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History of Invertebrate Zoology at the California Academy of Sciences

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From its inception as an institution in 1853, the California Academy of Sciences has maintained a strong interest in invertebrate zoology, irrespective of the fact that the integrity of a separate department of invertebrate zoology has only existed for part of the institution's 150-year history. Although the Academy's natural history collections and library were almost completely destroyed in the San Francisco earthquake and fire of 1906, rapid re-growth and expansion occurred during the 20th century.

Today, the California Academy of Sciences maintains four distinct collections in the Department of Invertebrate Zoology and Geology: recent invertebrates (both wet and dry collections), fossils (predominantly invertebrate), diatoms (both fossil and recent), and minerals.

The department houses approximately half a million specimen lots of recent invertebrates representing worldwide geographic scope but with emphasis on the Pacific Basin and the Indian Ocean. The collections are mostly from the marine realm, but also well represented are mollusks and crustaceans from freshwater and terrestrial habitats. The taxonomic groups represented by the largest segments of the collections are sponges, coelenterates, mollusks, crustaceans, echinoderms, and urochordates.

Historically significant collections currently maintained by the department include those of John Steinbeck and Edward Ricketts from the 1940 Gulf of California Expedition, which formed the basis for the book *The Sea of Cortez*. Other collections are from Hopkins Marine Station, the Natural History Museum of Stanford University, and the University of California, Berkeley, as well as the 1921 *Silver Gate* Expedition, 1932–1938 *Zaca* Expeditions, the U.S. Navy-sponsored *Mulberry* Continental Shelf Survey of 1949–1950, the 1953 *Orca* Expedition, and the 1964 Galápagos International Scientific Project.

CONTENTS

Invertebrate zoology, the study of animals without backbones, traces its roots in western societies to the marine studies of the Greek philosopher Aristotle (384–322 BC). However, it has only been since the first half of the nineteenth century that our understanding of the biology and evolutionary relationships of these often beautiful or seemingly strange and cryptic organisms has flourished.

The invertebrates represent a paraphyletic assemblage of staggering proportions. As a 1980 California Academy of Sciences in-house report stated, "The lumping together of all animals without backbones into a single heterogeneous group, The Invertebrata, is more an anthropomorphic anachronism than a scientific actuality." Pearse et. al. (1987) state, "Nearly two million species of living organisms have been described and named. The actual number may be closer to 10 to 20 million…most species of living things are multicellular organisms in the Kingdom Animalia." Only about 4–7% of the animal kingdom is composed of vertebrates (one part of one phylum), thus leaving the study of the other approximately 95% (representing all of the more than 30 presently recognized phyla) to invertebrate zoologists (Williams 1996; Brusca and Brusca 1990). Approximately one million species of invertebrates have been described, with estimates of five to thirty million more still undescribed at present (Wilson 1988). In 1875, Alfred Russel Wallace wrote concerning his book on zoogeography, "I think I must call the Book, - 'The Geographical Distribution of Land Animals' or the dredging men will be down upon me, for leaving out the 'most important part of the animal kingdom' etc. etc." (Raby 2001:215).

Paradoxically, most natural history research institutions and university biology departments devote more faculty, facilities, and curriculum to vertebrate zoology than to invertebrate studies. As an example of this, only two Academy research departments are currently dedicated to the study of invertebrate animals — Entomology, and Inverterbrate Zoology and Geology (IZG), while no less than five departments are committed to vertebrate zoology — Ichthyology, Aquatic Biology, Herpetology, Ornithology and Mammalogy, and Anthropology.

Nevertheless, the California Academy of Sciences has been actively involved in research regarding invertebrate zoology since the founding of the institution in 1853, over one hundred and fifty years ago. Much of what we know concerning the history of invertebrate zoology research at the Academy is contained in unpublished departmental reports (Anonymous, ca. 1980; Anonymous, ca. 1985; Chivers 1978; Miller 1960a, b; Rodda 1987; and Smith 1964). In addition, relevant events that occurred from the period of the Academy's founding to the time of the great San Francisco earthquake (1853-1906), are documented in Leviton and Aldrich (1997).

The Conchologists (1853-1970)

The close association between the disciplines of Geology and Invertebrate Zoology goes back to the early days of the Academy when invertebrate collections made from living material were accumulated mostly as comparative resources to supplement the fossil collections. During the mid to late nineteenth century, invertebrate paleontology and conchology (or malacology) did not present hard and fast disciplinary boundaries, as several notable conchologists were authorities in both disciplines. Included here were two Civil War veterans John B. Trask and James G. Cooper (Figs 1A–B). As a result of the initial efforts by these two productive individuals, a tradition of research in malacology and paleontology has been subsequently established at the Academy, with such work continuing to be published.

