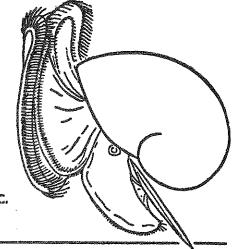
THE VELIGER

A Quarterly published by
CALIFORNIA MALACOZOOLOGICAL SOCIETY, INC.
Berkeley, California



Volume 18

OCTOBER 1, 1975

NUMBER 2

CONTENTS

Preliminary Report. (20 Plates)
Peter Jung
Structures of Recent Cephalopod Radulae. (4 Plates)
Alan Solem & Clyde F. E. Roper
Two Pleistocene Volutes from the New Hebrides (Mollusca: Gastropoda). (2 Plates; 1 Map)
Harry S. Ladd
Feeding and the Radula in the Marine Pulmonate Limpet Trimusculus reticulatus. (1 Plate; 4 Text figures)
JOHN R. WALSBY
Reproduction in the Giant Octopus of the North Pacific, Octopus dofleini martini, (1 Plate)
Susan Hoffer Gabe
Egg and Larval Development in the Green Mussel, Mytilus viridis Linnaeus (2 Plates)
W. H. TAN
A Seasonal and Histologic Study of Larval Digenea Infecting Cerithidea californica (Gastropoda: Prosobranchia) from Goleta Slough, Santa Barbara County, California. (2 Plates; 2 Text figures)
Тімотну Р. Уозніно
Notes on the Structure and Habits of Myadora (Pelecypoda). (1 Plate; 2 Text figures)
Michael J. S. Tevesz
Notes on the Spawning and Larval Development of Mitra idae Melvill (Gastropoda: Mitridae).
MICHAEL G. KELLOGG & DAVID R. LINDBERG

[Continued on Inside Front Cover]

Note: The various taxa above species are indicated by the use of different type styles as shown by the following examples, and by increasing indentation.

ORDER, Suborder, DIVISION, Subdivision, SECTION, SUPERFAMILY, FAMILY, Subfamily, Genus, (Subgenus)

New Taxa

CONTENTS - Continued

	New Tertiary and Recent Naticidae From the Eastern Pacific (Mollusca: Gastro-
	poda). (2 Plates; 3 Text figures)
	Louie Marincovich
	An Illustrated List of the Phyllidiidae from Seto, Kii, Middle Japan (Nudibranchia: Doridoidea). (5 Text figures)
	Kikutarô Baba & Iwao Hamatani
	Two New Cone Species from Senegal, West Africa. (1 Plate; 1 Text figure) Edward J. Petuch
	Studies on the Mytilus edulis Community in Alamitos Bay, California. V. The Effects of Heavy Metals on Byssal Thread Production. (6 Text figures)
	J. MICHAEL MARTIN, FRED M. PILTZ & DONALD J. REISH
	The Essential Amino Acids of Mytilus californianus (2 Text figures)
	Craig Harrison
	Growth in the Black Abalone, Haliotis cracherodii. (4 Text figures) MARY BERGEN WRIGHT
	Aspidosiphon schnehageni (Sipuncula) inhabiting Tornatina Shells. (4 Text figures)
	Antônio S. F. Ditadi
	Ecological Aspects of Zooplankton (Foraminifera, Pteropoda and Chaetognatha) of the Southwestern Atlantic Ocean. (7 Text figures; 3 Tables)
	Demetrio Boltovskoy
	NOTES & NEWS
	Range Extensions for Two Tropical West American Gastropods. Donald R. Shasky
	BOOKS, PERIODICALS & PAMPHLETS
K Reprint →	The Recent Mollusk Collection Resources of North America Alan Solem
	ALAN GULLAL



Distributed free to Members of the California Malacozoological Society, Inc.

Subscriptions (by Volume only) payable in advance to Calif. Malacozool. Soc., Inc.

Volume 18: \$25.- Domestic; \$26.50 in all Spanish Speaking Countries and Brazil;

\$27.- in all Other Foreign Countries (including Canada)

Single copies this issue \$18.-; postage additional.

Send subscription orders to Mrs. Jean M. Cate, P.O. Drawer 710, Rancho Santa Fe,

California 92067. Address all other correspondence to Dr. R. Stohler, Editor

Department of Zoology, University of California, Berkeley, California 94720

The Recent Mollusk Collection Resources of North America

A Report to the

Association of Systematics Collections

Compiled and Written by

ALAN SOLEM

for the

Council of Systematic Malacologists

Steering Committee:

Alan Solem, Chairman
(Field Museum of Natural History)
Arthur H. Clarke
(National Museum of Canada)
George M. Davis
(Academy of Natural Sciences, Philadelphia)
James McLean
(Los Angeles County Museum)

а
р
-
*

SUMMARY

A survey of recent mollusk collection resources in North America located about 72 000 000 specimens in 3 744 000 lots. About 73% of this material is catalogued and organized, with perhaps 775 000 lots in various stages of processing. Current growth is about 2.1% annually, but processing is about 1.6%, indicating a growing backlog problem.

The collections are highly concentrated, with eight institutions holding 80% of the specimens and 78% of the lots. Allowing for habitat and area specializations, only 12 collections would account for 86-93% of the total continental holdings in marine, freshwater and land mollusks. This high concentration of collections would permit maximum focus of support for malacological work, since equivalent coverage for vertebrate groups would require much more diffuse support, i.e., 20 bird and 39 mammal collections.

The total number of curatorial positions for malacologists has remained virtually unchanged since 1950, and remains highly concentrated, with 58% of the 26 total in six institutions, and 90% of the supporting staff positions at only 10 museum and university collections.

Without additional personnel and support for EDP of collections, the vast potential of molluscan collections to monitor changes in environmental conditions and quality will remain untapped.

INTRODUCTION

The ferment in the systematics community of the 1960's and early 1970's has led to attempts by practitioners of several systematic disciplines to survey the collection resources of the United States and to prepare recommendations as to how these can be used more effectively to meet the needs of society. To date, reports have been issued on birds (Banks, Clench and Barlow, 1973), mammals (Anderson, Doutt, and Findley, 1963; Anderson and Choate, 1974; Choate, 1975), herpetology (Wake, 1975), insects (Hurd, 1974), arachnids (Levi, 1974), and plants (Payne, 1974). A preliminary report of fishes was circulated at a 1974 meeting. Other reports are in various preliminary stages.

An initial meeting of malacologists to work towards this goal was held at the Academy of Natural Sciences, Philadelphia in November 1972. This was followed by a second meeting at Field Museum of Natural History, Chicago in May 1973. At the latter meeting it was decided to: 1) survey the collections of mollusks in the Americas; 2) prepare suggested guidelines as to alternative methods of preser-

vation and data standards for new materials to be added to collections; 3) to prepare recommendations as to the system of EDP most suitable for use with malacological collections; and 4) to seek means of funding retrospective capture of collection data useful to environmental impact statements and programs.

This report deals with the survey of malacological collections. Locating the major malacological collections presented few problems. The collections are massive and very highly concentrated, but their size makes extracting detailed data highly difficult. Originally it was intended to cover South and Central America also, but returns of questionnaires from these areas were too fragmentary to permit an assessment of their resources. Geographic coverage is thus restricted to the United States of America and Canada. Information was solicited concerning collection size and growth patterns, collection content on both systematic and geographic bases, type and extent of staff, library, and microscope equipment associated with the collections, participation in graduate education, and identification of particular strengths and weaknesses. Insofar as comparable data were received and the information permitted reaching conclusions, the data are summarized on the following pages and in several tables. While the emphasis here is on institutional holdings, one unusual feature of malacological work is the great number and size of private collections and the degree to which systematic and faunistic work on mollusks is dependent upon collecting efforts and publications by "non-professionals," people not employed as malacologists and university biologists. Probably 85% of the mollusks in major institutional collections today are materials collected by amateurs, rather than professional biologists.

Literally thousands of individual shell collections exist. At least a thousand such collections comprise 5 000 or more specimens. Within the time and support limits available, no comprehensive survey of private collections was possible, but an attempt was made to solicit data concerning collections on which research had been published in recent years. A short section lists twelve such collections containing in all 99 000 lots and about 1 000 000 specimens. In time, perhaps 50% of such collections end up in a major institution.

