurs. The fish were killed immediately, and their mouth tissue prepared for serial sectioning at eight microns and staining with acid fuchsin. The tissue examined revealed extensive damage caused by basitrichous izorhizas. It is concluded that the nematocysts found in the cerata of eolid nudibranchs serve a defensive function.

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## The Baja California Bulimulus of Jules Mabille

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The Baja California land snails of the genus Rabdotus (Pulmonata: Bulimulidae) described in 1895 by Jules Mabille as new species of Bulimulus have been reviewed. The following synonymies proposed by earlier workers are confirmed: Bulimulus (Scutalus) acholus Mabille = Rabdotus montezuma (Dall, 1893); B. (S.) cacotycus Mabille = R. excelsus (Gould, 1853); B. (Leptobyrsus) dismenicus Mabille = R. beldingi (Cooper, 1892); and B. (Globulus) recognitus Mabille = R. sufflatus (Gould, 1859). The status of two of Mabille's taxa, Bulimulus (Leptobyrsus) dentifer and B. (Scutalus) cosmicus, are confirmed as valid species of Rabdotus. Rabdotus cosmicus, the distribution of which was previously unknown, has recently been collected in the vicinity of San Bartolo and in the mountains east of Los Planes. The following new synonymies are proposed: Bulimulus (Thaumastus) Digueti Mabille = Rabdotus levis (Dall, 1893); B. (Leptobyrsus) lapidivagus Mabille = R. spirifer (Gabb, 1867); and B. (L.) subspirifer Mabille = R. inscendens (Binney, 1861).

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## New Distributional Records for Cancellaria cooperii (Neogastropoda: Cancellariidae)

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The northern limit of Cancellaria cooperii Gabb, 1865, has generally been considered to be Monterey Bay, California. However, reliable literature reports have shown C. cooperii also occurs off Davenport, Santa Cruz County, in 366-549 m (200-300 fms.) and as tide drift shells along the "Waddell beaches" just south of Point Año Nuevo, San Mateo County. Specimens in the collection of the California Academy of Sciences Department of Geology show C. cooperii to be distributed throughout the Farallon Gulf and at least as far north as Point Arena, Mendocino County, approximately 204 km north of Point Año Nuevo. Nine specimens were collected from 1936 to 1965 at depths ranging from 55-229 m (30-125 fms.) on a variety of soft bottom substrates. The apparent rarity of this species, as well as the lack of collecting in the areas involved, are probably responsible for gaps in the distribution of C. cooperii from Point Año Nuevo to just south of the Southeast Farallon Island, and from Cordell Bank, west of Point Reyes, Marin County, to Point Arena. Cancellaria cooperii may be found to occur even farther north as more dredging is done off northern California.

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# Anomalies in Comparing the Gorgonian Preferences of Six *Cyphoma gibbosum* (Gastropoda: Ovulidae) Populations in the West Indies

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*Cyphoma gibbosum* (Linnaeus) resides, browses and deposits egg masses on various species of gorgonian corals in the Caribbean. Kinzie reported that it is an indiscriminate predator on all gorgonians found on Jamaican reefs, but Birkeland & Gregory showed that *C. gibbosum* demonstrates a hierarchy of preferences for the various gorgonians at St. John in the U. S. Virgin Islands.

In order to determine how populations of this predator differ in their preferences, four *C. gibbosum* populations were studied on different reefs in the U. S. Virgin Islands -- three on the northeast shore of St. Croix and the fourth on St. John. Adult snails comprised the vast majority of each population. Within each population, a census of 100 to 400 gorgonian colonies was taken within large quadrats, and approximately 125 occurrences of *C. gibbosum* residing on the various gorgonians were recorded during midday. Less systematic observations served to support these quantitative data.

By comparing the proportion of snails observed on each gorgonian species to that gorgonian's proportion among available colonies, distinct degrees of preference for the various gorgonian species were found at each site. Preferences for each of the nine most common gorgonians differed markedly between the populations, including the population previously studied by Birkeland & Gregory at St. John. There were very different proportions of snails on each gorgonian species, as well as very different proportions of gorgonian colonies represented at each area. The different preferences do not seem to be due to different characteristics of the gorgonian species from place to place. For example, repeated experiments showed that two individuals in two populations with different preferences rejected transplanted colonies of each other's preferred species *in situ*. (Analogous laboratory tests were abandoned because the snails crawl excessively while in aquaria.)

Unfortunately, no trends (such as increased preferences for the locally more abundant species) were evident in comparing areas, and it cannot yet be predicted how the snails will utilize the available gorgonians in any given area. Frequencies of old feeding wounds on various gorgonians suggest that the foraging of a *C. gibbosum* population at a given locality can change within several years. Possibly, mass settlement of juvenile snails on a few gorgonian colonies, with an element of chance, influences the gorgonian preferences of adult *C. gibbosum*.

## Population Dynamics of *Tegula* and *Calliostoma* in Carmel Bay, with Special Reference to Kelp Harvesting

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A population study on six species of trochid gastropods living on *Macrocystis*, with special reference to the effects of kelp harvesting, was conducted subtidally over a one-year period in Carmel Bay, California. Four circular study sites 60 m in diameter were established with 25 randomly placed stations in each area. Two areas served as controls and two as experimental harvest areas. Vertical distribution of each of the six species was determined *in situ*, as were distribution and abundance patterns on the bottom. Size class distribution, sex ratios, feeding behavior, and predation were also determined. Altogether, during the course of the year, well over 8,000 animals were observed and cataloged.

*Tegula pulligo* was found to be the most abundant species throughout the year, followed by *T. montereyi* and *Calliostoma ligatum*. Seasonal variation was noted for all species, with minimums in May and maximums in January. This is in response to storms and food availability. *Tegula* was found to be herbivorous, feeding most commonly on *Macrocystis*. *Calliostoma* was observed to feed on colonial tunicates and hydroids. Kelp harvesting was shown to have a deleterious effect on populations of *T. montereyi*. All other species showed distributional changes, but within six months returned to patterns similar to those found before the harvest.

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## Allometric Variation with Intertidal Position in *Mytilus californianus*

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That intertidal organisms are very good indicators of hydrographic conditions can be shown by relative allometric growth studies of molluscan populations. This has been done on the Pacific Coast with *Mytilus*, frequently by means of statistical inference from mass-samplings. In the study reported here, *M. californianus* from a site near Santa Cruz, California, were collected in a series of random samples, stratified so as to represent several tidal height intervals. These samples were measured for linear dimensions, and subsamples were measured for shell and dry soft-part weights. The dimensions of these subsamples were determined by a Monte Carlo analysis of data from a pilot study. After a logarithmic transformation, these data were presented as reduced major axes, and the samples compared by means of a Z-statistic. Estimations of wave stress and emersion times at the various sampling horizons were made from tidal data recorded for Monterey, California.

Wave stress was found to be positively correlated with tidal height in the range studied, as were the ratio of time emersed to time immersed and the length of individual emersions. It is suggested that, in this mussel population, the ratio of time spent with valves closed to time spent with valves open is also positively correlated with tidal height.

The finding that shell weight with respect to shell length has a positive correlation with tidal height can be explained with the help of frequency distributions of age and the different growth rates found at the different sampling horizons in the mussel bed. Shell width was found to be positively correlated with tidal height. It has been suggested previously that increased mantle cavity volume counteracts the effect of a perpetually deposited nacreous layer, or increases thermal inertia. It is suggested here that increased shell width for the mussels higher up on the shore results from different emersion times and wave stress regimes by means of the configurations of the folds of the mantle which secrete the shell's prismatic layer. This suggestion has been tentatively verified by cryogenic sectioning and microscopy.

CONTRIBUTED PAPER

# Some Remarks on Felipe Poey's "Memorias Sobre la Historia Natural de la Isla de Cuba"

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Felipe Poey y Aloy (1799-1891), the Cuban savant and naturalist, was a man of an almost Humboldtian range of interests (See K.J. Boss & M.K. Jacobson, 1975, "Felipe Poey, with a catalogue of the Mollusca described by him." Harvard Univ., Mus. Comp. Zool., Occ. Pap. Moll. 4(53): 105-132). His most interesting work, one which rivals Humboldt's "Cosmos" in range of topics if not in actual bulk, is his "Memorias sobre la historia natural de la Isla de Cuba," consisting of 53 essays published in two volumes between 1851 and 1861. I first met this book while working with Dr. William J. Clench and later with Dr. Kenneth J. Boss on the Helicinidae of Cuba. Poey was the author of many of the most important land shells of the island, and we had to refer frequently to the "Memorias." My interest in the work as a whole, not only in the shell descriptions, was aroused one day when I came across the following passage:* "Since I called the former species Cyclostoma honestum, the "chaste one," because it modestly covers its umbilicus as it matures, it would not be a bad idea to call the present species Cyclostoma procax, the "shameless one," since it openly displays its naked bellybutton all through its life." A book, I felt, which contains such happy observations deserves to be read as a whole, and with attention. Following are a few of the more interesting comments which I found:

FELIPE POEY (1799-1891)

When he wrote about the behavior of animals, Poey did so

* All translations are by M.K.J.

with much skill and humor: "It is no easy matter to observe [Farcimen] when they move about, because they display such a tremendous amount of laziness and torpor when the time comes to be active. After newly collected specimens are placed on a table in a humid atmosphere and one of them gets ready to take a walk, he begins by extending his foot very, very slowly, taking long resting periods after each small exertion. When finally his head is entirely free of the shell, as much as an entire hour may go by before he makes another movement. He sits there, tentacles drooping, as though he were dead. Finally a slow movement begins, the heavy shell falls to one side, then plunges to the floor, its weight dragging the owner along."

At one point in the "Memorias" Poey discussed the question of modesty in a writer. He found that some "malignant reader" had objected to his use of his own name after each species described by himself instead of the more modest "mihi" or "nobis" which authorities in his time were accustomed to use. He did this, he pointed out, not out of a lack of modesty, but because he was a lover of the pure truth. "If I write out your name, why can't I write my own? Besides, if a species is indeed "mihi" (mine) and not "tibi" (yours), why should I write that it is "nobis" (ours)? And do not be offended that in most of my writing I use yo (I) and not nos (the editorial we). To my mind, nos means me and all the parasites I carry around with me. But I am certain that normally I don't carry many parasites."

When it came to making up new names for new species, Poey did not lack a sense of humor. When he had to select a name for the troublesome Cuban beach midge, or no-see-um, he based it upon the Greek word oicactes, "beach dweller." He decided to make the generic name masculine since the Cubans call the midge "el jején," a masculine term. "But my friend, Dr. Gundlach, with whom I entered into serious consultation on this matter, gave me a humorous answer which I think is not unworthy of being included here, despite the seriousness of the subject. This was that jején's mode of attack, silently and with a short stiletto, is 'propio del sexo feminino,' quite unlike the attack of the mosquito, which advances boldly to battle, music blaring and brandishing its long spear or lance, just like a man." Thus the species name is Oecacta furens Poey, feminine. (It is of interest to note that Gundlach, who lived to be 86 years of age, never married. Also it should be noted that Poey and Gundlach overlooked the fact that it is only the female mosquito who attacks in such a bold, "manly" fashion.)

In the case of the library beetle, which Poey named Anobium bibliothecarum, he found a good lesson for man in its habits. It was probably, he noted, a wise visitation from Providence to war against man's laziness and ostentation. The beetle attacks only unused and neglected books and dusty and overlooked herbaria and skin collections, but books and collections in constant use are safe from its predations. How wise is Providence in all its manifestations! Carrion, which is of no

use to anyone, is rapidly destroyed by insects which make up for their diminutive size by their enormous fecundity and rapid growth. But Anobium attacks man's archives and the storehouses of his knowledge. Hence Providence gives him a fair chance to preserve these priceless objects. It sends down an enemy of low fecundity, small destructive powers, and weak flying ability. A single unused volume can feed and shelter several generations of the beetle. Thus man can, with ordinary care and diligence, protect his books from this destroyer. In fairness it must be said that Poey gives many hints to librarians and book lovers as to how to preserve their volumes in the hot, humid Cuban climate, such as making sure that they are kept in dry and well-ventilated areas. With true literary grace, Poey described two incidents he witnessed in which bees and mollusks played a role. "At one time a slug entered a beehive; the inhospitable inhabitants immediately fell upon it with their barbarous stings and soon put it to death. When they realized that it was too large and heavy to be dragged out, and fearing the unpleasant consequences of its decaying, they encased the dead creature in a heavy coating of bee's wax and thus provided the unhappy victim with an embalmed tomb right in their own house." And again: "Another time a shelled snail crawled past the incautious bee warders in the night and entered the hive. When dawn came it was already pasted to the walls of the hive with a layer of wax over the aperture only. The entire animal did not need to be encased. The snail had entered the hive bearing its own coffin on its back."

At times Poey breaks out into truly poetical raptures, as when he addresses the Lepidoptera. "Graceful daughters of the air, winged flowers, symbols of innocence and guilelessness, may the crude hands of man never tarnish the delicate scales of your wings. May you come to me to ease my mind and to drive off the bitter cares which dealings with my fellow men so often bring me. But I deserve to suffer from these cares for having captured you and then, instead of taking from you the tranquil felicity which you might have provided, I chose instead to undertake the study which began with a crime and ended with bitter sacrifice." He quotes the French poet, Lamartine, to show us what roads are offered us: "Deux chemins différents devant vous vont s'ouvrir: L'un conduit au bonheur, l'autre mène a la gloire; Mortels, il faut choisir." (Two different roads lie open before you: one leads to happiness, the other to glory; Mortals, it is for you to choose.)