No less than ten curators aligned with paleontology and geology at the Academy have used conchology in their research, collected and compared fossil and recent shells, or have studied living mollusks as part of their research programs. These curators will be treated in greater detail in forthcoming paper on the history of geology at the Academy. Thus, only their contributions to invertebrate zoology at the Academy are discussed here.

John Boardman Trask (1824–1879) (Fig. 1A), one of the original founders of the Academy, discovered the first Cretaceous fossil from the new state of California (Trask 1856). Throughout his association with the Academy, he served variously as Curator of Conchology, Curator of Geology and Mineralogy, and Curator of Radiata, as well as being a founder and life member of the Academy. In addition to his work on fossil and recent mollusks, Trask (1857) also described new taxa of Pacific coast invertebrates including hydroids and bryozoans (Fig. 4A, D). A good account of Trask and the Academy is found in Leviton and Aldrich (1982, 1997).

Lewis Warrington Sloat (1815–1886), an amateur conchologist and a fellow founder of the Academy along with John Trask, was the original recording secretary of the Academy, and was elected Curator of Conchology in 1856. Sloat's contribution of a cabinet of mollusk shells from Baja California served as part of the core that began the Academy's collections. A brief biographic sketch of Sloat is that of Hertlein (1956:7). In that biography, Hertlein describes the influence to the Academy by Sloat the amateur conchologist, "No doubt the Secretary's interest in this field was a contributing factor in the Academy's decision to accumulate a collection of shells, which activity began with the inception of that institution and has continued to the present day, interrupted, unfortunately, by the total loss of the collection during the earthquake and fire in 1906. A few years after the founding of the Academy, Sloat went east, and little is known of his subsequent activities, nor is any photograph of him available in any biographical notice."

James G. Cooper (1830–1902) (Fig. 1B) contributed seminal works on the biogeography and systematics of western North American marine and terrestrial gastropods (Cooper 1886–1887). He published more than forty papers on malacology from 1859 to 1896, and is credited with the discovery of at least one hundred and sixteen new molluscan taxa. He was praised in writing by the noted malacologist and contemporary of Cooper's, Philip P. Carpenter, as a "zealous zoölogist." (Raymond 1902:75.) Cooper subsequently became the Academy's director, as well as a curator of recent and fossil shells. A biography of Cooper by W.O. Emerson was published in 1902.

William More Gabb (1839–1878) (Fig. 1C) was a member of the California State Geological Survey during the 1860s, which was headed by Josiah Dwight Whitney. This period coincided with the American Civil War, in which distant California was happily excluded from the military conflict. Gabb was elected Curator of Paleontology at the Academy on 6 January 1862. His appointment occurred at the same meeting at which John Trask was elected Curator of Conchology and James Cooper was elected Curator of Zoology. Gabb published on fossil and recent mollusks,