SURVEY PROCEDURE

A first draft of the proposed questionnaire was circulated to fifteen malacologists for suggestions and corrections. At the same time they were asked to add names for the final distribution. The final questionnaire was sent to 125 institutions and about 100 private collectors in September

1973, with nearly all returns received by January 1, 1974. Responses were received from 45 institutions and 50 collectors, after one follow-up letter to major institutions. Institutions with less than 5 000 lots and private collections with less than 3 000 lots are not included here in the tabular data. The total respondees eliminated by this cutoff are 19 institutions and 38 individuals, involving about 35 000 lots. Several major private collectors did not respond, but only one large institution failed to submit useable data. Hence this survey probably includes 90-95% of the significant recent mollusk material.

The results were collated initially by Ms. Jayne Freshour, who also handled typing and proofreading of the report. I am deeply grateful for her efforts, the support of Field Museum for postage and duplicating, and to Arthur H. Clark and José Stuardo for help in distributing questionnaires. Without the cooperation of busy museum curators and amateur collectors, this survey would not have been possible. My thanks to all who replied. Publication support was given by NSF grant BMS 75-10455.

COLLECTION SIZES

Cataloguing conventions differ with groups of organisms. Each mammal and bird specimen will be given a separate number, but fishes and mollusks often are catalogued by lots, i.e., all specimens of one species collected at one locality at one time. Each fish or mollusk specimen individually is subject to as much data analysis as each mammal or bird. Except for clumped clams fastened to or boring into rocks or wood, most mollusks are collected individually, handled individually and studied as individuals. Data on specimen and lot numbers both have meaning in evaluating collections for research potential. The previous generation of museum malacologists and most amateur collectors used large sets to provide "trading material." Thus most of the lots catalogued many years ago now have very few specimens per lot, frequently because of subsequent trading. During the last quarter century, many museum collections have retained all specimens in large samples to enable effective study of variation.

Estimates as to specimen numbers are difficult, since catalogue entries for large lots usually do not list an exact number. In replying to the questionnaire, several curators made random page counts from the catalogues, or had detailed annual accession statistics. Others could make an informed guess based on checking sample trays in cabinets, or long experience with a collection, while some used the modern convention of "10 specimens/lot." The latter cases are indicated by a question mark in the tables.

Tabulation of the institutional collections is presented in Tables I through III. Table I includes the eight institutions reporting more than 160 000 catalogued sets of mollusks. They total 41 500 000 specimens (79.7% of North American total) and 2243 000 lots (78.1%). Table II lists the nine institutions reporting 30 000 to 75 000 catalogued lots. They total $8\,350\,000$ specimens (16.1%) and $467\,000$ lots (16.3%). Table III reports nine collections with 9 000 to 28 000 catalogued lots. They total about 2 500 000 specimens (4.2%) and 160 000 lots (5.6%). All of these figures represent the situation as of the last quarter in 1973. They can be considered reasonably accurate, since only two major institutions, the Los Angeles County Museum (LACM in Table I) and the Carnegie Museum, Pittsburgh (data inadequate for listing) do not have a current consecutive numerical cataloguing system.

PATTERNS OF COLLECTION GROWTH

Two useful indices of collection growth and management are the annual rate at which specimens are being acquired, and the rate at which they are being processed into the research collections. Any museum will have small to large quantities of material waiting to be processed. No accurate census of such material is practical, but current estimates indicate that 775 000 unprocessed lots, an amount equal to 27% of the total organized collections, are held by the institutions listed in Tables I-III. Most of this material represents field collections, and the largest numbers are in the larger institutions. The number of specimens would probably average over 25/lot, compared with the probable 18/lot in organized collections.

The acquisition rate is summarized by the annual average for the years 1968-1972. One simple correlation is obvious. Those institutions with the most active acquisition programs, National Museum of Natural History, Academy of Natural Sciences, American Museum of Natural History, Delaware Museum of Natural History, National Museum of Canada, and Los Angeles County Museum, are, with the exception of the latter, the institutions with a ratio of 2.5-4.5 supporting staff per curator. The Los Angeles County Museum is functioning with the help of several volunteer paraprofessionals in its program. In contrast, those institutions with no supporting staff, Museum of Comparative Zoology and Bernice P. Bishop Museum, have virtually ceased acquiring specimens.

The total average rate of acquisitions from 1968-1972 is about 59 000 sets/year, or 2.1% of the current institutional holdings. This parallels the experience in other

Table 1

Largest Institutional Collections

		.,						
	NMNH	ANSP	MCZ	UMMZ	FMNH	AMNH	врвм	LACM
Number of cataloged lots	740000	336737	270000	232373	179000	175 000	160000	(1)
Estimated specimens (in thousands)	12000	8000	9000	P	2350	over 2000 (?)	6000	1000
Collection Facilities			. ,			(*)		
Composition:								
Marine	60%	57%	45%	5%	30%	75%	25%	95%
Freshwater	20%	16%	25%	60%	15%	5%	5%	1%
Land	20%	27%	30%	35%	55%	20%	70%	4%
Last major addition	1973	1973	1971	5	1973	1973	1971	1973
Average annual additions, 1968-1972, in lots	8000	4552	(2)	2500	3095	10000	350	10000
Staff:			, ,			2000.	000	10000
Curators	4	2	2	2.5	13	1	1	1
Supporting	10	5.5	0.25	2.5	2.25	3.5	ô	1.25
Microscopes	8+	11	7	20	6	4	7	3
Library					*	-	•	J
Current journals	20+	20+	20+	ç	20 +	20+	8	13
Reprints	40 000	27000	30000	10000	15000	20000	4000	5000
Iconographies	5	5	5	5	5	5	3	3
PhD students 1970-1973	3	0	6	3	2	1	0	2

¹The Los Angeles County Museum does not use a continuous catalog numbering system, so that no exact size estimate is readily available (ca. 160000);

NMNH=National Museum of Natural History; ANSP=Academy of Natural Sciences, Philadelphia; MCZ=Museum of Comparative Zoology, Harvard; UMMZ=University of Michigan Museum of Zoology; FMNH=Field Museum of Natural History; AMNH=American Museum of Natural History; BPBM=Bernice P. Bishop Museum; LACM=Los Angeles County Museum.

disciplines, that collections are expanding at about 2% annually.

Exact short-term estimates of processing activity are not feasible. Virtually all processing is done at the institution. In a typical sequence, incoming collections of mollusks must be sorted, housed, labeled, rough identified, catalogued, dry specimens numbered, wet collection labels prepared, wet material filed away in the alcohol collection cabinets, and dry specimens put into systematic sequence in the shell collection. The only easily tallied item is the number of catalogue entries, yet on a short-term basis, this measures only one of nine steps. On a long-term basis, cataloguing can serve as an indication of collection growth patterns. The results of an unintended experiment are presented in Table IV. In 1955 I distributed paratypes of several new species to some major museums, requesting catalog numbers. Comparing the rounded-off numbers obtained then with the total catalogued sets as of late 1973, gives an index of longer term processing activities. The

Academy of Natural Sciences, National Museum of Natural History, and Field Museum of Natural History had roughly equivalent processing rates with those at the Museum of Comparative Zoology and University of Michigan Museum of Zoology distinctly lower. In recent years, the National Museum of Canada and the Delaware Museum of Natural History have shown very high rates of processing activity, matching their high rates of acquisitions.

The total annual processing rate for these five institutions is 1.6% of their collections, or significantly less than the growth rate of 2.1%. Instead of coping with the backlogged materials, they are increasing in size.

STAFFING OF COLLECTIONS

Most of the largest collections are in administrative units that have responsibility only for mollusks, with their own curatorial and supporting staff. The National Museum of

²No annual accession records apparently are kept, but the last significant accession was noted as occurring in 1971;

⁹A second malacologist was added September 1, 1974.