Poey was an intensely religious man and, at least as evidenced in the "Memorias," he did not take readily to Darwin's ideas which were published two years before the last of the "Memorias." He apparently did not quite understand what Darwin was saying. Of course, he lived for 33 years after the last of the "Memorias appeared and may well have changed his mind. In Memoria 53 he gives fervid and often quite poetical expression to his basic belief in a Great Creator and Divine Purpose in the

scheme of nature. Below are a few extracts from this dithyramb. "It is the Lord who guides the stork on its course from far Scandinavian valleys to the banks of the Niger, from the lake of Niagara to the headwaters of the Orinoco; who disclosed to Kepler the laws of the stars; who guided Herschell and his telescope; who placed in Newton's head the idea of the fulcrum sought by old Archimedes to move the universe; who led Franklin to draw electricity from the skies; who opened the new world to Christopher Columbus; who gave Lavoisier the match with which, with a deafening explosion, he set flame to hydrogen and oxygen and produced water; who made manifest to Cuvier the bowels of the earth and led him to the discovery of hosts of ancient and extinct animals; who taught architecture to the beaver and geometry to the bees; who moistens the wings of the breezes over the surface of the waters to refresh the lands seared by the pitiless rays of the sun," and so on and on, often as beautiful as a Psalm of David. But what can we say to the verse which reads: "It was the Lord who dictated to Linnaeus the names of the plants and animals." Perhaps it is better to let the fault rest entirely with the famous Swede.

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1975-76 WSM STUDENT RESEARCH GRANT
PROGRESS REPORT

# Electrophoretic Studies of Selected Species of Rabdotus (Pulmonata: Bulimulidae), a Genus of Baja California Land Snails

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The purpose of this work is to study the taxonomic relationships of several species of the genus Rabdotus (Pulmonata: Bulimulidae) from Baja California, Mexico. The technique of polyacrylamide gel electrophoresis is being used to study these relationships as indicated by comparison of selected foot muscle proteins.

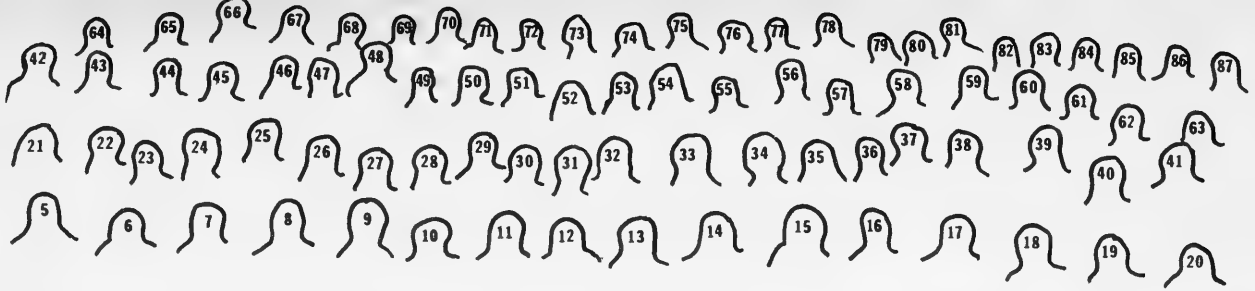
In polyacrylamide gel electrophoresis a protein extract is placed in a gel through which an electric current is passed. This current causes each protein to migrate through the gel at a rate which is determined by its charge and weight. The gel is then stained for the specific class of protein under study (esterases in the present work). The relative migration distance of each protein band is measured, and the bands present in a single individual or population are compared to those of another individual or population to give a measure of the degree of genetic resemblance between these entities.

In December 1975 collections of several species of Rabdotus were made in the southern region of Baja California Sur, Mexico. Samples were taken from seven populations of Rabdotus pallidior and from a single population each of R. striatulus, R. harribaueri, and R. montezuma. Specimens of R. spirifer had been collected on a previous occasion.

Rabdotus pallidior, an abundant and widely distributed species, is being used to demonstrate the amount of genetic variation which occurs within a single population and between different populations of one species. This phase of the work is now in progress, and specimens of four populations of R. pallidior have been examined. Upon completion of intra-specific studies of R. pallidior, specimens of other species will be examined and the degree of their genetic resemblance to each other and to R. pallidior will be determined. It is estimated that this work will be completed during the 1976-1977 school year.

The support of this work by the Western Society of Malacologists through its program of student grants is gratefully acknowledged.


WESTERN SOCIETY
OF
MALACOLOGISTS
1976



PICTURE DIAGRAM

See over for those attending but not in photograph.



1. Bill Bledsoe
2. John Pearse
3. Bill Waight
4. Leroy Poorman
5. John Slattery
6. Emery P. Chace
7. Forrest Poorman
8. Jo Ramsaran
9. Phyllis Slattery
10. Mary R. Larson
11. Merton J. Goldsmith
12. Peter N. D'Eliscu
13. James Nybakken
14. George E. Radwin
15. Carol C. Skoglund
16. Myra Keen
17. Clifton L. Martin
18. Joan Kershaw
19. Thomas Niesen
20. Veronica Parker Johns
21. Kathe Daniels
22. Ruth Greenberg
23. Vera Schieler
24. Eleanor Mead
25. Albert R. Mead
26. Jean Cate
27. Vida C. Kenk
28. Lucinda V. Draper
29. Bertram C. Draper
30. Ruth French
31. Edith M. Abbott
32. Kay Gudnason
33. Alice Luckey
34. Bernadine Hughes
35. Beth Brewer
36. Salle Crittenden
37. Richard L. Reeder
38. Noorullah Babrakzai
39. Walter B. Miller
40. Geraldine Walklet
41. Kirk W. Anders
42. Barry Roth
43. Paul Hughes
44. Jody Woolsey
45. Robert R. Talmadge
46. William D. Pitt
47. Lois Pitt
48. Ray Summers
49. Twila Bratcher
50. Nola Michel
51. Diana Wait
52. Debby Fishlyn
53. Barbara Good
54. Mike Frein
55. Alice E. Williams
56. Eugene Coan
57. Morris Karl Jacobson
58. John G. Saxby
59. Crawford N. Cate
60. John Arbit
61. Kathleen J. Jan
62. James T. Carlton
63. Gladys Weber
64. David K. Mulliner
65. James H. McLean
66. Robert Hoffman
67. Mark Ohman
68. Clayton Carlson
69. William K. Emerson
70. Michael G. Kellogg
71. Patrick LaFollette
72. Clifford A. Martin
73. Sally Bennett
74. Tom Rice
75. Carl C. Christensen
76. David Chapin
77. James Kershaw
78. William L. Pratt
79. Suzann Pratt
80. Melissa A. Barbour
81. James E. Sutton
82. Susan Gray
83. David R. Lindberg
84. Bruce H. Fowler
85. Bonnie Williams
86. Peter U. Rodda
87. Mary A. D'Aiuto

Also Attending but Not in Photograph

Warren O. Addicott
John K. Allen
Wayne Barnett
Hans Bertsch
Ralph Buchsbaum
Donald Cadien
Chet Chaffee
John Cooper
Phillip C. Crane
Phyllis Crane
Joanne Cremisino
Anthony D'Attilio
Helen DuShane
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Fay Wolfson
Bill Wright
Nicholas Yensen

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LIST OF EXHIBITS AT THE 1976 MEETING

Clifford A. Martin, Exhibits Chairman

Sally Bennett -- Oliva spicata Röding; Variations on a Theme

Twila Bratcher -- Shells Collected off the Coast of Venezuela, showing color variations of Phyllonotus globosus and large Cypraea mus

Crawford & Jean Cate -- An April Fool Newspaper from Florida

Mary A. D'Aiuto -- Native Melanesian Chest Ornament Decorated with Nassarius and Cypraea

Bertram C. Draper -- Minute Shells of the Eastern Pacific

William K. Emerson -- Photographs of New Exhibits at the American Museum of Natural History

A. Myra Keen -- Letters a Curator Receives! (see abstract on pp. 48-49)

William & Lois Pitt -- Neptunea, from California to Alaska

Katherine Stewart -- Haliotis of the World

Kate St. Jean -- Xenophora of the World

Robert R. Talmadge -- Intraspecific Variations in Neptunea pribiloffensis (see abstract on p. 46)

Edwin Womack -- Mollusks with Their Operculums

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DECEASED 1976
Allyn G. Smith

Late Renewal:

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Chico Seashell Club
Gladys B. McCormick, Treasurer
Route 2, Box 66
Orland, California 95963
(Meets twice a month: second Wednesday at 9:30 a.m. in members' homes, and last Wednesday at 7:30 p.m. in Jay E. Partridge School, Room 1, East Avenue, Chico, California)

Conchological Club of Southern California
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, first Monday of every month, unless a holiday, 7:30 p.m.)

Guam Shell Club
P. O. Box 2933
Agana, Guam 96910
(Meets at U. S. O., Piti, Guam, on the first and third Tuesday of each month at 7:30 p.m.)

Hawaiian Malacological Society
P. O. Box 10391
Honolulu, Hawaii 96816
(Meets first Wednesday of every month, 7:30 p.m. First United Methodist Church, 1020 S. Beretania Street)

Long Beach Shell Club
600 Long Beach Boulevard (YMCA Building)
Long Beach, California 90812
(Meets second Sunday of every month except July, 2:00 p.m.)

Northern California Malacozoological Club
c/o Mrs. John S. Crittenden (Salle S.)
624 Waterfall Isle
Alameda, California 94501
(Meets third Friday of each month, alternating between California Academy of Sciences and building behind El Cerrito Library)

Oregon Society of Conchologists
Dr. Byron W. Travis, Secretary
3228 N. E. 70th Avenue
Portland, Oregon 97213
(Meets first Sunday of each month, 1:30 p.m., in private homes; announcements given in monthly paper or by card)

Pacific Northwest Shell Club
c/o Mrs. Wilma G. Young, Corresponding Secretary
P. O. Box 1931
Seattle, Washington 98111
(Meets third Sunday of each month at 2:00 p.m., at the Port of Seattle, in the Port Commissioners' Board Room, Pier 66 on Alaska Way at the foot of Bell Street)

Pacific Shell Club
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
(Meets in Museum Lounge, first Sunday of each month at 1:30 p.m., October through June)

San Diego Shell Club
P. O. Box 1390
San Diego, California 92112
(Meets third Thursday of every month, Casa del Prado, Balboa Park)

Santa Barbara Malacological Society
P. O. Box 30191
Santa Barbara, California 93105
(Meets third Friday of every month, 7:30 p.m., Santa Barbara Museum of Natural History, 2559 Puesta del Sol, Santa Barbara)

Southwestern Malacological Society
c/o Mrs. Carol Skoglund
3846 E. Highland Avenue
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Yucaipa Shell Club
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# THE WESTERN SOCIETY OF MALACOLOGISTS

## ANNUAL REPORT

Pomona, California

June 15–18, 1977

Volume 10

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The Western Society of Malacologists

# Annual Report

Volume 10

Pomona, California

15-18 June 1977

*With a Ten-year Summary and Index*

*Issued:* DEC 14 1977

The **Annual Report** of the Western Society of Malacologists is based on its yearly meeting. Distribution of the **Annual Report** is free to regular and student members who are, at the time of issue, in good standing. Membership dues are $7.50 and $3.00 for students. Others of a regular member's family may join for an additional $1.00; each family receives only one **Annual Report**.

The Western Society of Malacologists has issued two **Occasional Papers** — No. 1, " 'Sea Shells of Tropical West America': Additions and Corrections to 1975" by Myra Keen & Eugene Coan; and No. 2, "A Catalogue of Collations of Works of Malacological Importance" by George E. Radwin & Eugene Coan. Each was priced at $2.50. At this moment, the first is out of print. The second is still available.

Correspondence regarding membership and orders for additional or back issues of the **Annual Report** or the **Occasional Papers** should be addressed to the current W.S.M. Treasurer, Mrs. Carol C. Skoglund, 3846 E. Highland Ave., Phoenix, AZ 85018.

When longer papers are included in the **Annual Report** or the **Occasional Papers** they are reviewed by two members of the Editorial Board in addition to the Editor.

# NOTICE OF THE 11th ANNUAL MEETING OF THE WESTERN SOCIETY OF MALACOLOGISTS

The 11th Annual Meeting of the Western Society of Malacologists will be held 28 June to 1 July at the University of Santa Clara, Santa Clara, California. The program is planned to include contributed papers, symposia on pulmonates and freshwater ecology, and exhibits on molluscan subjects.

Inquiries about the meeting should be directed to the W.S.M. Secretary, Mrs. Salle S. Crittenden, 624 Waterfall Isle, Alameda, CA 94501.

Applications for membership should be sent to the W.S.M. Treasurer, Mrs. Carol C. Skoglund, 3846 E. Highland Ave., Phoenix, AZ 85018. Dues are: regular membership — $7.50; additional family members — $1.00 per person; student membership — $3.00. Regular and student members receive the **Annual Report** of the Society.

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# PROGRAM SUMMARY

Wednesday, 15 June

| | |
|---|---|
| 10:00 — 12:00 | Registration |
| 12:00 — 1:00 | Lunch |
| 1:00 — 5:00 | Session I |
| 6:00 — 7:00 | Dinner |
| 7:00 — 10:00 | Get Acquainted Party, with slides by members |

Thursday, 16 June

| | |
|---|---|
| 8:00 — 9:00 | Breakfast |
| 9:00 — 12:00 | Session II |
| 12:00 — 1:00 | Lunch |
| 1:00 — 1:20 | Group Photograph |
| 1:20 — 4:00 | Session III |
| 4:00 — 5:00 | Preview of Auction Shells |
| 4:00 — 6:00 | Executive Board Meeting |
| 6:00 — 7:00 | Dinner |
| 7:00 — 9:00 | Auction |

Friday, 17 June

| | |
|---|---|
| 8:00 — 9:00 | Breakfast |
| 9:00 — 12:00 | Session IV |
| 12:00 — 1:00 | Lunch |
| 1:00 — 3:00 | Session V(a) |
| 3:00 — 3:20 | Business Meeting |
| 3:20 — 5:00 | Session V(b) |
| 6:00 — 7:00 | No Host Party |
| 7:00 — 10:00 | Banquet — Dr. Heinz Lowenstam, "A Potpourri of Living Fossils" |

Saturday, 18 June

| | |
|---|---|
| 8:00 — 9:00 | Breakfast |

# SUMMARY OF MINUTES, EXECUTIVE BOARD AND ANNUAL BUSINESS MEETINGS JUNE 16 & 17, 1977

The meetings were presided over by President Helen DuShane. The Minutes of last year's meeting, as contained in the Secretary's book and summarized in the 1976 **Annual Report**, were approved.