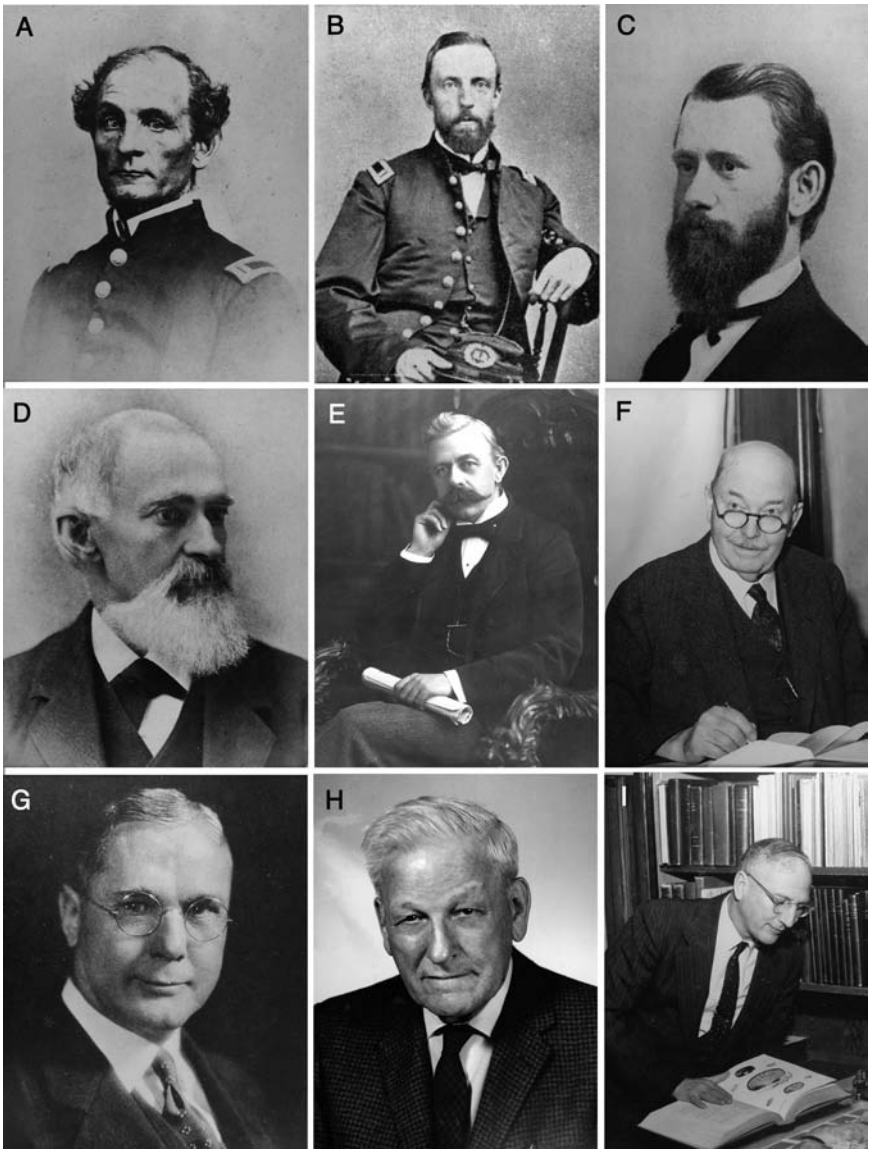

FIGURE 1. Conchology and Invertebrate Paleontology at the Academy. A. John B. Trask. B. James G. Cooper. C. William More Gabb. D. Robert Edward Carter Stearns. E. Josiah Keep. F. Frank Marion Anderson. G. Roy Ernest Dickerson. H. G Dallas Hanna. I. Leo G. Hertlein. Photographs courtesy Department of Invertebrate Zoology and Geology, California Academy of Sciences.

Cretaceous formation subdivisions in California, and other invertebrate groups such as pennatulacean coelenterates (Gabb 1862, 1864) (Williams 1999:25, 27).

Robert Edwards Carter Stearns (1827–1909) (Fig. 1D) served in a variety of capacities. He was deputy clerk of the Supreme Court of California in 1862, secretary of the California State Board of Harbor Commissioners in the 1860s, Secretary for the University of California in 1870s (where he acted as business executive for U.C. under the presidency of Daniel Gilman). He participated in research for the United States Fish Commission in 1882, and with William Stimpson made large

collections of invertebrates from Florida for the Smithsonian Institution. He was appointed paleontologist to the United States Geological Survey by Major John Wesley Powell in 1884, and Assistant Curator of Mollusks at the Smithsonian by Spencer Baird during the same period. In his obituary of Stearns, Dall (1909:72) reports, "He (Stearns) was an enthusiastic supporter of the California Academy of Sciences in its early days, and after the earthquake of 1868, when disaster threatened the Society, he, with Professor J.D. Whitney and a few other friends, stood between it and dissolution." Stearns replaced John Trask as curator of conchology in 1865 and became director of the Academy's museum in 1868. His relationship with the Academy is covered by Leviton and Aldrich (1997). During his productive career, Stearns published numerous papers on recent mollusks as well as other invertebrate groups including octocorallian coelenterates (Fig. 4B, E, H, N) (Stearns 1873a–d, 1880) (Williams 1999:25, 28).

William G.W. Harford (1825–1911) succeeded Stearns in 1867 as curator of conchology and then served as museum director from 1876 to 1886.

Josiah Keep (1849–1911) (Fig. 1E) was elected a resident member of the Academy in 1878 and appointed Curator of Conchology in 1881. In 1885, he became Professor of Natural Sciences at Mills College. Keep was also instrumental in the development of the Pacific Grove Museum. For a biography of Josiah Keep, see Dall (1911a).

Frank Marion Anderson (1863–1945) (Fig. 1F) was appointed an honorary curator of paleontology at the Academy in 1903. His position was also at times referred to as Curator of Invertebrate Paleontology. Anderson was largely responsible for the recollection and rebuilding of the fossil and recent shells and invertebrate collections during the aftermath of the 1906 earthquake. Rodda (1987) reported, "Immediately after the fire, F.M. Anderson, then Curator of Paleontology, entered the gutted and dangerous Academy structure and recovered many fire-damaged fossils including several type specimens of ammonite species he had described. This fragile material became the nucleus of the new collections that literally rose, phoenix-like, from the ashes." Unlike most of the Academy's molluscan paleontologists, Anderson did not work on recent molluscan or other invertebrate taxa but published solely on geological topics including mollusks as fossil indicators and stratigraphy, petroleum geology, Triassic volcanoes, and Neocene deposits.