Table 2

Middle-sized Institutional Collections

	INHS	DMNH	NMC	SDNH	SBM	SU¹	CAS	UINH	OSU
Number of cataloged lots	75000	70650	70632	63 500	52000	38 000	35000	32216	30000
Estimated specimens (in thousands)	?	1000 - (?)	2500	100	1000	500	250	250	over 2000 (?)
Collection Facilities									
Composition:									
Marine	0	60%	40%	75%	75%	80%	60%	?	20%
Freshwater	50%	20%	40%	5%	5%	8%	10%	2	60%
Land	50%	20%	20%	20%	20%	12%	30%	?	20%
Last major addition	1930's	1973	1973	1973	1973	1969	1973	1940?	1973
Average annual additions,									
1968-1972, in lots	0	4000	6600	1500	3250	400	1000	0	2000 +
Staff:									
Curators	part-time	1	1	1	1	0	12	0	2
Supporting	0	4.5	3.5	0.75	1.5	0	3.5	0	ca. 3
Microscopes	1	2	5	2	6	1	3	4	3
Library									
Current journals	0	20+	20+	12	18	14	15	?	?
Reprints	200	15000	10000	4000	4000	9000	15000	?	2500
Iconographies	0	5	5	4	0	4	4	?	0
PhD students 1970-1973	0	0	3	0	0	0	0	0	2
Malacologist in charge to:	1940	1973	1973	1973	1973	1970	1972	1931	1973

¹Until the retirement of Myra Keen in 1970, Stanford University had a very active research and educational program in malacology. Since then, Dr. Keen has been an unpaid, volunteer worker.

INHS=Illinois Natural History Survey; DMNH=Delaware Museum of Natural History; NMC=National Museum of Canada; SDNH=San Diego Natural History Museum; SBM=Santa Barbara Museum; UINH=U. of Illinois Natural History Museum; OSU=Ohio State U.; SU=Stanford U.; CAS=California Academy of Sciences

Natural History mollusk collection is part of the Department of Invertebrate Zoology, but its four curators and ten supporting staff have responsibility only for the mollusks. The American Museum of Natural History has a Department of Living Invertebrates, with both malacologists and specialists in other disciplines. Field Museum of Natural History has a Division of Invertebrates that functions as a mollusk unit, although having nominal responsibility for small collections of other recent invertebrates. The Los Angeles County Museum, San Diego, Santa Barbara, and University of Arizona have Invertebrate Sections headed by malacologists, while the zoological collections of the University of Colorado now are headed by a malacologist. In contrast, the California Academy of Sciences Department of Geology, which houses the shells of recent mollusks, long had been staffed by malacologists, but now is without a malacologist.

At the present time, with the recent addition of malacologists to the staff of Field Museum, University of Colorado, and Santa Barbara, there are 26 malacological curatorial positions (including Carnegie Museum), some of which are part-time (Arizona, two of three at the University of Michigan). Malacological positions have been eliminated at both Stanford and the California Academy of Sciences in recent years, although they still maintain collections. Formerly a malacologist and a significant collection were at the University of Kansas, but after the retirement of A. B. Leonard, a herpetologist was hired and the mollusk collection transferred to the National Museum of Natural History. Collections at the Illinois Natural History Survey and University of Illinois result from the work of F. C. Baker (pre-1940) and have been inactive since then. Currently 15 of the 26 malacological positions are at six institutions - National Museum of

²At the California Academy of Sciences, recent mollusks are housed with the fossils and a single curator has responsibility for both. The present curator is not a malacologist.

Table 3
Small Institutional Collections

TOTAL	UCM ¹	FSM	CMC	UNSM	EKU	UBC	UAT ³	MPM	WSM:
	CCANE.	EOM	CIVIC	UNSW	EKU	Oac	UAT	MPW	VV SEVE
Number of cataloged lots	26800	22174	27700	22 000 ²	ca. 9000	10244	12758	18390	11000
Estimated specimens (in thousands)	500	750 (?)	56.5	220 (?)	250 (?)	100	₹ .	153	?
Collection Facilities									
Composition:									
Marine	50%	30%				100%			80%
Freshwater	25%	30%			20%				10%
Land	25%	40%			80%				10%
Last major addition	1972	1973	1943	?		1973	1973	?	1967
Average annual additions,									
1968-1972, in lots	150	?	3	0	250	500	500	318	?
Staff:									
Curators	1	1	0	0	0	0	1	0	0
Supporting	0.6	0.5	0	0	0	0	0.75	0.5	0
Microscopes	3	4	1	0	?	2	4	1	1
Library									-
Current journals	5	12	1	0	6	9	7	3	11
Reprints	12000	15000	0	0	11000	500 €	2	60	**
Iconographies	1	3	2	0	0	2	è	1	2
Malacologists in charge to:	1933	1973	7	none	1973	1973	1973	none	1973

¹At the cutoff date for this survey, the University of Colorado appointed Dr. Shi-Kuei Wu, a malacologist, as Curator of Zoological Collections.

UCM=U. of Colorado Museum; FSM=Florida State Museum; CMC=Charleston Museum, Charleston; UNSM=U. of Nebraska State Museum; EKU=Eastern Kentucky U.; UBC=U. of British Columbia; UAT=U. of Arizona, Tucson; MPM=Milwaukee Public Museum; WSM=Washington State Museum.

Natural History, Academy of Natural Sciences, Museum of Comparative Zoology, University of Michigan Museum of Zoology, Field Museum of Natural History, and Ohio State University.

A total of 44 full-time equivalent supporting staff positions were reported. This is somewhat misleading, since at several institutions their time is spent partly on other collections, acting as research assistants, or are on temporary grant funds. Ten institutions account for 39.5 of the 44 positions, with such massive collections as the Bernice P. Bishop Museum and the Museum of Comparative Zoology having virtually no collection help. The establishment of adequate supporting staff levels for major collections is vital if the collections are to be maintained adequately, much less continue to grow and be functionally useable in research.

LIBRARY AND MICROSCOPE FACILITIES

Few families of mollusks have had comprehensive monographic revisions in this century and the literature is widely scattered. For identifications and research, adequate library facilities are essential. Information was gathered on four aspects of library coverage: 1) number of current subscriptions to malacological journals; 2) estimated size of institutional and curatorial separates (reprints) holdings; 3) whether or not complete sets of five standard iconographies were present—Kiener, Martini-Chemnitz (second edition), Reeve, Sowerby's Thesaurus, and Tryon & Pilsbry; and 4) whether complete sets were held of eleven malacological journals. These journals were: Nautilus, Malacologia, Journal of Conchology, Proceedings of the Malacological Society of London, Basteria,

²All uncataloged.

³Both the University of Arizona and Washington State Museum have had graduate students in malacology during recent years.

Table 4

Longer Term Specimen Cataloguing Rates

Institution	Number	of lots in:	Average lots catalogued annually,
	1955	1973	1955-1973
ANSP	194000	336737	7930
NMNH	610 000	740 000	7 222
FMNH	54000	179000	6944
MCZ	202 000	270 000	3778
UMMZ	185000	232373	2632

Archiv für Molluskenkunde, Veliger, Venus, Journal de Conchyliologie, Johnsonia, and Indo-Pacific Mollusca. This selection includes century-old to recent origins, and hence gives an adequate idea as to the comprehensiveness of library holdings.

Currently published journals on mollusks range from highly technical to shell club notes, with more than 20 journals publishing systematic reports, faunistic lists, or significant ecological observations. Reports varied as to the journals to be included, so that "20+" arbitrarily indicates comprehensive current subscriptions. Most of the major, active collections, have comprehensive journal coverage, large collections of separates, and complete sets of the iconographies (see Tables I, II and III). The Bernice P. Bishop Museum long ago chose to specialize on the Pacific Basin, and has not attempted comprehensive literature coverage, while the Los Angeles County Museum comparatively recently attained active status. They have only five journals complete, and the Bishop Museum six journals. All other institutions in Table I, plus the California Academy of Sciences, Stanford University, Delaware Museum of Natural History, National Museum of Canada, and Florida State Museum have all eleven journals. The San Diego Museum of Natural History and University of British Columbia have nine complete, while the University of Arizona, University of Colorado, and Santa Barbara Museum of Natural History hold seven journals. All others report less than three complete sets of journals.

Information on the number of separates and iconographies is self-explanatory and requires no special comments. Since many amateur collectors accumulate substantial libraries, over the years most major institutions have been able to acquire most of the major works. Thus literature resources associated with most of the major collections are quite adequate to superior in coverage.

Microscope equipment varies in quantity and quality. Only a summary number is listed to give a rough indication of how many instruments are associated with the collection facility, and its research unit. High numbers correlate with student and grant projects.

USE IN GRADUATE EDUCATION

The curators in charge of the collections listed in Table I report that 21 PhD students in 1970-1973 made significant use of the collections, and/or the curators were involved in thesis direction. In addition, the National Museum of Canada reports three students, Delaware Museum of Natural History reports two, and single students used the resources at Stanford University and the University of Colorado. A total of 28 PhD students made direct use of these resources in thesis projects. Many other students made more peripheral use, but the data reported are inadequate and not comparable from questionnaire to questionnaire.