Treasurer Merton J. Goldsmith made his report. A total of $2,462.77 was on hand on June 1st. Registration for the 1977 meeting was 72, and auction receipts were $850. The report was approved.

James Nybakken, Chairman of the Nominating Committee, submitted the following slate of officers for 1977-78 which was approved unanimously:

President ..... Dr. Peter N. D'Eliscu
First Vice President ..... Mr. Barry Roth
Second Vice President ..... Dr. Vida C. Kenk
Secretary ..... Mrs. Salle S. Crittenden
Treasurer ..... Mrs. Carol C. Skoglund
Members-at-Large ..... Mrs. Sally Bennett
Mr. Patrick L. LaFollette

Peter D'Eliscu reported that the 1978 conference will be at the University of Santa Clara, Santa Clara, California, June 28 to July 1, 1978. A tentative invitation to hold a joint conference with the American Malacological Union in 1979 on the Gulf Coast of Texas was tentatively accepted.

Editor Eugene Coan submitted a plan to improve the **Annual Report** by using smaller type and arranging the material in two columns with justified margins. This will reduce the size of a typical **AR** by about half, cut printing costs, but will cost more to typeset. The net change in cost will not be great. The current policy of gratis **AR** distrubution to malacolgical institutions is to be continued for another year. Foreign publications received in exchange for the **AR** are to be placed in West Coast institutions at the discretion of the Editor. The Secretary applied for an International Standard Serial Number for the **AR**. (It is ISS 0361-1175.)

The incoming President is to appoint a committee of three to draft a proposed By-law amendment to provide guidelines for the Editor and Editorial Board and covering publication of the **Annual Report** and the **Occasional Papers**. (In 1975, the Executive Board voted by mail to publish 300 copies of **Occasional Paper** 1. They have all been sold for a net profit to the W.S.M. of $130.)

The Board gave Honorary Memberships to Dr. Wendell O. Gregg and Mr. Emery P. Chace. It also presented the 1977 Honor Award to Dr. Rudolf Stohler.

To cover rising costs, the annual dues were increased to the following:

Regular Members — $7.50
Additional Family Members — $1.00
Students — $3.00

The incoming President is to appoint a committe of three to prepare a report on the functions of the Auditing Committee and the advisability of creating a Budget or Finance Committee. This report is to be presented at the Executive Board meeting in 1978.

A suitable list is to be placed in the gavel case showing the names of the past Presidents and the year they served, this to replace the lost plaque.

The Student Grants Committee Chairman, Mr. James T. Carlton, was authorized to organize a half-day symposium for the 1978 conference. His expenses will be reimbursed. Janice E. Thompson of the Scripps Institution of Oceanography was awarded the biennial Student Research Grant for a project "On the nature of food of *Diodora aspera* (Gastropoda) and its commensal *Arctonoe vittata* (Polychaeta)." (She was present at the banquet to receive her $500.)

# TREASURER'S REPORT

1 July 1977

| | | | | | |
|---|---|---|---|---|---|
| On hand, 1 August 1976 | | Savings Account | $1,391.19 | | |
| | | Checking Account | 1,071.58 | 2,462.77 | |
| | | **RECEIPTS** | | | |
| Dues 1976 | 4 regular | 20.00 | | | |
| | 3 student | 6.00 | | | |
| 1977 | 147 regular | 735.00 | | | |
| | 20 family | 20.00 | | | |
| | 18 student | 36.00 | | | |
| | 1 paid twice | 5.00 | 822.00 | | |
| Publications | *OP* #1 | 65.00 | | | |
| | *OP* #2 | 160.00 | | | |
| | Annual Reports | 175.00 | | | |
| | Volunteered postage | 2.60 | | | |
| | Reprints | 25.00 | 427.60 | | |
| Interest | Savings Account | 41.96 | 41.96 | | |
| Conference | operations | 26.38 | | | |
| | auction | 860.65 | 887.03 | 2,178.59 | 4,641.36 |
| | | **EXPENSES** | | | |
| Publications | Postage, telephone, supplies | 222.68 | | | |
| | Printing *OP* #2 | 449.99 | | | |
| | Typing & printing *AR* #9 | 956.06 | | | |
| | Reprints | 38.24 | 1664.94 | | |
| Student Research Grant | | 500.00 | | | |
| Chairman's Committee on Student Grants expenses | | 103.04 | 603.04 | | |
| Bank of America service charges | | 5.07 | | | |
| Dues, AMU, 1976 & 1977 | | 20.00 | | | |
| President's expenses | | 42.79 | | | |
| Secretary's supplies, postage | | 111.43 | | | |
| Treasurer's postage, printing | | 30.74 | | | |
| Historian's pictures, supplies | | 37.28 | | | |
| Dues refund (paid twice) | | 5.00 | 252.31 | | 2,572.29 |
| | | | | | $2,119.07 |
| On hand, 2 July 1977 | Savings Account | | | 933.15 | |
| | Checking Account | | | 1,172.42 | |
| | Undeposited | | | 13.50 | $2,119.07 |

Auditing Committee:

Respectfully submitted

Vida C. Kenk

Merton J. Goldsmith, Treasurer

Forrest L. Poorman

Bertram C. Draper

# PAPERS PRESENTED TO THE TENTH ANNUAL MEETING: TITLES AND ABSTRACTS

## THE GENUS *CYMBIUM* OF SENEGAL, WEST AFRICA

**Twila L. Bratcher**
8121 Mulholland Terrace
Hollywood, California 90046

Specimens of *Cymbium marmoratum* Link, 1807, were observed to be nocturnal feeders, crawling on the surface of the sand at night in depths of two to five meters. They are ovoviviparous and were found to have up to six fully formed young whose shells were about 26 mm each. In several cases partially developed young were found with the shells completely formed except for the protoconch, which appears to be the last portion formed.

*Cymbium pepo* ([Lightfoot], 1786) is the heaviest member of the genus and is frequently used for food by the Senegalese. One female of this species produced thirteen young after being taken out of the water. Each measured 50 mm in length.

Other genera in the subfamily Cymbiinae are found from Australia to East Africa, but the genus *Cymbium* is believed to be the only which is ovoviviparous.

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## HIGHLIGHTS OF THE 1976 W.S.M. CONFERENCE

**James H. McLean**
Malacology Section
Los Angeles County Museum
of Natural History
900 Exposition Boulevard
Los Angeles, California 90007

[This was a slide show of people present at the 1976 meeting.]

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## THE ENIGMATIC *RHODOPETALA* (GASTROPODA: PATELLACEA)

**David R. Lindberg**
Department of Invertebrate Zoology
California Academy of Sciences
Golden Gate Park
San Francisco, California 94118

The limpet, *Rhodopetala rosea*, described in the genus *"Nacella?"* by Dall in 1872, was originally considered to be a member of the Patellidae. In 1921 Dall established *Rhodopetala* as a section of the Acmaeidae with *R. rosea* as its type species by monotypy. However, subsequent workers still treated *R. rosea* as a patellid. In 1972 Golikov & Kussakin illustrated the radula of *R. rosea*; it is distinctly acmaeid. Still other evidence, shell micro-structure, appeared to be just as distinctly patellid. The problem has been further complicated by the lack of specialized gills in this species, a character of the Lepetidae.

Based on the three diagnostic characters now used in patellacean systematics: (1) gill morphology, (2) radular morphology, and (3) shell micro-structure, *Rhodopetala* is unassignable to family. Further study of the anatomy of this species, now in progress, will hopefully resolve this enigmatical situation and help to elucidate patellacean systematics and phylogenies.

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## HYDROBIID SNAILS OF THE MOAPA WARM SPRING COMPLEX, NEVADA

**William L. Pratt**
Museum of Natural History
University of Nevada
4505 Maryland Parkway
Las Vegas, Nevada 89154

The Moapa Springs are a complex of warm springs emerging along the strike of the eastern limb of the Arrow Canyon syncline in eastern Clark County, Nevada. The spring runs join to form the Muddy River, which occupies the lower end of the Pleistocene White River drainage. The springs form an island of isolated aquatic, marsh, and riparian habitats amid the shrub desert of the northeastern Mohave Desert. The aquatic environments of the system support a fauna in part locally endemic and in part endemic to the White River system.

Three species of the prosobranch family Hydrobiidae are known from the system. *"Flumincola" avernalis* Pilsbry, 1935, endemic to the Moapa system, is restricted to three springs emerging on the slope of the erosional scarp of the Moapa Valley and is absent from springs on the alluvial plain. It is found on pebbles in the shallow water of the upper part of the spring runs. Two of the springs it inhabits have been modified for human recreation. *Tryonia clathrata* Stimpson, 1865, occurs in spring systems throughout the White River drainage. There is some evidence for genetic variation between populations. It is found in sunny areas on rocks, exposed tree rootlets, algal mats, and aquatic plants. An undescribed species of *Fontelicella* is endemic to the Moapa Spring complex, where it is found on rocks, hard clay, and peat banks in all the springs sampled. Both *Tryonia clathrata* and the *Fontelicella* are abundant amid gravelly bottom debris in at least one concrete flume carrying water from a spring to irrigated fields on the valley floor.

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## WEST MEXICAN OPISTHOBRANCHS — AN OVERVIEW

**Leroy H. Poorman & Forrest L. Poorman,**
*Museum Associates*
Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Blvd.
Los Angeles, California 90007

The commentary included illustrations of 25 habitats where opisthobranchs have been collected and observed from the head of the Gulf of California to Manzanillo, Colima, Mexico. Eighty-seven examples of the 47 families recognized in the tropical eastern Pacific were discussed and illustrated as an evolutionary progression, with emphasis placed on anatomical structures and their importance in taxonomic placement.

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## INDO-PACIFIC *CONUS*

**William E. Old, Jr.**
Department of Living & Fossil Invertebrates
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

About 1,500 names have been proposed for Recent species and varieties of *Conus*. The best estimate on the number of living species is about 400. Most occur in the tropical Indo-Pacific. While about 70 generic names have been proposed, one genus, *Conus*, is usually recognized by workers in this country, with some supraspecific names used as subgenera.

The fish-eating cones are the most dangerous to humans, with the majority of the known fatalities being attributed to *Conus geographus* Linnaeus.

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## THE W.S.M. STUDENT RESEARCH GRANT AND PARTICIPATION PROGRAM, 1972-1977

**James T. Carlton**
Department of Geology
University of California
Davis, California 95616

[This was an outline of the history of the Student Research Grant and Participation Program. A brief summary of this program is given in the ten-year index in this volume.]

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## BLIGH'S SECOND BOUNTY

**Jean M. Cate**
P.O. Drawer 710
Rancho Santa Fe, California 92067

Captain William Bligh, commander of the **Bounty**, was a collector of shells which he brought home from his far-flung travels to enrich his wife's excellent collection. Interior and exterior views of **Bounty II**, were shown, together with species known to have been contained within the collection of Elizabeth Bligh when it was sold at auction in 1822. By extrapolation, certain species in her collection may be supposed to have been collected by Bligh during his service under Captain James Cook. Some species were described in the Appendix to the "Bligh Catalog" by William Swainson.

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## NEW RECORDS OF THE MONOPLACOPHORAN FROM CORTEZ BANK, CALIFORNIA

**James H. McLean**
Malacology Section
Los Angeles County Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007

[No abstract submitted]

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## THE HALL OF MOLLUSKS AND MANKIND

**William E. Old, Jr.**
Department of Living & Fossil Invertebrates
American Museum of Natural History
Central Park West at 79th Street
New York, New York 10024

In December 1975 the American Museum of Natural History opened its new mollusk hall. It embodies a new concept combining malacology, anthropology, and art, and is divided into these three areas. The visitor enters the section devoted to "Biology of Mollusks," where models and specimens depict various life functions. A film shows live mollusks.

The ethnological section, "Mollusks and Human Society," is devoted to exhibits and uses of shells and shellfish by primitive and advanced cultures. The third area, "Mollusks and Art Forms," contains displays of shells in art and architecture, shell collecting, including rare and choice collector's items. The final alcove contains a slide show depicting shells in art.

[The hall is illustrated and discussed in an article appearing in **Curator** vol. **19**, no. 2, 1976.]

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## COMMENTS ON THREE WEST AMERICAN BIVALVE NOMENCLATURAL PROBLEMS

**Eugene V. Coan,**
*Research Associate*
Department of Geology
California Academy of Sciences
Golden Gate Park
San Francisco, California 94118

*Netastoma* Carpenter, 1864, is not preoccupied by *Nettastoma* Rafinesque, 1810, a genus of fish. Legally, then, *Netastoma* would have to be used for our genus of pholadid clam rather than the better known replacement name *Nettastomella* Carpenter, 1865. However, George Kennedy and I have petitioned the International commission on Zoological Nomenclature to preserve the latter.

The Pacific Coast rock scallop should be known as *Hinnites giganteus* (Gray, 1828). This name is available and has never required replacement. *Pecten* (*Chlamys*) *multirugosus* Gale, 1928, is a junior synonym.