COLLECTION CONTENT

Potentially the most useful portion of this report would be a review of collection content, both as to systematic group and geographic area. Because the collections are filed systematically, are not cross-indexed (with rare exceptions), and are not entered into any electronic data processing system (except for limited portions of the National Museum of Natural History and much of the National Museum of Canada collections), specific information is not available. Respondees were asked to report the percentage distribution between land, freshwater and marine collections, to indicate outstanding features of their collection, and to indicate, for geographic areas, whether their collection contained "much unstudied, much studied, good synoptic, some material, little or none" for each area. All such estimates involve considerable subjectivity. What might be considered "little or none" in a collection of 740 000 lots, might be rated "much" in a collection of 5 000 lots. There also is considerable difference in curatorial familiarity with collections. A newly appointed curator is far less able to indicate collection strengths than a veteran of 50 vears with the same collections.

Given the above limitations, three discussions are presented: 1) habitat coverage and identification of the major collections in these areas; 2) a brief outline of apparent major geographic gaps in the total collection resources of North America; and 3) a brief comment on major strengths and potentials in collections.

HABITAT COVERAGE

Although many malacologists will work on land, freshwater and marine mollusks, in general there is a tendency

for scientists and collectors to specialize on materials from one of the three major habitats. The diversity of mollusks is not equally distributed among these, with perhaps 24 000 land, 4 200 freshwater and about 57 000 marine species. On a habitat basis, a "balanced collection" would encompass about 28% land, 5% freshwater, and 67% marine material. For 20 collections there are estimates as to the habitat composition. By applying these percentages against the number of lots, a collection by collection estimate of lots was obtained. When these were totalled, the overall composition works out at 26% land, 21% freshwater, and 53% marine. The comparative abundance of freshwater material reflects history, natural abundance in former years, and the fact that Eastern North America had perhaps one-third to one-half the total freshwater mollusk fauna of the world, most of it endemic. Huge collections of North American freshwater mollusks have been accumulated by many dedicated amateur and professional collectors.

On the basis of percentage estimates furnished by the responding curators, the seven largest collections of land mollusks, with estimated numbers of lots, are:

National Museum of Natural History	148 000
Bernice P. Bishop Museum	120000
Field Museum of Natural History	99000
Academy of Natural Sciences, Philadelphia	90000
University of Michigan Museum of Zoology	81 500
Museum of Comparative Zoology, Harvard	81000
American Museum of Natural History	35000

These account for roughly 93% of the total land mollusk collections.

The seven largest collections of freshwater mollusks probably are:

National Museum of Natural History	148000
University of Michigan Museum of Zoology	139000
Museum of Comparative Zoology, Harvard	67000
Academy of Natural Sciences, Philadelphia	54000
Ohio State University Museum of Zoology	39000
Field Museum of Natural History	29 000
National Museum of Canada	28000

These account for about 86% of the holdings.

The nine largest marine collections are:

National Museum of Natural History	444 000
Academy of Natural Sciences, Philadelphia	192000
Los Angeles County Museum	152000
American Museum of Natural History	131 000
Museum of Comparative Zoology, Harvard	122000
Field Museum of Natural History	54000
San Diego Museum of Natural History	48000

Delaware Museum of Natural History 42 000 Bernice P. Bishop Museum 40 000

These collections include about 88% of the total North American marine mollusk holdings.

Four institutions, National Museum of Natural History; Academy of Natural Sciences, Philadelphia; Museum of Comparative Zoology, Harvard; and Field Museum of Natural History appear on all three lists. The Bernice P. Bishop Museum, University of Michigan Museum of Zoology, and American Museum of Natural History rank in the top groups for two out of three areas. Ohio State University Museum of Zoology, National Museum of Canada, Los Angeles County Museum, San Diego Museum of Natural History, and Delaware Museum of Natural History are outstanding in one area.

As can be seen by examining the percentage distributions recorded in Tables I and II, most of the largest and middle-sized collections are attempting to maintain a balanced approach. Exceptions are the University of Michigan Museum of Zoology, which has little marine material; the Los Angeles County Museum, which has virtually no land and freshwater mollusks; and the Illinois Natural History Survey, which has no marine material.

Major Geographic Gaps in Collection Resources

Viewed in overall context, if the seven to nine largest collections have 86% to 93% of all holdings and they lack significant materials from an area, then there exists a major geographic gap, unless some other institution reports a specialization in that area. Using this guideline, a review of the reported strengths in area coverage shows several significant lacks.

For marine mollusks, no institution reports major holdings from the Eastern Atlantic. The historically important J. G. Jeffreys collection is at the National Museum of Natural History, but only synoptic materials exist otherwise. Only the Museum of Comparative Zoology and American Museum claim good synoptic material from West Africa. The Red Sea, Persian Gulf, China, Siberia, Korea, and Antarctica seem to be virtually unrepresented. The West Coast of South America is far better represented in collections than the East Coast. Good synoptic collections exist from the Mediterranean, South Africa, Australia, New Zealand, Polynesia, Micronesia, Japan, and the Philippines. In contrast, Western North America, the Caribbean, Gulf of Mexico and Atlantic Coast of North America are well represented in many institutions.

For freshwater mollusks, New Guinea, Malaysia, India, the Middle East, South Africa, and Tropical Africa are weakly represented. Several institutions report strong Neotropical and North American collections, but for most

foreign areas, the holdings are "some material" rather than "good synoptic" or "much material".

For land mollusks, the Neotropical and Nearctic regions are well represented, but North Africa, Tropical Africa (except for the Museum of Comparative Zoology), Malagasy Islands, Indian subregion, and many parts of the Oriental region are either very poorly represented, or only one institution has significant collections.

Despite their large size, the molluscan collections extant today are weak in material from many areas of the world. The entire area from the Red Sea to Malaya is very poorly covered, and, with the exception of single collections, Australia, New Zealand, Melanesia, Tropical Africa, and North Africa are surprisingly poorly represented. In contrast, Neotropical and West Indian land; Pacific coasts of both Americas and the Atlantic coast of North America for marine mollusks; and Eastern North American freshwater mollusks are abundantly represented in collections.

All of the above statements are based, of necessity, upon unquantified impressions of curators. Unfortunately, in the absence of EDP collection management, no real assessment of the collection coverage will be possible.

Major Areas of Collection Strength

Mention has been made on previous pages of the larger than expected freshwater mollusk collections. These form an invaluable resource to society, since freshwater mollusks are notoriously sensitive to pollution and environmental degradation. The collections from past years give invaluable base line data against which to measure faunal change and water quality recovery. Similarly, the accumulated collections of marine mollusks from harbor and bay areas provide a detailed record against which change and recovery can be marked.

This resource is unused and inaccessible at present. Collections are organized systematically, and it is virtually impossible to assemble data quickly concerning the fauna of a stream or harbor. Massive data on the marine mollusks of both coasts of North America are present in a dozen or more institutions. Unionid clams of Eastern North America amounted to half the world species and major collections exist in at least ten institutions. Many of these clams soon may be extinct, but the record of changes they document can be used effectively in impact statements and environmental surveys. Records of land mollusks are almost as extensive, and perhaps equally useful.

To date the major use of molluscan collections has been in systematic and biogeographic studies. This will continue, but the most direct value to society probably lies in the data concerning changes in species composition, distribution, and growth forms from areas subject to environmental disturbance. The massive collections from North America accumulated in the past 150 years undoubtedly form the most extensive mass of such base line data extant. Unlocking this asset for such use will require prompt assistance for retrospective data capture from collections, and for accompanying increased revisionary and faunistic work.

PRIVATE COLLECTIONS OF RECENT MOLLUSKS

Although 100 questionnaires were distributed to private collectors, many did not reply. Such major collections as those of S. Stillman Berry, D. Steger, the McGintys, and Walter J. Eyerdam are not listed below. The twelve recorded here, totalling about 99 000 lots and 1 000 000 specimens, form only a sample of the private collections. The total private holdings of research caliber might be three to four times these figures. Even so, they would amount to less than 15% of the institutional holdings.

The collections are listed in descending size order.

Leslie Hubricht (Meridian, Mississippi). About 28 000 sets and 300 000 land snails from Eastern North America. Most comprehensive collection anywhere from this area.

H. D. ATHEARN (Cleveland, Tennessee). Freshwater mollusks of Eastern North America. Some 13 000 catalogued lots of 328 000 specimens, with 6 000 lots as unprocessed backlog.

RALPH W. JACKSON (Cambridge, Maryland). Comprehensive land snail (95%) collection, 12 822 lots with about 100 000 specimens, especially strong in Eastern North America, Neotropical, and Philippine Island species. Best collection of Ecuador non-marine.

Munroe L. Walton (Glendale, California). Deceased 1974, with North American land snails to Delaware Museum of Natural History. A balanced collection, 28% marine, 14% freshwater, 58% land, strongest in land snails of Western North America. Some 10 226 lots, many of very long series.

HELEN DUSHANE (Whittier, California). Mostly self collected marine mollusks, Alaska to Galapagos, especially strong in epitoniids. About 5 800 lots, 25 500 specimens.

James X. Corgan (Clarksville, Tennessee). About 5 000 lots of micro-marine mollusks, mainly from Gulf of Mexico.

DOROTHY E. BEETLE (Cincinnati, Ohio). Non-marine mollusks, mainly self collected from Wyoming, North Caro-

lina, Virginia. Publications, 4 446 lots in all, some exchange material.

ROBERT R. TALMADGE (Eureka, California). About 3 200 catalogued and 1 500 uncatalogued lots, mainly marine species. Some published material on haliotids, neptuneids and buccinids.

HAROLD W. HARRY (College Station, Texas). About 3 000 lots from Gulf of Mexico and Indo-Pacific, mostly (75%) marine.

CLARENCE M. Burgess (Honolulu, Hawaii). About 40 000 specimens of the marine family Cypraeidae.

JEAN and CRAWFORD N. CATE (Rancho Santa Fe, California). Some 35 000 marine mollusks, specializing in the Cypraeidae, Ovulidae, Mitridae, Muricidae.

TWILA BRATCHER (Hollywood, California). About 3 000 lots, specializing in the Terebridae and general marine material from Western North America.

REMARKS AND COMPARISONS

Data extracted from available surveys of collection resources not only demonstrate that systematists have been seriously underestimating the total size of collection resources, but point out several contrasts between disciplines. The total sizes of collection resources are estimated at:

Systematic Group	Total number of collections surveyed	Total l specimens
Mammals	400	over 2 000 000
Birds	283	4001175
Herpetological	ca. 122	3 300 000
Fishes	150	34 890 000
Insects	58 4	120 000 000
Arachnids	ca. 30	2 200 000
Mollusks	38	72 000 000
Plants	1 000	45 811 608

Mollusk collections are exceeded in total size only by insects and are more concentrated into a few centers than any group except arachnids. The eight large (over 160 000 catalogued lots) mollusk collections (Table I) hold 80% of the lots and 78% of the specimens in North American collections. In contrast, the 39 largest mammal collections contains 86% of the total holdings (Anderson, Doutt & Findley, 1963); the 20 largest bird collections have 82% (Banks, Clench & Barlow, 1973); the 20 largest herpetological collections have 82% (Wake, 1975); the ten largest fish collections have only 42% (unpublished); the 25 largest insect collections have 80% (Hurd, 1974); the three largest arachnid collections have 64%; and the botanists identify 105 "National Resource Collections" for potential support.

The varying size of collections must be balanced against estimated levels of diversity for the different groups. The approximately 85 000 species of mollusks (Solem, in preparation) far outnumber the 4500 species of mammals; 8 600 birds; 9 000 reptiles and amphibians; 20 000 fishes; and 20 000 arachnids, but are dwarfed in number by the 250 000 vascular plants and more than 1 000 000 described species of insects. On a "specimen per species" basis, the collections group into three categories: low, medium, and high. These are:

LOW

Arachnids	110 specimens/species
Insects	120 specimens/species
Plants	183 specimens/species

MEDIUM

Reptiles & Amphibians	366 specimens/species
Mammals	444 specimens/species
Birds	465 specimens/species

HIGH

Mollusks	847 specimens/species
Fishes	1744 specimens/species

Both the mollusk and fish figures are somewhat inflated by the large numbers of some common species in collections. Many collecting gaps exist in terms of both systematic and geographic coverage. Nevertheless, these calculations do suggest that there are massive data associated with mollusk collections, and that these collections are extremely concentrated when compared with those representing other major taxonomic groups.

If we allow for habitat specialization in collection contents, then 12 institutional mollusk collections hold 86% to 93% of the total materials in North America. Support given to 11 United States museums and the National Museum of Canada thus would provide support for more than seven-eighths of the total molluscan collections. To provide nearly equivalent support for birds would mean supporting 20 collections, and for mammals it would require contributing to 39 collections.

Current growth of mollusk collections is about 2.1% annually, but current processing of new materials into the major collections is only about 1.6%. The current estimated backlog of only partly processed or unprocessed materials in major museum collections of 775 000 lots (27% of total collections) is growing, rather than being reduced. This is despite very high concentration of curatorial and supporting staff positions. There are 58% of all

curators in only six of 27 institutions and 90% of all supporting staff positions in only 10 institutions. Several important collections, Stanford University, California Academy of Sciences, Illinois Natural History Survey, University of Illinois Natural History Museum, and Charleston Museum have no malacologists, and at a few other collections the chances of continuing malacological positions are considered poor.

Despite the great expansion of science in the late 1950's and 1960's, the number of curatorial posts for malacologists has remained virtually unchanged in totals, yet the collection growth continues, primarily because of the huge input of valuable materials from amateurs.

CONCLUSIONS

Because of their huge collection size, particularly in regard to mollusks from communities directly subject to pollution and disturbance, mollusk collections provide a massive international resource for environmental monitoring. Without support for retrospective EDP, which will have to come from outside present institutional budgets, this resource will remain virtually untapped.

Perhaps more than in regard to any other systematic grouping for which major collections exist, targeted support to a relatively few collections will enable the collection managers for one discipline, malacology, to meet the goals of the systematics community as outlined in "America's Systematics Collections: A National Plan" (Irwin, Payne, Bates and Humphrey, 1973:3-4). Since these statements may not be readily available to all malacologists, I quote the three sets of goals from this report.

"The primary goals of the systematics community are:

- 1. To improve the condition of systematics collections as a national resource.
- 2. To improve the quality and efficiency of services associated with systematics collections resources.

"The specific goals of the systematics collections community are:

Management of the specimen inventory and associated documentation to insure: a) permanent conservation of the specimens themselves; b) ready access to them and their documentation; and c) space, facilities and library resources enabling systematists to improve the information content of the collections through identification, classification and elaboration of the intrinsic information carried by each specimen.

2. Addition of new specimens and associated information that: a) reflect the goals and priorities of basic and applied science; and b) improve the quality and quantity of specimen- and taxon-related data, so that the information content of each specimen is enhanced.

"The *specific service-related goals* of the systematics collections community are to:

- Make available upon demand specimen- or taxon-related information in a variety of useful forms.
- Enable incorporation of specimens and associated data in the information management system.
- 3. Enable ready access to the specimens themselves, and to associated documentation and library materials."

With currently available personnel resources, it is not possible for the managers of malacological collections to meet these goals. The addition of both curatorial and supporting staff will be necessary.

APPENDIX I

Institutional collections of recent mollusks in North America. The following account is organized geographically, with data abstracted from the questionnaires. While I am fully responsible for errors in copying and misinterpretation of answers, the data are as supplied by curators. For each collection, I have given mailing address, name and title of respondee, a brief summary of the collection emphasis, then such details of deposited collections and expedition materials as were supplied to me. Statistical data from the Tables is not repeated.

NORTHEAST

Museum of Comparative Zoology (Harvard Unive sity, Cambridge, Massachusetts 02138; Kenneth J. Boss, Curator, Department of Mollusks). Excellent Western Atlantic marine, unionid clams, Solomon Island, Chinese and West Indian land. Tradition of active exchanges with scientists and amateurs by curators such as J. G. Anthony (1865-1877), William F. Clapp (1911-1923) and William J. Clench (1926-1966). Hence material received from huge variety of sources and many areas. Numerous expedition materials and collections made by staff and associates. Detailed list not available.