Given the 1972 changes in the International Code of Zoological Nomenclature regarding replacement names, the West Coast species of *Glans* will have to be known as *G. carpenteri* (Lamy, 1922). For all practical purposes, a name validly replaced prior to 1961 is permanently rejected unless this would be against virtually all usage and the species involved is very widely known.

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## MOLLUSK COLLECTIONS IN THE DEPARTMENT OF GEOLOGY, CALIFORNIA ACADEMY OF SCIENCES

**Barry Roth**
Department of Geology
California Academy of Sciences
San Francisco, California 94118

The collection of Recent mollusks, Cenozoic stratigraphic collection, and Paleontological Type Collection of the Department of Geology, Stanford University, have been transferred on indefinite loan to the Department of Geology, California Academy of Sciences, where they are now available for study. The combined Academy-Stanford shell collection, containing an estimated one million specimens is housed in newly refurbished quarters with floor-to-ceiling cabinets and work space for visitors. The collection is worldwide in scope, with emphasis on eastern Pacific marine mollusks and land snails of western North America. The combined Academy-Stanford fossil collection, also numbering about one million specimens, is particularly strong in mollusks from the late Mesozoic and Cenozoic of the Pacific Coast. The Academy and Stanford type collections contain several thousand primary and secondary type specimens; the majority of these are Recent and fossil mollusks.

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## CHEMICAL RECOGNITION OF PREY BY THE GASTROPOD *EPITONIUM TINCTUM*

**Carey Resch Smith**
Department of Invertebrate Zoology
Santa Barbara Museum of Natural History
2559 Puesta del Sol Road
Santa Barbara, California 93105

The ptenoglossan gastropod *Epitonium tinctum* (Carpenter, 1864) locates its prey anemone, *Anthopleura elegantissima* (Brandt), by the use of chemical stimuli. In choice chamber olfactometer experiments *E. tinctum* consistently orients to effluent from its prey in preference to sea water. The specificity of an attracting substance was tested by placing alternate prey anemone effluent in the olfactometer contrasted to sea water. To *A. xanthogrammica* (Brandt), an anemone in the same genus as its natural prey, the snail demonstrated the same consistency of attraction. Chemical effluent from distantly-related anemones did not attract *E. tinctum* in statistically significant numbers, even if the anemones were readily consumed by the snail in the laboratory. Orthokinesis experiments were conducted to compare the snail's velocity in anemone effluent to that in sea water. Snails were found to increase their velocity significantly in effluent from *A. elegantissima* and *A. xanthogrammica*. Klinokinesis experiments were conducted to measure an increase or decrease in the rate of random turning in an environment of uniform anemone effluent. Snails did not change their angular velocity appreciably in the effluent of any of the experimental anemones.

[For the published version of this paper, see **The Veliger 19**(3): 331-340; 4 text figs. (1 Jan. 1977)]

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## METHANOL TOXICOLOGY OF MOLLUSKS AND OTHER SELECTED INVERTEBRATES OF THE CENTRAL CALIFORNIA COAST

**Peter Neal D'Eliscu**
Department of Biology
University of Santa Clara
Santa Clara, California 95053

Investigations of the biological consequences of coastal methanol pollution indicate that marine and estuarine invertebrates vary in susceptibility to this alcohol within experimental concentrations of 100 PPM to 5%. Acute, short-term exposure to methanol is tolerated by some hard-shelled and hard-tubed organisms, but many invertebrates cannot survive concentrations ranging from 0.1 to 5% in filtered sea water. Immediate physiological consequences of acute exposure include reversible ciliary narcosis, neuronal disruptions leading to disorientation, "biological clock" suppression and alteration, inappropriate color changes, untimely autotomy, and cardiac arrhythmia. Carbon-14-labeled methanol was found to concentrate in excretory organs, neurons, and gonadal tissues after only a few hours exposure to low-level alcohol-sea water mixtures. Chronic exposure to methanol

(.01-1% for 7-14 days) proved to be disruptive to gametogenesis, embryogenesis, larval development, and larval settling in many mollusks, crustaceans, polychaetes, and other invertebrates. Some crustaceans (including species of *Cancer, Pugettia, Hemigrapsus,* and *Pachygrapsus*) undergo premature molts at instar and adult stages in response to chronic exposure. Resistance to both tissue invasion and destruction by trematode parasites is greatly reduced in many mollusks (especially *Ilyanassa obsoleta*) during and after chronic exposure. Planktonic mollusk and polyhaete larvae are generally susceptible to methanol concentrations as low as 100 PPM. However, these larvae and many invertebrates with ciliated respiratory structures are much less affected in highly aerated conditions.

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## A DEEP-WATER PARADOX

**A. Myra Keen**
Department of Geology
Stanford University
Stanford, California 94305

An expedition in February 1977 to study hot springs along the Galapagos rift zone, discovered an abundant fauna at a depth of 2,500 meters. Professor Tjeerd van Andel, oceanographer from Stanford University, participated in dives to the sea-floor in the submersible vessel **Alvin**. He brought back not only photographs of a varied fauna but also some valves of large clams 150 to 250mm in length. The abundance and size of the specimens seems much more in keeping with shallow than with deep water. Fish, crabs, tube-worms, hydroids, and other bottom-dwellers were also seen. Limpets were observed to be grazing on a black film that coated rock surfaces, presumably a film of bacteria that could multiply in the hydrogen-sulfide-rich but oxygen-poor water of the springs. How such an abundant fauna could be recruited remains to be explained. The largest mollusk is a bivalve of the genus *Calyptogena* (*Calyptogena, s.s.*), probably a new species. Recent work on the family to which it belongs, the Vesicomyidae, indicates that in the eastern Pacific there are 11 or 12 species in three genera: *Calyptogena* (with two subgenera — *Calyptogena, s.s.*; and *Archivesica*); *Vesicomya* (with two subgenera — *Vesicomya, s.s.*; and *Callogonia*); and *Kelliella. Calyptogena, s.s.*, has not previously been recorded south of Baja California. *Modiolus, s.l.*, another large bivalve obtained from the hot springs, has only been recorded in shallow water in the tropical eastern Pacific.

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## THE EXORDIUM

**Bernardine Hughes**
12871 Foster Road
Los Alamitos, California 90720

[This was a brief presentation on the history of the W.S.M. A ten-year Summary and Index is given in this volume.]

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## USING THE SEM TO DETERMINE DIFFERENCES AMONG FOUR SPECIES OF *CAECUM*

**Bertram C. Draper**
*Museum Associate*
Malacology Section
Los Angeles Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007

In my study of the eastern Pacific Caecidae, I have been faced with a problem in determining how many species of the group of *Caecum* having squared, flat-topped rings can be recognized in the Panamic province. There are eight species and one variety named in the literature.

Three taxa were described by C.B. Adams in 1852, all of which prove to be forms of one species, *C. firmatum*. Carpenter in 1857 described *C. quadratum* and a variety of it, *compactum*, which is a form of the same species. In 1867 de Folin described three *Caecum* species with squared, flat-topped rings. One, *C. taeniatum* is a synonym of *C. firmatum*; the other two, *C. elegans* and *C. uncinatum*, are synonyms of Carpenter's *C. quadratum*. In 1939 Strong & Hertlein described one species of this group, *C. richthofeni*, which differs sufficiently to be considered separable. I have also found one form that appears to be undescribed. Thus, this leaves four probably separable species.

Cross sections of the shells of each species to show their structure convinced me that *C. firmatum* is a distinct species. Patrick Lafollette of the Los Angeles County Museum helped dispel remaining doubts about the other three by use of the Scanning Electron Microscope at the University of Southern California. After gold plating selected shells, he obtained photos of the entire shells, 400x views of their rings, and one view of rings at 1000x. The rings have a structure of many tiny segments, and the nature of the segmentation differed among the species sufficiently to remove any doubts that there are four taxa.

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## NATURAL HISTORY, SYSTEMATICS, AND REPRODUCTION OF THE MARINE GASTROPOD *ONCHIDELLA BOREALIS*

**John K. Allen**
Department of Zoology
University of California
Berkeley, California 94720
*and*
Bodega Marine Laboratory
Box 247
Bodega Bay, California 94923

*Onchidella borealis* Dall, 1871, a posteriorly lunged intertidal shell-less gastropod, is common on fronds of the alga *Odonthalia floccosa* and in beds of the mussel *Mytilus californianus* from Alaska to San Luis Obispo, California. Average length of individuals collected at Bodega Head, Sonoma County, California, is 6.5mm. Nests of eight to twenty individuals occur in small cracks in the rock substrate from which the animals creep

forth to feed on the epiphytic diatom *Cocconeis* when the tide is low, and to which the same individuals return before the tide returns to the level of the nest opening. The animals bear 20 to 24 repugnatory glands along the edge of the dorsum which secrete an exudate of pH 2.7.

*Onchidella borealis* juveniles are male, and adults are simultaneous hermaphrodites. Hemispherical egg masses 3 mm in diameter containing 10 to 20 ovoid capsules 1.4 mm long are laid from May to September within the nests or under rocks. The veliger stage passes within the egg capsule, and after 42 days of development, 1.2 mm-long juveniles emerge. Neither lung nor generative organs are developed at this time.

Although the Onchidiidae often has been placed in the Opisthobranchia, because it possesses many opisthobranch characters, it also possesses pulmonate characters and is best regarded an offshoot of the early Pulmonata which, in turn, shared an ancestor with the modern opisthobranchs.

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## CHITONS: THEIR PHYSIOLOGY AND HABITAT

**Michael S. Frein**
279 Stafford Street
Box N
Cambria, California 93428

Chitons, Class Polyplacophora, are among the most primitive mollusks and have a simple anatomy. Their shell is composed of eight dorsal plates, all similar except the head and tail plates; each consists of two layers, the tegmentum and the articulamentum. Chitons have a large muscular foot used in locomotion and adhesion and a large number of paired gills. Most species are herbivorous, but one species has been reported to take in over half its food as animal matter. Most chitons use a radula to scrape food off hard substrates. Chitons have a simple circulatory system, and a nervous system with a nerve ring and two lateral cords. Among their sense organs are a subradular "tasting" organ and, in some species, photoreceptors in the shell valves called aesthetes. Chitons are dioecious with external fertilization.

There are about 600 living species and 100 fossil forms. The west coast of North America is one of the richest chiton regions.

[*Student, Coast Joint Union High School*]

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## A POTPOURRI OF LIVING FOSSILS

**Heinz A. Lowenstam**
Department of Geology
California Institute of Technology
Pasadena, California 91108

[No abstract submitted]

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## THE XENOPHORIDAE — HOW AND WHY THEY COLLECT: SOME NEW INSIGHTS

**Kate St. Jean**
P.O. Box 2356
Carmel, California 93921

There seems to be a definite purpose in the activities of members of the Xenophoridae. Everything they do seems to suggest means of eluding detection. Even the animals' method of gathering food is a possible means of olfactory protection: Its foot is lifted above the substrate while the animal feeds, leaving very little scent for an enemy to follow. Its characteristic "leaping" (lifting and falling forward) during its sudden, discontinuous locomotion means that the shell will cover the body at almost all times and will blend into the substrate and leave no continuous trail for a predator to follow. They also bury their feces as another means of eluding detection.

Their implantation of materials on their shells makes it difficult for predators to differentiate them from the rubble on the ocean floor. But of possibly greater significance is the implantation of material around the base of the shell in such a way as to provide a skirt or frill that raises the shell and its aperture above the substrate. This provides the animal with a canopy under which it can safely graze and also facilitates its method of locomotion over the rubble.

When the animal chooses bivalve shells for implantation, those with the concave side down are evidently difficult to pick up. Valves with the convex side down are easier for the animal to pick up with its foot. Once a shell is grasped, the animal moves its own shell into position by pushing down against the substrate with its proboscis while the propodium brings the shell to be implanted into position. Clam valves are generally cemented to the carrier's shell concave side outward.

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## GUIDELINES FOR WRITERS AND READERS: A WORKSHOP

**A. Myra Keen**
Department of Geology
Stanford University
Stanford, California 94305

When starting to prepare a scientific report, one needs always to review some of the many style manuals and other aids to good writing. Thus the many pitfalls of padded writing may be avoided. A fairly recent and readily available work is a book entitled "Geowriting" published by the American Geological Institute, Falls Church, Virginia 22041. For taxonomic work — proposal of new species or revisions of existing groups — the "International Code of Zoological Nomenclature" is requisite. The beginning writer, in addition to needing a personal bookshelf of these bibliographical aids, should study the publications of some more experienced workers critically, and, finding some that seem to be models of conciseness and clarity, follow them as a guide until practice in writing effectively has become a habit. Criticism from one's peers —

especially before publication — is helpful. Willingness to recast foggy writing and to prune out excess verbiage should win the esteem of any such reviewer and, later, of any editor.

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## THE POTENTIAL IMPORTANCE OF SQUID STATOLITHS FOR UNLOCKING THE FOSSIL RECORD

**John E. Fitch**
California State Fisheries Laboratory
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Almost without exception, the more than 10,000 known fossil species of cephalopods have been described from external or internal shells. However, with the exceptions of *Sepia, Spirula,* and *Argonauta*, the 1,000 or more living species belonging to about 50 coleoid families have no calcareous shells. Until now, their recognized fossilized remains have consisted of body imprints, beaks, hooks, radulas, chitinous pens, and ink sacs. Of these, beaks, body imprints, and pens have the greatest potential for relating fossils to living forms, but are too few at present to allow the construction of even the most modest of phylogenetic trees.

During my investigations of fish otoliths, I sampled a number of North American fossil deposits that yielded squid statoliths. These statoliths, composed of aragonite, a stable form of calcium carbonate, appear to represent at least 14 species of squids and span the most recent 60 million years of the earth's history.

During April and May, 1977, Dr. Malcolm Clarke and I spent five weeks at the Plymouth Laboratory in England, critically comparing the fossil statoliths with material from living species. As a result, we are preparing a manuscript describing 10 of the 14 species and believe that statoliths offer the greatest chance yet to unravel the evolutionary history of modern soft-bodied cephalopods.

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## TROPHONINAE — SUBFAMILY OR CATCH-ALL?

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Because of criticism of the treatment of the muricid subfamily Trophoninae in our book "Murex Shells of the World," some of the many sources of problems relating to the taxonomy and phylogeny of this complex, polyphyletic group are reviewed.

Although the generally-accepted concept of a trophon refers to members of the Northern Hemisphere genus *Boreotrophon*, *Trophon* itself is austral. The shell form and radular dentition of *Trophon* differ substantially from those of *Boreotrophon*. Other austral genera are even more divergent and may, in fact, be assignable to other neogastropod families. Such assignment may be possible only by obtaining soft-parts of these, in many cases, very rare species.

Even within *Boreotrophon* the great variation in shell morphology and scarcity of specimens makes a true taxonomic and phyletic synthesis an unattainable goal at present.

To make matters worse, the generality of the few features used to define the subfamily has caused confusion, and members of other muricid subfamilies could and have, with some justice, been placed here. The solution to this problem should include a complete re-definition of the subfamily, using as many diagnostic characteristics as are available. A concerted effort to obtain live-collected specimens of the type species of all the unusual austral "trophons" should also be made.

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## THE GATUN FORMATION OF PANAMA

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My wife and I have recently returned from a fossil collecting trip to Panama where we collected material from the Gatun Formation.

Gatun fossils have affinities with those of the Miocene of Florida and with species of the Recent Caribbean and Panamic faunas. The Gatun contains many of the forms ancestral to species of these Recent faunas, but even with the many people on the West Coast working on Panamic problems there are few institutions that have Gatun collections for comparison with Recent material.

Unfortunately, many of the collecting localities listed in the major report on the Gatun, U.S. Geological Survey Professional Paper **306A**, by Woodring, are either underwater or so overgrown that it would be very difficult to obtain material from them. The lower part of the Gatun Formation provides the most accessible collecting, but many of these localities are now starting to be overgrown. Fortunately, through new construction, localities are also being opened up.

We have not yet completed the curation of our material from these new localities, but the faunal assemblages seem to differ somewhat from the other Lower Gatun localities. These new sites may possibly give a different picture of the Gatun and will certainly produce additions to the faunal list.

We would like to thank Dr. Wendell Woodring of the U. S. National Museum, who supplied information, and Mr. & Mrs. Robert Stewart of Panama, who took us to some of the locations. Without their help we would not have done as well as we did.

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# EGG CAPSULES OF FIVE SPECIES OF *NASSARIUS* (GASTROPODA) FROM BAHÍA CHOLLA, SONORA, MEXICO

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Eight species of *Nassarius* occur intertidally at Bahía Cholla, Sonora, Mexico (Skoglund, 1974). Each occupies a slightly different habitat. In the course of random collecting and quantitative sampling of the molluscan fauna of Bahía Cholla over a period of several years, egg capsules of many mollusks have been seen, but only an occasional *Nassarius* egg capsule has been found. This study was undertaken in an attempt to find out if *Nassarius* egg capsules are species specific.

The egg capsules of *Nassarius reticulatus* (Linné) and *N. incrassatus* (Ström) from Great Britain were described by Lebour (1931). The capsules of three species from the east coast of the United States were described by Scheltema (1962) and Scheltema & Scheltema (1965) — *Nassarius obsoletus* (Say, 1822), *N. vibex* (Say, 1822), and *N. trivittatus* (Say, 1822). MacGinitie & MacGinitie (1949) described the egg laying process and the capsules of *N. fossatus* (Gould, 1850) from the west coast of the United States. These capsules are laid on eel grass in rows in a "shingled" manner.

Two Panamic Province *Nassarius* egg capsules have also been reported. Gemmell (1973) found that the egg capsules of *Nassarius brunneostomus* (Stearns, 1893) are carried on the opercula of the mollusks. *Nassarius* egg capsules came up in the same dredge load as the holotype of *N. exsarcus* (Dall, 1908) from the Galápagos Islands. Cernohorsky (1975) figured them and assumed them to be this species, but positive identification of the capsules is not possible. The capsules appear to be simple, flat pouches that are attached without a peduncle.

## METHODS

Specimens of six of the eight Bahía Cholla *Nassarius* species were collected in the intertidal area on extreme low tides in May 1973. These were *Nassarius angulicostis* (Pilsbry & Lowe, 1932), *N. pagodus* (Reeve, 1844), *N. taeniolatus* (Philippi, 1845), *N. (Arcularia) iodes* (Dall, 1917), *N. (A.) moestus* (Hinds, 1844), and *N. (A.) tiarula* (Kiener, 1841).

Ten to thirty individuals of each species were placed in separate two-gallon aerated sea water aquaria at room temperature of about 26°C. No sand was provided, but a few dead shells were also placed in each aquarium. These had been checked to be sure they were free of egg capsules. Each individual *Nassarius* was also checked under a microscope to be sure there were no egg capsules on either its shell or operculum before it was placed in the aquarium.

All six species produced veligers visible to the naked eye. No capsules were seen for *Nassarius pagodus*. The experiment was repeated a second time using fresh aquaria and clean air stones. The animals were rechecked for externally attached capsules before replacing them in the aquaria.

The same results were obtained for all six species in both trials.

## RESULTS

Within one to four days, five of the six species of *Nassarius* produced transparent, colorless capsules. These were each attached to the substrate by a basal membrane. The eggs, contained in an inner membrane, filled only a small portion of each capsule when it was first laid. Hatching occurred within the capsule and, as development continued, the veligers filled the capsule, forcing the inner membrane against the outer wall where it could no longer be easily distinguished.

The capsules of each species are distinct. The general shape of the capsule, the presence and shape of the apical plug, the number of eggs per capsule, and the type of substrate preferred differed from species to species. Within a species there is almost no variation in capsule shape or size.

The capsules of *Nassarius angulicostis* (Figure 1) averaged 1.9 mm in height. The simple, laterally compressed, slightly flanged pouches lack a distinct peduncle, and no apical plug is present. The escape aperture is assumed to be along the wide distal surface of the capsule, possibly near one corner. The adult *N. agulicostis*, averaging 14.5 mm in length, laid capsules, each containing from 80 to 100 eggs, on the side of the aquarium in widely spaced, random fashion.

The vasiform capsules of *Nassarius taeniolatus* (Figure 2) have both a definite apical plug for escape and a moderately long peduncle for attachment to the basal membrane. The irregularly rounded, slightly shouldered capsules give the impression of having many small, expandable pleats. Sutures run from the oval, slightly raised plug to the top of the peduncle where they join. Capsules average 0.6 mm in height. The adult *N. taeniolatus*, averaging 6 mm in length, laid the capsules, each containing from 14 to 16 eggs, on the sides and bottom of the aquarium in a widely spaced, random fashion.

The vasiform capsules of *Nassarius iodes* (Figure 3), averaging 0.5 mm in height, are without sutures, ribs, or

flanges. The slightly compressed, rounded capsules are attached to the basal membrane by a long, slender peduncle. Veliger escape is possible through a simple, slightly oval, apical plug. The adult *N. iodes*, averaging 6.5 mm in length, laid the capsules, each containing five large eggs, on the sides and bottom of the aquarium. These are widely spaced and in no particular pattern. Only four of the five eggs hatch into free-swimming veligers; the fifth egg appeared to be infertile but was not used as a nurse egg.

The capsules of *Nassarius brunneostomus* (Figure 4) are laterally compressed pouches which, except for the long, slender peduncle, are similar to those of *N. angulicostis*. Lateral sutures run from the top of the peduncle to the wide, compressed apex, which lacks any definite plug. The adult *N. brunneostomus*, averaging 11 mm in length, always laid the capsules on the operculum, with as many as 18 capsules in various stages of development on a single operculum. Whether or not an individual deposited capsules on its own operculum or that of another individual was not observed. Each capsule holds about 90 eggs. Capsules average 0.5 mm in height.

The vasiform capsules of *Nassarius tiarula* (Figure 5) are laterally compressed, with a suture running from the raised flange of the apical plug to the top of the very short peduncle. They average 1.4 mm in height. The adult *N. tiarula*, averaging 17 mm in length, preferred to lay their egg capsules on the shells in the aquarium and on the airstone hose. Capsules were laid close together but without a noticeable pattern. Occasionally one capsule would be laid on the basal membrane of another. Capsules averaged 35 eggs each.

## DISCUSSION

*Nassarius reticulatus* and *N. incrassatus* from Great Britain and *N. vibex* from the east coast of the United States have been reported to have vasiform capsules with apical plugs. Three Bahía Cholla species can now be added to this list — *N. iodes, N. tiarula*, and *N. taeniolatus*.

Two Bahía Cholla species have compressed pouches, with a wide distal end laking any evidence of a plug. These are *N. angulicostis* and *N. brunneostomus*. No other species having capsules of this type have been reported.

A third type of capsule, which differs greatly, occurs in the East Coast species *N. obsoletus* and *N. trivittatus* and in the West Coast *N. fossatus*. These capsules are irregular, spiny, and sessile (Scheltema, 1962). No Bahía Cholla species yet studied falls into this group.

A possible fourth type of reproduction is represented by *Nassarius pagodus*, which produced free-swimming veligers but for which no externally laid capsule has been observed. More work remains to determine the method of development in this species. Adult *N. pagodus* average 20 mm in length and are the largest intertidal *Nassarius* at Bahía Cholla.

The egg capsules of Bahía Cholla *Nassarius* show relationships that do not follow those presently assigned on the basis of shell characters. Two species in the present subgenus *Arcularia* (*N. tiarula* and *N. iodes*) have vasiform capsules with plugs, while the third species (*N. moestus*) has a compressed pouch without a plug. The same is true for the two species currently assigned to *Nassarius*, s.l. *Nassarius taeniolatus* falls in the group with a plug, and *N. angulicostis* in the group without.

Keen (1971) states that subgeneric divisions within *Nassarius* are difficult to define. More work on egg capsules might lead to a new revision that would be more satisfactory than the present one based solely on shell characters.

## ACKNOWLEDGMENTS

I would like to thank Eva Schroeder of Tempe, Arizona, for the drawings.

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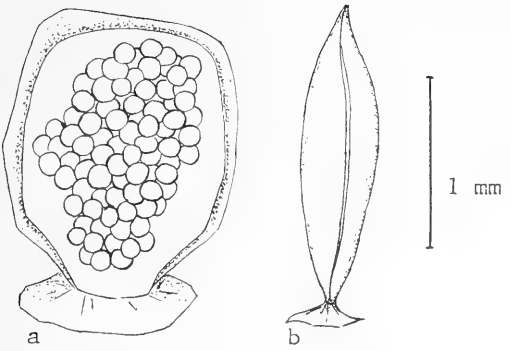


**Figure 1.** Egg Capsules of *Nassarius angulicostis*.
**a.** View of the flat side.
**b.** Lateral view.

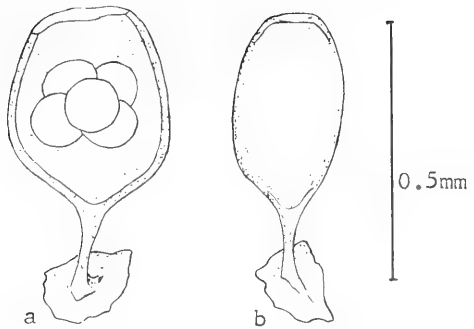


**Figure 3.** Egg Capsules of *Nassarius iodes*
**a. & b.** Lateral views.

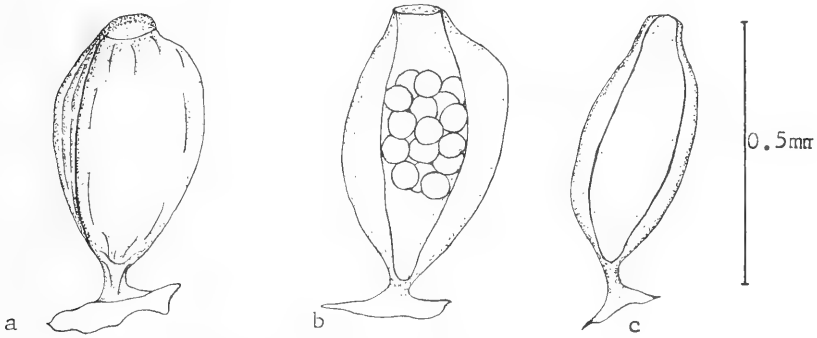


**Figure 2.** Egg Capsules of *Nassarius taeniolatus*.
**a.** Capsule tilted toward viewer to show apical plug (showing pleats).
**b.** View of slightly shouldered capsule (pleats omitted).
**c.** Lateral view (pleats omitted).

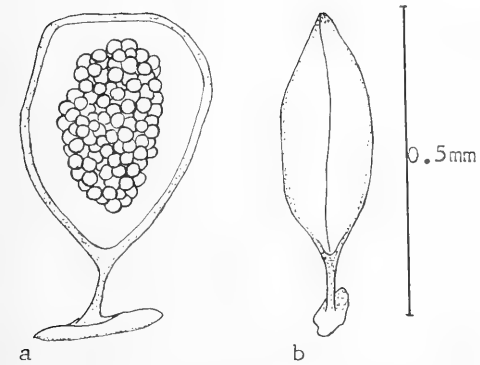


**Figure 4.** Egg Capsules of *Nassarius brunneostomus*
**a.** View of the flat side.
**b.** Lateral view.

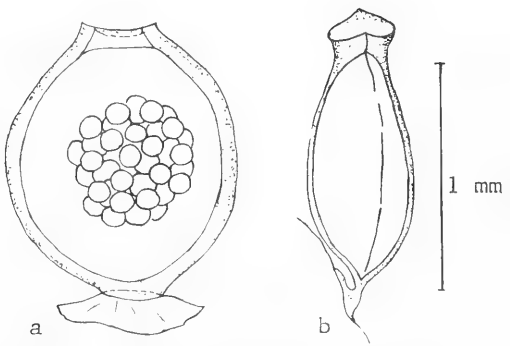


**Figure 5.** Egg Capsules of *Nassarius tiarula*
**a.** View of the flat side.
**b.** Lateral view.

# Mary Alice Willcox

## 1856 – 1953

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Our knowledge of early twentieth century malacologists is often limited to published biographies, frontispieces, personal anecdotes from those who knew them, and the "in-house" stories that were left behind at institutions. To these we add our own impressions of these workers based on their published works and manuscripts.