AMERICAN MUSEUM OF NATURAL HISTORY (Central Park West at 79th Street, New York, New York 10024; William K. Emerson, Curator of Mollusks, Department of Living Invertebrates). Major Eastern Pacific and Western Atlantic marine, fine Congo and

Philippine non-marine, general marine collections. Collections include John C. Jay, D. Jackson Steward, William A. Haines, James A. Constable, Metcalfe, Julius Wisoff, Robert L. Stuart, M. K. Jacobson, Jess L. Webb, John E. Holeman. Expeditions include Lang & Chapin Congo (1909-1915), Whitney South Sea (1929-1930), "Askoy" (1941, 1957), "Puritan" to Eastern Pacific, Templeton Crocker and "Zaca" to Eastern Pacific.

MIDDLE ATLANTIC

NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION (Washington, D.C. 20560; Joseph Rosewater, Curator, Department of Invertebrate Zoology). World-wide comprehensive collection containing about one-fourth of total North American holdings. Excellent Indo-Pacific, European, Polynesian, Eastern Pacific, and West Indian marine, good world-wide land, excellent West Indian land, excellent unionid collections. Collections of Isaac Lea, A. A. Gould, A. Binney, F. C. Baker, W. G. Binney, W. H. Dall, R. E. C. Stearns, J. G. Jeffreys, C. T. Simpson, A. E. Verrill, P. Bartsch, W. B. Marshall, J. B. Henderson, Jr., U. S. Exploring Expedition, North Pacific Exploring Expedition, Albatross Expedition, and many others.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA (19th Street & The Parkway, Philadelphia, Pennsylvania 19103; George M. Davis, Chairman, Department of Malacology). Outstanding type collection, Indo-Pacific marine, North American land, unionids, Asian freshwater. World-wide coverage after long history of malacological efforts. Major materials from Pease, Heilprin, A. D. Brown, Redfield, Binney, Gabb, S. R. Roberts, Hirase, Oldroyd, Stearns, Ferriss, Hatcher, Swift, Preston, Bequaert, Rhoads, Garrett, Rush, Hemphill, Ashby, Langford, McGinty, Thaanum, Kuroda, Say, Conrad, Purchon, Hesse, Locklin, Moise, Pilsbry, H. B. Baker. Extensive expedition materials, too numerous to list.

Delaware Museum of Natural History (Box 3937, Greenville, Delaware 19807; R. Tucker Abbott, Curator, Department of Mollusks). A new collection engaged in an aggressive acquisition program of a world-wide nature. Excellent Solomon Island marine material and world collection of Volutidae. Collections include John E. du Pont (30 000 lots), E. Doremus (14 000), Leonard Richardson (12 000), Helen Boswell (5 000), W. J. Clench, R. Tucker Abbott, Norman W. Lermond, and Munroe L. Walton land snails.

Carnegie Museum of Natural History (4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213; Juan José Parodiz, Curator, Section of Invertebrates). Apparently no significant additions since 1969. A collection that is mostly not catalogued (ca. 20 000 lots in 1930), known to be rich in unionid clams, freshwater and land mollusks from West Virginia, Pennsylvania. Many additions from Neotropical region since early 1950's. A catalogue of types as of 1931, listed 24 holotypes and 700 "type lot" materials. The latter were mainly of Japanese land snails described by Pilsbry and Hirase, purchased from Hirase. The data available do not permit including this collection in the Tables. Collections of Ortmann, Brooks, Kutchka (= McMillan), Parodiz.

SOUTHERN

FLORIDA STATE MUSEUM (University of Florida, Museum Road, Gainesville, Florida 32601; Fred G. Thompson, Associate Curator,

Malacology Division). Specializes in non-marine mollusks of Mexico (15 000 unstudied lots); southeastern United States, Central America, and Peru (11 000 unstudied lots); some Indonesian (3 000 lots). Collections of F. G. Thompson (25,000, W. Auffenberg (2 000).

THE CHARLESTON MUSEUM (121 Rutledge Avenue, Charleston, South Carolina 29401; Albert E. Sanders, Curator of Natural History). World-wide collections especially strong in South Carolina material. Last major accession in 1943 (William G. Mazÿck collection). Collections of Edmund Ravenel (3 000 lots), William G. Mazÿck (12 700).

EASTERN KENTUCKY UNIVERSITY (Department of Biology, EKU, Richmond, Kentucky 40475; Branley A. Branson, Professor of Biology). Basically a personal collection of non-marine mollusks from Ozarkian and Appalachian areas, some Pacific Northwest.

EASTERN CANADA

NATIONAL MUSEUM OF NATURAL SCIENCES, NATIONAL MUSEUMS OF CANADA (Ottawa, Canada K1A 0M8; A. H. Clarke, Curator of Mollusks, Invertebrate Zoology Section). Major collection of Canadian material, growing very rapidly in recent years with an estimated 85 000 lot backlog. Much material eastern United States. Collections of J. F. Whiteaves (5 000 lots), Robert Bell (500), A. H. Clarke (5 000 pre-1959 collecting), H. D. Athearn (1 000), V. Conde (5 000), W. Grimm (10 000), A. LaRocque (7 000), R. J. Drake (2 000), post-1959 materials worked on by A. H. Clarke and E. L. Bousfield. Materials from Canadian Arctic Expedition (1914-1918), much biological survey materials. Best Arctic marine collection.

MIDDLE WEST

Museum of Zoology, University of Michigan (Ann Arbor, Michigan 48104; John B. Burch, Curator, Mollusk Division). Premier freshwater collection, good world-wide land material, both based on Bryant Walker collection (100 000 lots), extensive field work in recent years for medical malacology projects. No collection details submitted.

FIELD MUSEUM OF NATURAL HISTORY (Lake Shore Drive & Roosevelt Road, Chicago, Illinois 60605; Alan Solem, Curator, Division of Invertebrates). Rapidly expanding collection started in 1938. Excellent Neotropical, Pacific Island, North American, Australian non-marine. Marine collections mainly synoptic, except for Western North America, Florida Keys, Ambon, Chile, Japan. Collections include G. K. Gude (10 000 lots), W. F. Webb (12 000), W. J. Eyerdam non-marine (14 000), James Ferriss (6 000), James Zetek non-marine (2000), E. E. Hand (5000), C. D. Nelson (10000), Sargent (5 000), C. C. Billups (5 000), University of Utah (3 000). Goodwin (3 000), Frederick Stearns (15 000), D'Alte Welch Cuba and Jamaica land (5 000), W. Biese Chilean (5 000), Fred Button (12 000), Tom Burch non-marine (2 000), A. Solem (8 000), F. F. Laidlaw (1 000), A. S. Koto (9 000), DeBoe (2 000), Winte (I 000), George Arnemann (2000), Wegner (1000). Expedition materials from Panama, many Pacific Islands, Australia, New Zealand, Malaya, United States, West Indies.

Museum of Natural History (University of Illinois, Urbana, Illinois 61801; Donald F. Hoffmeister, Director). Mainly non-marine collections assembled by F. C. Baker prior to 1931. Inactive since

then. Collections of D. E. Biddle, A. R. Cahn, L. E. Daniels, A. O. Gross, A. A. Hinckley, H. E. McClure, A. H. Worthen.

ILLINOIS NATURAL HISTORY SURVEY (Natural Resources Building, Urbana, Illinois 61801; John D. Unzicker, Assistant Taxonomist, Section of Faunistic Surveys and Insect Identification). A collection of non-marine mollusks from the Middle West, mostly accumulated through the efforts of F. C. Baker up to the late 1930's. Inactive since then. Collections include T. D. Foster, Frank C. Baker, Nason, and Richardson.

MILWAUKEE PUBLIC MUSEUM (800 West Wells Street, Milwaukee, Wisconsin 53233; Joan Jass, Scientific Assistant, Invertebrate Division). A general collection with no area of specialization.

Ohio State University Museum of Zoology (1813 North High Street, Columbus, Ohio 43210; David H. Stansbery, Curator, Division of Bivalve Mollusks and Carol B. Stein, Curator, Division of Gastropods). Mainly freshwater of Eastern North America, mostly professionally collected, currently under reorganization in new quarters. Collections include C. B. Stein & D. Stansbery (10 000 lots), David T. Jones (3 000), Homer Price northwest Ohio land snails (3 000), Charles Oehler (2 000), L. G. Yates non-marine, Henry Moores, Kenneth Wood freshwater from Lake Erie (1 000). A continuing program of one to two months each year in the field sampling the vanishing Eastern North America freshwater fauna.