I recently reviewed many acmaeid papers in preparation of a chapter on the anatomy and morphology of the Acmaeidae for a forthcoming volume in the series "Invertebrates of the San Francisco Bay Estuary System." No review of acmaeid anatomy would be complete without reference to Walter K. Fisher's 1914 monograph on the anatomy of *Lottia gigantea* Sowerby, 1834. A remark in this work caught my attention; Dr. Fisher acknowledged the work of a "Miss Willcox." Although the name M.A. Willcox was a familiar one, I had not imagined this worker to be a woman. I obtained the Willcox acmaeid papers, six in all, and immediately became intrigued. In addition to the excellent and varied work, I found a mystery. In her 1906 paper on the anatomy of *Acmaea testudinalis* (Müller, 1776) she explained, "I have now decided to publish the entire monograph in sections of which the present is the first." But this paper was her last publication. I attempted to locate the unpublished manuscript and to find out what had happened to M.A. Willcox. I could not locate the manuscript, but what I did find was a fascinating account of an outstanding malacologist and naturalist.

Mary Alice Willcox was born into a distinguished Maine family on April 24, 1856. Her father, William Henry Willcox, was a congregational minister in Kennebunk, Maine, and later became a trustee of Wellesley College, Massachusetts. Her mother, Anne Holmes Goodenow, was the daughter of Daniel Goodenow, a justice of the Supreme Court of Maine, and granddaughter of John Holmes, one of Maine's first senators. Her younger brother William Francis, was Professor of Economics and Statistics at Cornell University, and during the early nineteen hundreds authored the foreword of the United States Census Reports. A younger sister, initials believed to be E. E., completed the family. Shortly after Mary Alice's birth the family moved to Reading, Massachusetts.

Dr. Willcox began her education at the State Normal School in Salem, Massachusetts, and graduated in 1875. After five years of teaching and independent studies,

Dr. Mary Alice Willcox surrounded by Wellesley students – 1883. (from Glasscock, 1975)

she traveled to England and studied for three years at Newnham College, Cambridge University. Her studies in Europe included winter breaks spent at the College de France in Paris and a summer at the London Zoological Gardens. She returned to the United States in 1883 without a degree. According to her correspondence in the Wellesley College Archives, Cambridge did not give degrees to women at this time. She traveled to Europe again in 1896 and completed her Ph.D. (with honors) in just one and one-half years at the University of Zurich. After a short stay at the Naples Marine Station, she returned to the United States in 1899.

A list of her friends and professors reads like a "who's who" in the natural sciences for this period. In her early years she received guidance from and attended lectures by Alpheus Hyatt of the Boston Society of Natural History; Alexander Agassiz invited her to spend summers at his Newport Marine Station, and even considered her for a position at Harvard's Museum of Comparative Zoology. Henry Durant, the founder of Wellesley College, offered her a position at the college and encouraged her to study abroad in preparation for the position. While at Cambridge University, she studied under the physiologist Sir Michael Foster, the embryologist Sir Francis Balfour, and the anatomist Joseph Lister. Her personal friends in England included Mr. & Mrs. Horace Darwin, Charles' youngest son and founder of the Cambridge Scientific Instrument Company. Some of her happiest moments in England were spent playing with their son Erasmus, and it was at their home that she dined with Sir Charles and his wife on one of his rare

visits to Cambridge shortly before his death. The winters in Paris included lectures by the physiologists Francois-Frank and Brown-Sequard and work in the histological laboratory of Raniver. Her mentor at the University of Zurich was Dr. Arnold Lang, and she received specimens for her thesis work from the New Zealand malacologist, Henry Suter. On her return to the United States, her correspondents included William H. Dall and Charles W. Johnson.

During her tenure at Wellesley College as Professor of Zoology from 1879 to 1910, Dr. Willcox introduced many innovative teaching methods and established her department as one of the foremost in the country. Her curriculum included embryology and field work in both freshwater and marine invertebrates. Her course on the anatomy of the cat was modeled after those in Europe and was in all probability one of the first in the nation. She also taught Philosophical Zoology and Laboratory Physiology. The latter met four times a week at Wellesley, while at Harvard it was only offered on one afternoon per year.

Her research and publications are divisible into two distinctive periods. Prior to her Ph.D. thesis in 1898, her main interest was ornithology, and her book "Pocket Guide to Common Land Birds of New England" was the result of these early studies. Marine invertebrates and insects were secondary during this period although she did spend many hours as a volunteer at the Newport Marine Station and the Boston Society of Natural History Museum. Beginning with her doctoral thesis on the anatomy of *Acmaea fragilis* (Sowerby, 1823), Dr. Willcox's research centered on the family Acmaeidae. Her papers dealt with a variety of topics, including anatomy, histology, systematics, and behavior.

Her last paper (on the anatomy of *Acmaea testudinalis*) was published in 1906, four years before her retirement from Wellesley. Her retirement was, according to tangential sources, due to "health" and although the exact cause has never been stated, several remarks made in a 1928 letter suggest rheumatism, which by then kept her bedridden for up to ten days at a time. It is possible that this ailment prevented her from finishing or editing the rest of the manuscript for publication.

The manuscript could not be located at Wellesley College, among the family papers in the Cornell Archives, at the Museum of Comparative Zoology, nor at the Museum of Science in Boston. It is likely that the manuscript remained at Wellesley after her retirement since Dr. Willcox left her personal library and other papers with the Zoological Museum she had founded there. However, a fire in 1914 totally destroyed College Hall which had housed the Museum, library, and Zoology Department.

Mary Alice Willcox died on June 4, 1953, at Pocasset, Massachusetts. She was 97 years old. Her work on the family Acmaeidae had lasted only eight years, but because of her thoroughness and expertise, her papers are still widely cited and referred to today.


## ACKNOWLEDGMENTS

I wish to gratefully acknowledge the following individuals for their assistance in locating information and the published works of Dr. Willcox at their respective institutions: Ms. Wilma R. Slaight, Wellesley College Library; Dr. Kenneth Boss and Ms. Ann Blum, Museum of Comparative Zoology, Harvard; Dr. Joseph Rosewater, United States National Museum; and Mrs. Barbara Wiseman, Museum of Science, Boston.


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# INBREEDING AND INTRASPECIFIC VARIATION IN *CHRYSALLIDA* CARPENTER, 1857 (GASTROPODA: PYRAMIDELLIDAE)

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## INTRODUCTION

*Chrysallida* Carpenter, 1857, and other genera of Pyramidellidae present major taxonomic problems. These difficulties result from their complex patterns of variation, thought by most workers to represent many closely related species. This interpretation has led to the proposal of numerous species-level taxa. In the eastern Pacific there are approximately 100 nominal species referable to *Chrysallida* and some 800 pertaining to the entire family.

Extensive speciation in the family has been considered a result of the parasitic lifestyle of the group. All pyramidellids for which feeding behavior is known are ectoparasites on other invertebrates; their specialized feeding apparatus suggests this is true for the family as a whole (Ankel & Christensen, 1963). The pyramidellids have also been thought to be host specific (Fretter & Graham, 1946). Berry (1955) suggested that such niche specialization might explain the existence of so many closely allied sympatric species.

Examination of eastern Pacific *Chrysallida* in the Los Angeles County Museum of Natural History (some 5,000 specimens in 795 lots) in the course of work on a revision of the genus in the eastern Pacific, has convinced me that there is much greater phenotypic variability within certain species than was previously recognized. This variability seems to be expressed as numerous, more or less homogeneous, populations that are patchily distributed. Many samples, considered separately, could easily be interpreted as representing distinct species. Taken together, however, such samples show complete intergradation. Moreover, the evidence summarized below that pyramidellids are not host-specific makes the "numerous host-specific species" interpretation difficult to accept.

Even though I do not accept host specificity, I believe that the parasitic lifestyle is largely responsible for the patterns of variation. Close association with the host combined with non-swimming larvae in certain species greatly reduces the opportunity to interbreed, resulting in numerous small, highly inbred populations, internally similar but differing substantially from their neighbors. A pattern of variation consistent with this hypothesis is evident in three of the four most common species of *Chrysallida* in the Californian and Oregonian faunal provinces. Although the taxonomy has not yet been completely worked out, these three species appear to have at least 27 synonyms among them.

Because my interpretation of the phenotypic diversity within *Chrysallida* differs from that reflected by the current state of its taxonomy and requires acceptance of a pattern of intraspecific variability not commonly recognized, an explanation of what I believe to be its probable cause is given here.

## ACKNOWLEDGMENTS

I wish to express my gratitude to James H. McLean, Donald B. Cadien, and Mark Rogers for observing and recording some of the *Chrysallida* host-parasite relationships here reported; to Mike Haufler for supplying collecting data for the specimens examined at University of Southern California's Catalina Marine Science Center; and to Bertram C. Draper and James H. McLean for taking photographs used to illustrate the paper. The manuscript has been critically reviewed by Eugene Coan, James H. McLean, and Barry Roth.

## HOST-SPECIFICITY

Fretter & Graham (1949) state that members of the family are host-specific: "Each species of pyramidellid appears to be associated with one definite host . . . . They will be found to feed on no other animal." This conviction was later reaffirmed, though slightly moderated (Fretter & Graham, 1962).

Berry (1955) was evidently the first to consider the parasitic life style of the family in formulating an explanation of its phenotypic and taxonomic difficulties. Apparently basing his argument on Fretter & Graham's (1949) discussion, he stated, "The close host-parasite specificity there indicated with other mollusks, annelids, coelenterates, etc. affords the first reasonable explanation of the existence of so many often closely allied sympatric species. . . ." This explanation would be quite reasonable if a high degree of host-specificity could be demonstrated, for Kohn & Orians (1962) indicated that "Sibling species are . . . to be expected in groups in which niche specialization by close adaptation to a particular type of food in the environment is possible." Host-specificity is, of course, the most extreme form of food specialization.

Evidence is accumulating, however, to indicate that most — perhaps all — pyramidellid species are not host specific. Ankel & Christensen (1963) enumerate known hosts for two European species — eight for *Odostomia eulimoides* Hanley (seven pelecypods and a gastropod) and five for *O. scalaris* Macgillivray (four gastropods and a pelecypod). Multiple hosts have also been reported for four species from the eastern United States, including two species of *Chrysallida. Chrysallida seminuda* (C.B. Adams) parasitizes at least seven species of mollusks, five pelecypods and two gastropods (Hackney, 1944;

Robertson, 1957; Wells & Wells, 1961; Merrill & Boss, 1964; Boss & Merrill, 1965; Porter, 1976). *Chrysallida dianthophila* (Wells & Wells) has been reported on four different serpulid polychaete hosts (Wells & Wells, 1961, 1969). *Menestho impressa* (Say) has been observed to feed on eight hosts, including five gastropods, a pelecypod, a polychaete, and a tunicate (Hopkins, 1956; Allen, 1958). Twelve hosts have been reported for *Menestho bisuturalis* (Say), including four bivalves and eight gastropods (Medcof, 1948; Hopkins, 1956; Loosanoff, 1956; Boss & Merrill, 1965; Scheltema, 1965; Robertson, 1967; Bullock & Boss, 1971).

## MULTIPLE HOSTS OF EASTERN PACIFIC *CHRYSALLIDA*

There have been very few host associations published for eastern Pacific pyramidellids, and thus far no cases of multiple hosts. My field observations and specimens with detailed habitat information in the Los Angeles County Museum of Natural History document multiple hosts for one eastern Pacific species of *Chrysallida* and are suggestive of multiple hosts for another.

*Chrysallida cincta* Carpenter, 1864, is now known to have five, possibly six gastropod hosts. **Figure 1** shows *C. cincta* in place on the operculum of *Tegula eiseni* Jordan from San Pedro, California. As many as four adults have been found on a single host, invariably on the operculum in living material. This association has been found at numerous localities in southern California and Baja California Norte, Mexico. Though feeding was not observed, the consistent position of the *Chrysallida* and the absence of other potential hosts leaves little doubt that the *Tegula* is the host.

**Figure 1**. *Chrysallida cincta* on operculum of *Tegula eiseni*. LACM 76-49. Intertidal, rock ledges, E. side White's Point, San Pedro, Los Angeles County, California. X3.5

*Norrisia norrisi* (Sowerby) is another trochid host of *Chrysallida cincta*. The parasite was found in place on the operculum of a dried specimen of *Norrisia* collected at Portuguese Bend, Palos Verdes Peninsula, Los Angeles County, California. Additional specimens were found dried in place on the opercula of *Norrisia* from three stations at Isla Cedros, Baja California Norte, Mexico. Although it was not observed living, the consistent placement of the dried *Chrysallida* on the opercula and the absence of other potential hosts epizoic on the *Norrisia* shells indicates that *Norrisia* was the host.