GREAT PLAINS

University of Nebraska State Museum (14th and U Streets, University of Nebraska, Lincoln, Nebraska 68508; Harvey L. Gunderson, Curator of Zoology). All uncatalogued, no major specialization.

ROCKY MOUNTAINS

UNIVERSITY OF COLORADO MUSEUM (Boulder, Colorado 80302; Shi-Kuei Wu, Curator of Zoological Collections). Major Rocky Mountain non-marine, many California marine mollusks. Inactive from 1933-1973). Collections of J. H. Johnson, P. Robinson, Woodrow W. Reynolds, Julius Henderson, Mitchell, Hemphill, Oldroyd, Hannibal.

TEXAS AND SOUTHWEST

FORT WORTH MUSEUM OF SCIENCE AND HISTORY (1501 MONTGOMERY, Fort Worth, Texas 76107; W. L. Pratt, Jr., Assistant Curator of Science, Natural Science Department). Texas land snails, 3 100 lots with 26 000 specimens, a few freshwater lots.

University of Texas at El Paso (Museum of Arid Lands Biology, Department of Biological Sciences, University of Texas at El Paso, El Paso, Texas 79968; Artie L. Metcalf). Land snails of Southwestern United States, especially southern New Mexico and western Texas. About 3 650 catalogued lots and 1 000 uncatalogued.

DALLAS MUSEUM OF NATURAL HISTORY (P.O. Box 26193, Fair Park Station, Texas 75226; Richard W. Fullington, Curator, Invertebrate Zoology). A new collection of about 3 600 lots, apparently mainly of non-marine mollusks from the Southwestern United States.

Invertebrate Museum, Department of Biological Sciences, University of Arizona (Tucson, Arizona 85721; Richard L. Reeder, Curatorial Assistant). Mollusks from Southwestern United States, plus northwestern Mexico (non-marine) and Gulf of California (marine).

CALIFORNIA

San Diego Natural History Museum (P.O. Box 1390, San Diego, California 92212; George E. Radwin, Curator, Department of Marine Invertebrates). Worldwide collection, strongest in tropical Eastern Pacific, several family groups of marine mollusks well represented. Collections of H. N. Lowe, A. M. Strong, Fred Baker, C. R. Orcutt, Henry Hemphill, Joshua L. Baily, Jr., J. F. Anderson, Viola Bristol, C. L. Cass, M. G. Beckwith, G. D. Porter, Arthur F. Fischer, Clara K. Graham, Kate Stephens, D. R. Shasky (part), V. D. P. Spicer, F. H. Wolfson, F. Button (part), F. W. Kelsey, Carl Hubbs, Anthony D'Attilio. Several Gulf of California and Galapagos expeditions.

Los Angeles County Museum of Natural History (900 Exposition Boulevard, Los Angeles, California 90007; James H. McLean, Curator, Section of Invertebrate Zoology). Especially Eastern Pacific marine mollusks, including Hancock Collection from University of Southern California. Report 241 primary types and 346 paratype lots. Other collections include George Willett (4000 lots), Fred Lewis (2000 lots), Twila Bratcher (700), Thomas Burch (10000), Crawford Cate (5000), Howard Hill (10000), Earl Huffman (10000), James McLean (8000), Wendel Gregg (6900), Ruth Richmond (1300), Albert Shershow (5500). All Hancock expedition materials (except bivalves), much cruise material from Eastern Pacific, Marincovich from Chile.

Santa Barbara Museum of Natural History (2559 Puesta del Sol Road, Santa Barbara, California 93105; F. G. Hochberg, Curator, Department of Invertebrate Zoology). Eastern Pacific marine mollusks. Collections of Gale Sphon (1 000 lots), Faye Howard (20 000), Jean Wilkins (8 000), L. G. Yates (5 000), Frank Van Den Bergh (5 000), George MacGinitie (1 000).

STANFORD UNIVERSITY (Department of Geology, Stanford University, Stanford, California 94805; A. Myra Keen, Curator Emeritus of the Cenozoic Collection). Marine mollusks of Western North and Central America, also Philippine Islands. No paid curator since 1970. About 155 primary types, 350 lots of paratypes. Collections of Annie Law, Henry Hemphill (9 000 lots), Harold Hannibal, T. S. and I. Oldroyd (10 000 sets), Delos and Ralph Arnold, Sarah Mitchell, James Zetek marine, Eric Jordan, H. G. Schenck, expeditions to Gulf of California and Puget Sound.

California Academy of Sciences (Golden Gate Park, San Francisco, California 94118; Peter U. Rodda, Curator, Department of Geology). Especially strong in Eastern Pacific marine and Galapagos, Baja California and Galapagos land mollusks, Western North American land. Collections include Henry Hemphill, D. D. Baldwin, E. & L. Allyne, E. Rixford, D. L. Frizzell, W. J. Raymond, A. Sorenson, Ruth Coats, Josiah Keep, Louis Fletcher, Leo Hertlein, G. D. Hanna, F. M. Anderson, Allyn G. Smith, Barry Roth. Expedition materials include many to Gulf of California and Galapagos, Templeton Crocker, New York Zoological Society of Eastern Pacific, and Point Barrow, Alaska.

NORTH-WEST

THOMAS BURKE MEMORIAL WASHINGTON STATE MUSEUM (University of Washington, Seattle, Washington 98195; Alan J. Kohn,

Adjunct Curator of Malacology). Specializes in marine mollusks of Alaska to Oregon and tropical Indo-West Pacific. No cataloguing since 1968. Collections of Trevor Kincaid, P. B. Randolph, Ralph Jones, A. J. Kohn.

WESTERN CANADA

UNIVERSITY OF BRITISH COLUMBIA (Vancouver 8, British Columbia, Canada; Ian McT. Cowan, Professor of Zoology. Specializes in northwest coast of North America, particularly British Columbia, mostly collected by Dr. Cowan.

HAWAII

Bernice Pauahi Bishop Museum (P.O. Box 6037), Honolulu, Hawaii 96818; Yoshio Kondo, Malacologist, Division of Malacology . Specialized collection of non-marine mollusks from Polynesia, Micronesia and parts of Melanesia without equal. Excellent Hawaiiàn, Line Island, and Micronesian marine collections. Collections include Gulick, Garrett, Pease, Cooke, Baldwin, Ancey, W. A. Bryan, Castle, Conde, Crampton, Emerson, Fulton, Harris, Judd, Lyman, McInerny, Meinecke, Merriam, Mighels, Munro, Moss, Newcomb, Oswald, Rixford, Spalding, Thaanum, Thurston, Thwing, Wilder, Williams, Arnemann, Blackman, Cheatham. Expedition materials are Pacific Entomological Survey of Marquesas (1929-1932), Mangarevan Expedition (1934), Samoan (1926), Micronesian (1935-1936), Lapham Fiji (1938), Western Samoa (1940), work in Solomons, Bismarcks, Masatierra, New Hebrides, Tonga, Samoa, Loyalty, Fiji, Society, and Marquesas (1966-1971).

APPENDIX II

MOLLUSK COLLECTION SURVEY

The attached questionnaire is part of a survey being carried out by the Council of Systematic Malacologists for the Association of Systematics Collections. It attempts to identify the malacological collection resources of the Americas, in regard to location, size, strengths, and degree of current use. The information will be used to prepare an overall assessment of the malacological collection resources available for systematic and other information uses; as partial raw data for identification of National Resource Collections by the Association of Systematics Collections; and to aid in preparation of a handbook outlining the systematic resources of the United States that will encompass many disciplines.

There are two parts to this survey. The first part should be answerable quickly and with minimal research effort. The second portion will require an expenditure of time, but the data requested will enable compiling a reasonably accurate total picture of malacological resources. Development of a total picture is a necessary preliminary to discovering major gaps in area or group coverage, to developing recommendations for additional support to collections and collecting activities, and to make known to the non-systematic community the extent and variety of collection resources.

Your cooperation in completing and returning AT LEAST THE FIRST PART OF THIS QUESTIONNAIRE NO LATER

THAN NOVEMBER 15TH will be greatly appreciated. The material should be sent to:

Dr. Alan Solem Curator of Invertebrates Field Museum of Natural History Lake Shore Drive & Roosevelt Road Chicago, Illinois 60605

Name of Institution

Mailing address

Name and title of respondee

Name of administrative unit in charge of mollusk collection

Name, title, academic degrees of person currently in charge of mollusk collection

If not a specialist on mollusks, please indicate field or research interest of person in current charge of collection. What was the last date on which a mollusk specialist was in charge of the collection? Who was this person?