This same species has also been found on two species of *Astraea*: It was collected on *A. undosa* (Wood) at Flatrock Point, Palos Verdes Peninsula, Los Angeles County, and at Mission Bay, San Diego County, California, and also on *A. gibberosa* (Dillwyn) at Isthmus Cove, Catalina Island, California (**Figure 2**). In the latter two records, the *Chrysallida* were positioned on the base of the host's shell near the columellar side of the aperture. The host specimens were completely free of encrusting epizoans; it therefore seems likely that the *Astraea* were the hosts.

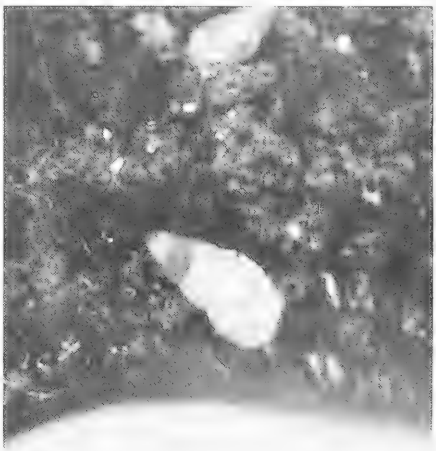

Figure 2. *Chrysallida cincta* on base of *Astraea gibberosa*. White area at bottom of picture is the columella. LACM 71-99. 9-30m, Isthmus Cove, Catalina Island, California. X8.5

*Chrysallida cincta* were observed apparently feeding on a specimen of *Haliotis corrugata* Wood in an aquarium at University of Southern California's Catalina Marine Science Center approximately six months after it had been collected at Bird Rock, Catalina Island. Two specimens of the parasite were observed to crawl part way under the edge of the *Haliotis* shell, extending their

heads toward the mantle, which seemed to contract slightly. They remained in this apparent feeding position for 30 to 45 minutes, then withdrew to the back of the host's shell where approximately 20 additional *C. cincta* were distributed.

The same species was collected on tubes of the vermetid gastropod *Serpulorbis* at Doheny Beach, Orange County, California. It is not established that the parasite was feeding on *Serpulorbis*, though this seems likely, as the other known hosts are all gastropods.

Another species of *Chrysallida* for which records suggest multiple hosts is *C. reigeni* Carpenter, 1857. It was found abundantly under rocks in association with the chiton *Stenoplax conspicua sonorana* Berry at Puerto Peñasco, Sonora, and at San Felipe, Baja California Norte, associated with *Chiton virgulatus* Sowerby and *Lepidozona* sp. Actual feeding will have to be observed to demonstrate conclusively that chitons are the host and that *C. reigeni* feeds on more than one species. This would represent the second known case of a pyramidellid parasitizing chitons, the other being *Odostomia chitonicola* E.A. Smith, reported by Robertson & Orr (1961) to live on *Dinoplax gigas* (Gmelin).

A number of pyramidellid species have therefore been shown to be non-host-specific. Specificity in host selection, on the other hand, has apparently not been demonstrated for any species of pyramidellid, although it has been suggested. Krestensen (1970) reports having experimentally confirmed host-specificity in *Menestho diaphana* (Jeffreys) on the sipunculid *Phascolion strombi* (Montagu). However, the only experiment reported that tested the response of *M. diaphana* to potential hosts other than *P. strombi* involved a single parasite observed for one half hour. The test animal was placed in a petri dish with six species, of which one was the known host. At the end of the half hour, the *Menestho* had succeeded in locating the *P. strombi* and extended its proboscis. Comparison of his methods and results with whose of Boss & Merrill (1965) for the non-host-specific species *Menestho bisuturalis* and *Chrysallida seminuda* indicates that Kristensen demonstrated only host preference. The species tested by Boss & Merrill also showed preference for the host from which they were collected, although they also fed on a variety of other species.

More extensive observations and laboratory experiments will be required to support claims of host-specificity in cases in which it is suspected. Experiments in which the behavior of a suspected host-specific species is observed over an extended period in the presence of potential hosts, excluding its known host, have yet to be done. The fragmentary nature of our knowledge of pyramidellid-host relationships makes confident statements impossible, but based on the evidence now available, non-host-specificity seems to be the dominant pattern.

The question of host-specificity is important because, to the extent that pyramidellids are not host-specific, the probability of their forming numerous closely related sympatric species is reduced. Based on the above evidence, one may infer that the large number of phena (reasonably phenotypically homogeneous samples) exhibited by *Chrysallida* and some other pyramidellid genera probably do not represent distinct near-sibling species, each occupying a highly specialized food niche, as was suggested by Berry (1955). Intraspecific variation, the alternative explanation for the observed phenotypic diversity, is therefore more likely.

## RESTRICTION OF DISPERSAL AND INTERBREEDING

Thorson (1946) showed that pyramidellids with scalariform, sinistrally coiled larval shells have relatively long pelagic larval stages and are common in plankton tows. He suggests that species with minimal larval shells, on the other hand, either lack pelagic veligers or have very brief free-swimming stages. Both Thorson (1946) and Fretter & Graham (1962) enumerate a number of pyramidellids known to have planktonic veligers. Most eastern Pacific species of "*Turbonilla*" and some "odostomias" have scalariform, sinistral larval shells and therefore probably have planktonic larval stages. In such species the young might be widely dispersed, leading to considerable mixing of the population with each new generation. The result should be considerable interbreeding — with consequent mixing of the gene pool — and a normal pattern of intraspecific variation.

A planktonic larval stage would obviously have a much greater impact on dispersal and the mixing of the gene pool than the adult behavior of these minute species. The closeness of association betweeen the adult parasite and its host will result in inbreeding only when there is no significant larval dispersal. Whether a brief planktonic stage would restrict dispersal sufficiently to cause significant inbreeding, and how brief a planktonic stage would have to be to have a restricting effect, is problematic.

A few species are known or believed to lack a planktonic larval stage. The European species *Brachystomia rissoides* (Hanley) has been reported to lack a free-swimming veliger under some environmental conditions, although having an apparently brief pelagic stage under others (Rassmussen, 1944, 1951; Thorson, 1946). Robertson & Orr (1961) suggested that *Odostomia chitonicola* from South Africa lacks a pelagic veliger. None of the eastern Pacific species of *Chrysallida* have the scalariform, sinistrally coiled larval shells associated by Thorson with a long pelagic stage, and thus some might lack pelagic larvae. Moreover, there is evidence (presented below) that *C. cincta* does not have a free-swimming veliger.

Species that lack a swimming veliger may be free-living, returning to their host(s) only to feed, or may spend their entire life on or immediately adjacent to their host. Those that move about freely should have access to a larger and more diverse pool of potential mates, reducing the degree of inbreeding.

In a paper on intraspecific variation in a group of non-specific, ectoparasitic mites, Wharton (1957) discusses

the effect of inbreeding and distinguishes two categories in which inbreeding occurs. The first are parasites that infest the nests of their hosts, reproducing in the nest and returning frequently to the host to feed. Of these, he states "Many thoroughly inbred lines may result in any given locality and thus it is possible for the inherent variability of the genetic pattern to become apparent in the same area, just as it is possible to select or breed out many different strains of organisms by inbreeding." Species in the second category spend their entire life-cycle, including reproduction, directly on their host, with consequently even more intensive inbreeding. Species of *Chrysallida* and some other pyramidellids apparently fall into equivalent categories — the first being species that spend considerable time off their hosts and the second, species that spend their entire life-cycle on the host.

Two eastern Pacific species of *Chrysallida* might fit the first category. *Chrysallida reigeni* and *C. lucca* Dall & Bartsch have been observed off their hosts, crawling on the underside of rocks in the intertidal zone, the latter by the author at San Pedro, Los Angeles County, California. Both lack scalariform nuclear whorls, but whether this indicates non-swimming larvae remains to be demonstrated. *Chrysallida lucca* shows considerable, apparently patchily distributed, intraspecific variation, which could be explained by inbreeding, were non-pelagic larval development demonstrated. *Chrysallida reigeni*, on the other hand, is considerably less variable, perhaps the result of pelagic larval dispersal. In experiments reported by Boss & Merrill (1965), *Chrysallida seminuda* and *Menestho bisuturalis* spent about a third of their time on the substratum away from their hosts.

## PYRAMIDELLIDS SPENDING ENTIRE LIFE CYCLE ON HOST

At least two pyramidellid species seem to spend their entire life-cycles, including reproduction and larval development, directly upon their host. Robertson & Orr (1961) suggested that this is the case for *Odostomia chitonicola*. Their evidence was circumstantial but convincing. They collected specimens of *O. chitonicola* ranging in size from nepionic to adult on a single specimen of its host, the chiton *Dinoplax gigas*. The nuclear whorls meet Thorson's criterion for non-(or briefly)-pelagic larval development. Of six host animals, all collected within a short distance of one another, the largest was the most heavily infested. Three had no infestation at all, and the remaining two had relatively few parasites. If the young were pelagic, one would expect to find the parasites more evenly distributed through the host population, and extreme juveniles to be absent, this stage being passed before settlement.

The second case is that of the southern Californian *Chrysallida cincta*, for which the circumstantial evidence is similar to that for *O. chitonicola*. I have found individuals ranging from nuclear whorls to adults on a single *Tegula eiseni*, while other specimens of this host in the immediate vicinity were free of infestation. Most of the smallest juveniles were found on a single host. Large specimens of *T. eiseni* were more frequently and more heavily infested than younger ones. Extreme juvenile *C. cincta* were found only with adults. Finally, the pattern of intraspecific variation observed in *C. cincta* fits what one would expect of a species with intensive inbreeding within small populations. Specimens collected from a single host or host colony are homogeneous in shell characters (**Figure 3**), while specimens collected over a few hundred meters of shoreline show greater variability. Collections made over a distance of several kilometers, such as around the Palos Verdes Peninsula, Los Angeles County, show most of the extensive variation expressed by the species as a whole. **Figure 4** shows the range of variation of *C. cincta* in southern California.

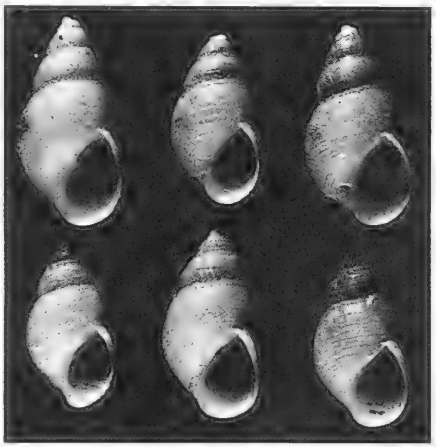

Figure 3. *Chrysallida cincta* — 6 specimens from a single host showing narrow range of variation. LACM 21057. On margin of *Haliotis corrugata*, 22 m, W. end Bird Rock, Isthmus Cove, Catalina Island, California. X11.5

## INBREEDING AND INTRASPECIFIC VARIATION

Studies of population dynamics have established the normal life spans of two species of pyramidellids, *Menestho impressa* (Say) (Wells, 1959) and *Menestho diaphana* (Jeffreys) (Kristensen, 1970). In both cases, the life cycle is annual, most individuals dying after one year. It would seem reasonable for the same to be true for other pyramidellids, including eastern Pacific *Chrysallida*.

The hosts, at least of *Chrysallida cincta*, appear to live much longer. Californian abalones, including *Haliotis corrugata*, attain a size of 7 to 10 cm within 4 or 5 years (Cox, 1962). Presumably they live for 10 years or longer. Although I could not find life expectancy information for *Tegula eiseni*, another species of this genus, *T. funebralis* (A. Adams), has been reported to live up to 30 years (Darby, 1964). *Norrisia norrisi*, *Astraea undosa*, and *A.*

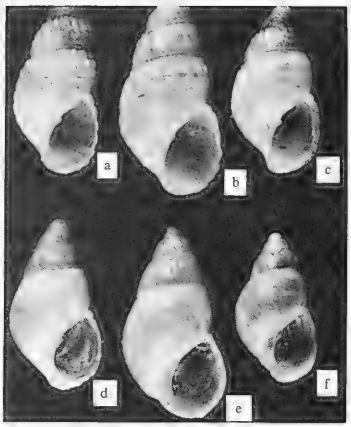


Figure 4. *Chrysallida cincta* — 6 specimens showing sculptural variation from cancellate to spiral to nearly smooth. **4a-d.** LACM 66-51. Intertidal to 6 m, Wilson Cove area, San Clemente Island, California. **4e.** LACM 60-13. Intertidal, Lunada Bay, Palos Verdes Peninsula, Los Angeles County, California. **4f.** Draper Collection. Intertidal, San Pedro, Los Angeles County, California. X10

*gibberosa* probably live several years, judging from their size. A single host could, therefore, support several generations of parasites.

Starting with the limited genetic variation carried by the founders of a population to a new host, relatively few generations of inbreeding should be required to produce a genetically and phenotypically homogeneous population. If the founders derive from similarly inbred (and genetically homogeneous) populations, the process will be accelerated. This could cause the homogeneity observed within populations of several species of eastern Pacific *Chrysallida*. The founder principle (Mayr, 1963), which predicts greater divergence between populations the smaller the number of founders, could account for the wide range of variation between populations observed within limited geographic areas.

Limited interbreeding between populations is necessary, however, to maintain the intergradation of forms observed on a larger geographic scale. Death of the host, with subsequent movement of its parasite population to adjacent hosts, is the most obvious method of dispersal. I have observed this for *Chrysallida cincta* on *Tegula eiseni* in an aquarium. *Chrysallida cincta* will also relocate if it is mechanically dislodged from its host. Movement by the host during its lifetime probably also contributes to dispersal. Interbreeding resulting from these methods should be sufficient to maintain the unity of the species.

*Brachystomia rissoides*, as mentioned earlier, has been shown to have both pelagic and non-pelagic larval development. If such flexibility in manner of larval development occurs in eastern Pacific *Chrysallida*, it could explain the wide geographic distribution of similar intraspecific variants.