Information on the collection

Mollusk collections generally are catalogued by *lots*. A lot is all material of one species collected at one locality at one time. It can contain 1 or 10 000 specimens. It would help greatly if you could report numbers in accord with the above definition. If this is impossible, please indicate on other sheets the method of filing material and how your estimates of collection size were derived.

What is the total number of catalogued sets of mollusks

What is the estimated number of uncatalogued lots of mollusks What is the estimated total number of specimens (if known); how was this estimate obtained; if organized in a different way, please specify

Please describe briefly the major geographic area covered by the mollusk collection, whether it specializes in certain groups (please name), or list any outstanding aspects of the collection.

The following questions attempt to determine recent patterns of collection growth:

What is the average annual number of lots added during 1968 through 1972

What is the average annual number of lots from professional field work or expeditions

What is the average annual number of lots by purchase

What is the average annual number of lots from miscellaneous sources, gifts, exchanges, etc.

Date of last significant addition to collection (year)

Information on support facilities

Is a library on Mollusca actively maintained for use with the collection

State the number of mollusk journals now being subscribed to How many scientists (curators) are employed full-time How many supporting staff work with the collection:

Custodian

Secretary Technical Assistant

Full time or Part time (%)

Research Assistant Others (specify)

Are other research labs associated directly with the collection, such as karyology, immunology, electrophoresis, etc. Please indicate the

types and personnel associated on separate sheets, if needed. How many microscopes are available for use with the collection:

Dissecting ; compound ; other (specify)

What is the annual, non-salary budget, available for support of the collection and non-grant supported research and travel activities of the staff, i.e., the dollar support, except for salaries, given by the institution:

Under \$1 000 ; \$1 000-\$2 000 ; \$2 000-\$4 000 ; \$4 000-\$8 000 ; \$8 000-\$12 000 ; over \$12 000 ; sthis being supplemented by research grants ; special

Is this being supplemented by research grants restricted endowments ; private gifts

Information on advanced education uses

How many PhD students have either based their theses primarily on this collection or had a staff scientist chair or serve as committee member in the years 1970, 1971, 1972 and 1973

Please name recent PhD recipients in malacology during these years Indicate ways, if any, collection is used in college or university research or teaching

PART TWO

This section is designed to provide detailed information on the strengths of individual collection coverage. When data is combined from all museums and major private collections, the first rough outline of overall strengths and weaknesses of malacological collections can emerge. Many of the following questions may not be applicable or impossible to answer without advice of a professional malacologist. If you are uncertain of how to answer a question,

please so indicate and return incomplete. Any information will be helpful in roughing out the national picture of collection data.

Origin of mollusk materials

Names of scientists or amateur collectors whose material is deposited in your collection. If known, include approximate number of lots from each source.

Major field trips or expeditions whose materials are deposited in this collection.

Areas of specialization

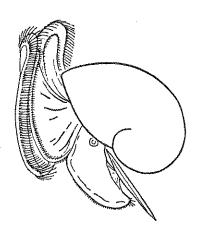
What percentage of collection is: marine ; fresh-water terrestrial

On the basis of your comparative knowledge of American molluscan collections, which areas of the collection do you feel represent one of the "five best collections" among all those in the United States. This can be either geographic or systematic in scope. For example, it could be "top collection of Conidae," "excellent Ohio drainage unionids," "one of most comprehensive Florida marine,"

Geographic coverage of collection

On the basis of your knowledge of the collection, would you indicate the extent of available materials for each area. This will have to be partly synoptic, but will help identify what areas are poorly represented in extant collections.

[The geographic charts of the questionnaire are not reproduced here]



THE VELIGER is open to original papers pertaining to any problem concerned with mollusks.

This is meant to make facilities available for publication of original articles from a wide field of endeavor. Papers dealing with anatomical, cytological, distributional, ecological, histological, morphological, physiological, taxonomic, etc., aspects of marine, freshwater or terrestrial mollusks from any region, will be considered. Even topics only indirectly concerned with mollusks may be acceptable. In the unlikely event that space considerations make limitations necessary, papers dealing with mollusks from the Pacific region will be given priority. However, in this case the term "Pacific region" is to be most liberally interpreted.

It is the editorial policy to preserve the individualistic writing style of the author; therefore any editorial changes in a manuscript will be submitted to the author for his approval, before going to press.

Short articles containing descriptions of new species or lesser taxa will be given preferential treatment in the speed of publication provided that arrangements have been made by the author for depositing the holotype with a recognized public Museum. Museum numbers of the type specimens must be included in the manuscript. Type localities must be defined as accurately as possible, with geographical longitudes and latitudes added.

Short original papers, not exceeding 500 words, will be published in the column "NOTES & NEWS"; in this column will also appear notices of meetings of the American Malacological Union, as well as news items which are deemed of interest to our subscribers in general. Articles on "METHODS & TECHNIQUES" will be considered for publication in another column, provided that the information is complete and techniques and methods are capable of duplication by anyone carefully following the description given. Such articles should be mainly original and deal with collecting, preparing, maintaining, studying, photographing, etc., of mollusks or other invertebrates. A third column, entitled "INFORMATION DESK," will contain articles dealing with any problem pertaining to collecting, identifying, etc., in short, problems encountered by our readers. In contrast to other contributions, articles in this column do not necessarily contain new and original materials. Questions to the editor, which can be answered in this column, are invited. The column "BOOKS, PERIODICALS, PAMPHLETS" will attempt to bring reviews of new publications to the attention of our readers. Also, new timely articles may be listed by title only, if this is deemed expedient.

Manuscripts should be typed in final form on a high grade white paper, 8½" by 11", double spaced and accompanied by a carbon copy.

A pamphlet with detailed suggestions for preparing manuscripts intended for publication in THE VELIGER is available to authors upon request. A self-addressed envelope, sufficiently large to accommodate the pamphlet (which measures $5\frac{1}{2}$ " by $8\frac{1}{2}$ "), with double first class postage, should be sent with the request to the Editor.

EDITORIAL BOARD

Dr. Donald P. Abbott, *Professor of Biology* Hopkins Marine Station of Stanford University

DR. WARREN O. ADDICOTT, Research Geologist, U. S. Geological Survey, Menlo Park, California, and Consulting Associate Professor of Paleontology, Stanford University

DR. JERRY DONOHUE, Professor of Chemistry
University of Pennsylvania, Philadelphia, and
Research Associate in the Allan Hancock Foundation
University of Southern California, Los Angeles

Dr. J. Wyatt Durham, Professor of Paleontology University of California, Berkeley, California

Dr. E. W. Fager, *Professor of Biology* Scripps Institution of Oceanography, La Jolla University of California at San Diego

Dr. Cadet Hand, Professor of Zoology and Director, Bodega Marine Laboratory University of California, Berkeley, California

DR. JOEL W. HEDGPETH, Resident Director Marine Science Laboratory, Oregon State University Newport, Oregon

Dr. A. Myra Keen, Professor of Paleontology and Curator of Malacology, Emeritus Stanford University, Stanford, California DR. VICTOR LOOSANOFF, Professor of Marine Biology Pacific Marine Station of the University of the Pacific

Dr. John McGowan, Associate Professor of Oceanography

Scripps Institution of Oceanography, La Jolla University of California at San Diego

Dr. Frank A. Pitelka, Professor of Zoology University of California, Berkeley, California

Dr. Robert Robertson, Pilsbry Chair of Malacology Department of Malacology

Academy of Natural Sciences of Philadelphia

Dr. Peter U. Rodda, Chairman and Curator, Department of Geology California Academy of Sciences, San Francisco

MR. ALLYN G. SMITH, Research Associate Department of Geology California Academy of Sciences, San Francisco

Dr. Ralph I. Smith, *Professor of Zoology* University of California, Berkeley, California

Dr. Charles R. Stasek, Bodega Bay Institute Bodega Bay, California

DR. T. E. THOMPSON, Reader in Zoology University of Bristol, England

EDITOR-IN-CHIEF

DR. RUDOLF STOHLER, Research Zoologist, Emeritus University of California, Berkeley, California

ASSOCIATE EDITOR

Mrs. Jean M. Cate Sanibel, Florida