## SELF-FERTILIZATION

Self-fertilization, the most extreme form of inbreeding possible, can occur in pyramidellids because they are simultaneous hermaphrodites. Robertson (1967) described spermatophores of three species of eastern North American odostomias and stated that the spermatophores of *Odostomia modesta* Stimpson were "apparently used exclusively for self-fertilization." To the extent that this is true and the exchange of genetic material between individuals is limited, intraspecific variation will be unchecked by the damping effect of interbreeding. Beyond that, the definition of species would become problematic, each individual being in effect an incipient species. Simultaneous hermaphroditism raises the possiblity of occasional as well as obligatory self-fertilization. Self-fertilization could, for example, take place when a breeding partner was not available, allowing a single individual to found a new colony that would immediately be genotypically and therefore probably phenotypically uniform. This would short-cut the need for several successive generations of inbreeding to produce the homogeneous populations previously described.

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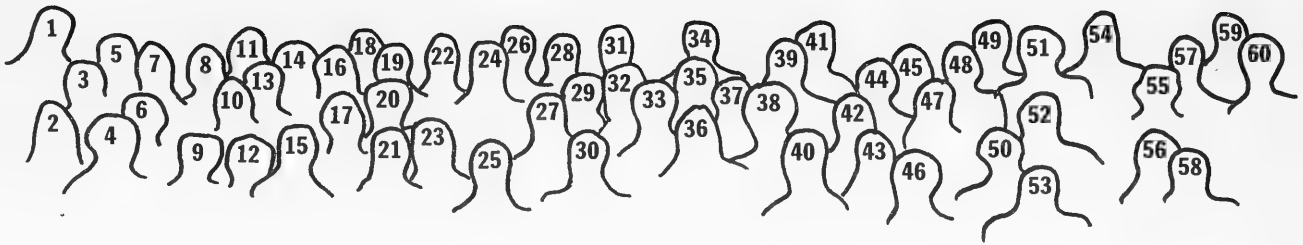


# KEY TO GROUP PHOTOGRAPH

1. Charles L. Powell
2. Loralynn Williams
3. Paul O. Hughes
4. Bernadine Hughes
5. Charles Powell, II
6. Rose A. Burch
7. Yvetta Williams
8. Carey Resch Smith
9. Kate St. Jean
10. Elois Crum
11. Michael S. Frein
12. Edith M. Abbott
13. Gladys C Weber
14. Carol C. Skoglund
15. A. Myra Keen
16. Lois Pitt
17. David K. Mulliner
18. Ian Berke
19. William D Pitt
20. Sandra M. Gardner
21. Merton J Goldsmith
22. William K Emerson
23. Twila L Bratcher
24. Louie N Marincovich
25. JoCarol Ramsaran
26. John W. Cooper
27. Douglas E. Hunt
28. David R. Lindberg
29. Mae-Dean Richart
30. Peter N D'Eliscu
31. Michael G Kellogg
32. Patrick I. LaFollette
33. Eugene V. Coan
34. Bruce H Fowler
35. Marjorie Neiswanger
36. Barry Roth
37. Audrey B. Holiman
38. John K. Allen
39. H. Wayne Holiman
40. Helen DuShane
41. William L. Pratt
42. Mary Larson
43. Ruth C. Greenberg
44. Forrest L. Poorman
45. Suzann Pratt
46. James T. Carlton
47. Barbara J. Good
48. Jody Woolsey
49. Leroy H. Poorman
50. Ruth French
51. Donald R. Shasky
52. Jean M. Cate
53. Emery P. Chace
54. William E. Old, Jr
55. Crawford N Cate
56. Lucinda V. Draper
57. James H McLean
58. Bertram C. Draper
59. George L. Kennedy
60. Kay Webb

## ALSO ATTENDING BUT NOT IN PHOTOGRAPH

Sally Aucerman
Thelma Crow
Anthony D'Attilio
Ralph E Ferguson
Dr. & Mrs. John E. Fitch
Chris Hunt
Heinz Lowenstam
Jack D. Mount
James W. Nybakken
George E. Radwin
Ed Swaboda
Robert R Talmadge
Janice E Thompson

### CORRECTIONS IN LAST YEAR'S GROUP PHOTOGRAPH

#3 is Bill Wright
#60 is John Cubit
#61 is Kathleen J. Barr

# WESTERN SHELL CLUBS

**Chico Seashell Club**
Gladys B. McCormick, Treasurer
Route 2, Box 66
Orland, California 95963
*(Meets twice a month: second Wednesday at 9:30 a.m. in members' homes and last Wednesday at 7:30 p.m. in* Jay E. Partridge School, Room 1, East Avenue, Chico, California.*)*

**Conchological Club of Southern California**
c/o Malacology Section
Los Angeles Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
*(Meets in Museum Lounge, 7:30 p.m. first Monday of every month, unless a holiday, then on Wednesday of the same week.)*

**Hawaiian Malacological Society**
P.O. Box 10391
Honolulu, Hawaii 96816
*(Meets first Wednesday of every month, 7:30 p.m.,* First United Methodist Church, 1020 S. Beretania Street. *December Christmas party at another location.)*

**Long Beach Shell Club**
600 Long Beach Boulevard (YMCA Building)
Long Beach, California 90812
*(Meets second Sunday of every month except July, 2:00 p.m.)*

**Northern California Malacozoological Club**
P.O. Box 1249
El Cerrito, California 94350
*(Meets third Thursday of each month, alternating between California Academy of Sciences and El Cerrito Fairmont Recreation Center.)*

**Oregon Society of Conchologists**
Dr. Byron W. Travis, Secretary
3228 N.E. 70th Avenue
Portland, Oregon 97213
*(Meets first Sunday of each month, 1:30 p.m., in private homes, announcements given in monthly paper or by card.)*

**Pacific Northwest Shell Club**
c/o Mrs. Wilma G. Young, Corresponding Secretary
P.O. Box 1931
Seattle, Washington 98111
*(Meets third Sunday of each month at 2:00 p.m.; looking for a permanent meeting place.)*

**Pacific Shell Club**
c/o Malacology Section
Los Angeles Museum of Natural History
900 Exposition Boulevard
Los Angeles, California 90007
*(Meets in Museum Lounge, first Sunday of each month at 1:30 p.m., October through June.)*

**San Diego Shell Club**
3883 Mt. Blackburn Avenue
San Diego, California 92111
*(Meets third Thursday of every month, Casa del Prado, Balboa Park.)*

**Santa Barbara Malacological Society**
P.O. Box 30191
Santa Barbara, California 93105
*(Meets third Friday of every month, 7:30 p.m.,* Santa Barbara Museum of Natural History, 2559 Puesta del Sol.*)*

**Southwestern Malacological Society**
c/o Mrs. Carol C. Skoglund
3846 E. Highland Avenue
Phoenix, Arizona 85018
*(Meets third Wednesdays, September through May, 7:30 p.m.,* Asbury United Methodist Church, 1601 West Indian School Road, *in auxiliary rooms.)*

**Yucaipa Shell Club**
c/o Mousley Museum of Natural History
Bryant Steet & Panorama Drive
Yucaipa, California 92399
*(Meets third Sunday of every month except August, 2:00 p.m., in the Museum.)*

# LIST OF EXHIBITS AT THE 1977 MEETING

**Leroy H. Poorman, Chairman**

Twila L. Bratcher . . . . . *Cymbium* from West Africa
Bertram C. Draper . . . . . Minute Shells and their Photographs
Ralph E. Ferguson . . . . . Unusual Starfish and Other Oddities
James H. McLean . . . . . The *Fissurella* of Peru and Chile
Jack D. Mount . . . . . Fossil Mollusks from Southern California
David K. Mulliner . . . . . Photographs of Opisthobranchs
William D. & Lois Pitt . . . . . Gatun Fossil Mollusks from Panama
Forrest L. Poorman . . . . . Odds and Ends from Dredging
Leroy H. & Forrest L. Poorman . . . . . Shelled Opisthobranchs from West Mexico
Robert R. Talmadge . . . . . How to Make Inexpensive Specimen Trays
George E. Radwin . . . . . Some Trophonids and Related Taxa

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55, Rue Buffon
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**Naturhistorisches Museum, Basel**
Augustinergasse 2 CH-4051
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**Naturhistorisches Museum, Wien**
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# TEN-YEAR SUMMARY AND INDEX

## TEN-YEAR SUMMARY

### MEETINGS

| Meeting Number | Place | Dates | Approx Attendance | President |
|---|---|---|---|---|
| 1 | Asilomar, Pacific Grove, Calif. | 19–22 June 1968 | 69 | David K. Mulliner |
| 2 | Asilomar, Pacific Grove, Calif. | 18–21 June 1969 | 106 | William K. Emerson |
| 3 | Stanford University, Calif. | 24–27 June 1970 | 115 | A. Myra Keen |
| 4 | Asilomar, Pacific Grove, Calif. | 16–19 June 1971 | 90 | Eugene V. Coan |
| 5 | University of Redlands, Calif. | 18–21 June 1972 | 115 | Beatrice L. Burch |
| 6 | Asilomar, Pacific Grove, Calif. | 11–14 June 1973 | 75 | Twila L. Bratcher |
| 7 | Kellogg West, California State Polytechnic University, Pomona, Calif. | 19–22 June 1974 | 101 | James H. McLean |
| 8 | California State University, San Diego, Calif. | 22–26 June 1975 | 245 | George E. Radwin, W.S.M. President |
| | *Joint Meeting with the American Malacological Union* | | | (Donald A. Moore, A.M.U. President) |
| 9 | Asilomar, Pacific Grove, Calif. | 23–26 June 1976 | 129 | James W. Nybakken |
| 10 | Kellogg West, California State Polytechnic University, Pomona, Calif. | 15–18 June 1977 | 74 | Helen DuShane |

### AWARDS

| YEAR | AWARD OF HONOR | CHAIRMAN'S AWARD | HONORARY MEMBERSHIP |
|---|---|---|---|
| 1968 | (none) | | Frank E. Good |
| 1969 | (none) | | |
| 1970 | Jean M. & Crawford N. Cate | | |
| 1971 | Anthony D'Attilio | | |
| 1972 | William K. Emerson | Dwight W. Taylor | |
| 1973 | Robert R. Talmadge | | A. Myra Keen |
| 1974 | Katherine Van Winkle Palmer | | Rudolf Stohler |
| 1975 | (none) | | |
| 1976 | (none) | | |
| 1977 | Rudolf Stohler | | Wendell O. Gregg<br>Emery P. Chace |

# PUBLICATIONS

## Annual Reports

| VOLUME | YEAR | TITLE | EDITOR | DATE OF ISSUE |
|---|---|---|---|---|
| 1 | 1968 | "The Echo" | David K. Mulliner | 20 March 1969 |
| 2 | 1969 | "The Echo: Abstracts and Proceedings. . ." | Judith Terry Smith | 9 March 1970 |
| 3 | 1970 | same | Barry Roth | 9 March 1971 |
| 4 | 1971 | same | " | 27 December 1971 |
| 5 | 1972 | same | " | 5 March 1973 |
| 6 | 1973 | same | " | 3 April 1974 |
| 7 | 1974 | "Annual Report" | Eugene V. Coan | 12 November 1974 |
| 8 | 1975 | same | " | 1 November 1975 |
| | 1975 | "Bulletin of the American Malacological Union" [containing the abstracts of the joint meeting] | Dee S. Dundee & Eugene V. Coan | 30 January 1976 |
| 9 | 1976 | "Annual Report" | Eugene V. Coan | 12 October 1976 |
| 10 | 1977 | same | " | |

## Occasional Papers

| | | |
|---|---|---|
| 1 | " 'Sea Shells of Tropical West America': Additions and Corrections to 1975" — *A. Myra Keen & Eugene V. Coan* | 22 June 1975 |
| 2 | "A Catalogue of Collations of Malacological Importance" — *George E. Radwin & Eugene V. Coan* | 17 August 1977 |

# STUDENT RESEARCH GRANTS

**1972 —**

**Carl A. Stiefbold**
Biology Department
Portland State University

$250

"The role of neurosecretion in the transformation of the rock-boring clam, *Penitella penita*, from the working-asexual to the resting-sexual form"

**1973 —**

**Carol N. Hopper**
Department of Zoology
The University of Hawaii

$250

"The effects of particle size and concentration on the feeding behavior of the vermetid *Petaloconchus keenae* Hadfield and Kay, 1972"

**1975 —**

**Judith M. Christensen**
Department of General Biology
University of Arizona

$500

"Electrophoresis studies of selected species of the genus *Rabdotus*"

**1977 —**

**Janice Evelyn Thompson**
Scripps Institution of Oceanography
University of California, San Diego

$500

"On the nature of the food of *Diodora aspera* (Gastropoda) and its commensal *Arctonoe vittata* (Polychaeta)"

## MALACOLOGICAL PUBLICATIONS RECEIVED ON EXCHANGE FOR THE W.S.M. PUBLICATIONS AND THEIR PLACE OF DEPOSIT

*Argamon* ..... San Diego Museum of Natural History

*Levantina* ..... San Diego Museum of Natural History

*Bulletin* of the Malacological Society of China ..... Los Angeles County Museum of Natural History

Newsletter of the Sociedade Brasileira de Malacologia .... Los Angeles County Museum of Natural History

*Littorinid Tidings* ..... Los Angeles County Museum of Natural History

*Soosiana* ..... California Academy of Sciences

*Folia Historico-Naturalia Musei Matraensis* ..... California Academy of Sciences

*Malakologischen Abhandlungen* ..... California Academy of Sciences

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The date given is the year in which the volume was published. (See list of publications for exact dates.) "A" and "B" are used for those years in which two volumes were issued in the same calendar year. Small-case letters (a, b, c, and d) are used when one person is the author of more than one abstract in the volume.

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