Roy Ernest Dickerson (1877–1944) (Fig. 1G) succeeded Frank Anderson as Curator of Paleontology in 1916, the same year the Academy moved into its new facility in Golden Gate Park. Dickerson was in turn succeeded by G Dallas Hanna as Curator of Paleontology in 1919. During Dickerson's limited time at the Academy, he was a prolific author. He published on fossil faunas of the Tertiary, climatic zones of the Eocene, ancient Panama canals, influence of climate on Oligocene faunas, evolution of marine molluscan faunas, and Tertiary and Quaternary history of the northern San Francisco Bay region.

Arguably, no other scientist in the Academy's history made major contributions in such a wide range of fields as G Dallas Hanna (1887–1970) (Fig. 1H) called "Doc" or "Doc Hanna" by his associates. Regarding his name, Miller (1962:5) explained,

> His [Hanna's] first name is G, just like that, no period. This causes no end of confusion among editors and bibliographers. Acquaintances of fifty years' standing have been known to call him Dallas, but most of his friends and colleagues skirt the question of which name to use by comfortably addressing him as 'Doc'.

Hanna's wide-ranging contributions and interests included wildlife and fisheries biology; optics; planetarium projector design and construction; photographic color printing; microfossils as indicators of oil rich sediments; systematics of diatoms, radiolarians, and silicoflagellates; invertebrate paleontology; and malacology. For an excellent biography of Hanna, see Miller (1962).

Leo George Hertlein (1898–1972) (Fig. 1I) also had a prolific forty-three year career as a cura-

tor of paleontology at the Academy. He was first hired as assistant curator in 1926; he retired as Curator of Paleontology in 1969. He maintained a close association with fellow curator G Dallas Hanna, as the pair co-authored many papers. Hertlein's interests were mainly in Cenozoic invertebrate paleontology (mollusks, echinoids, and brachiopods), and recent molluscan faunas of the eastern Pacific (bivalves and gastropods). He was a highly productive contributor to the fossil and recent molluscan literature, having authored over one hundred and fifty papers, including five hundred new taxa. He had a reputation for carefully produced research and curation. Addicott (1970:41) praises Hertlein's work,

> Hertlein's publications stand as models of thorough and painstaking scientific investigation, special qualities that have characterized all aspects of his scientific career. The high quality of his reports, at once obvious to anyone who has had occasion to refer to them, is the result of meticulous searching of all pertinent literature, and, wherever possible, solicitation and careful weighing of the views of associates…As a curator, his high standards are clearly reflected by the expertly and meticulously maintained invertebrate type collections in the Academy's Department of Geology as well as by the carefully arranged and labeled general collections of fossil and living invertebrates."

Biographies of Hertlein are by Emerson (1973) and Addicott (1970).

Invertebrate Zoology
1853 to 1906

The Academy's first constitution, which was adopted on 16 May 1853, specified the appointment of seven officers "and three or more curators." The three original curators elected at the subsequent meeting of 23 May 1853 were Albert Kellogg, Edwin R. Campbell, and Henry Gibbons. These appointments were curators-at-large as no research departments were identified at that time. The first departments were defined at the meeting of 6 January 1855, when William Orville Ayres was elected Curator of Zoology, W.J. Andrews as Curator of Botany, and William P. Gibbons as Curator of Geology and Mineralogy. By 1875, the Department of Zoology had been transformed and expanded into four research departments. These were Crustacea, Radiates and Ichthyology (William N. Lockington, Curator); Conchology (William G.W. Harford, Curator); Ornithology (F. Gruber, Curator), and Entomology (Henry Edwards, Curator). The two other departments were Paleontology and Mineralogy (Henry G. Hanks, Curator) and Botany (Henry N. Bolander, Curator), making a total of six research departments at the Academy by the mid-1870s. The recent invertebrate collections were dispersed among three departments — Crustacea, Radiates and Ichthyology; Conchology; and Entomology. During the 1880's, interest in invertebrates other than mollusks and insects declined. By the time the Academy moved into its elegant new facilities on Market Street in 1891, only three departments and curators were recognized — Entomology (H.H. Behr, Curator), Ornithology (L.M. Loomis, Curator), and Botany (Alice Eastwood, Curator).

Regarding invertebrate zoology during the early period of the Academy's history, Rodda (1987) writes, "During these early years there was no department of invertebrate zoology, and collections such as are now in I.Z. & G. (Invertebrate Zoology and Geology) were cared for by departments variously called Geology, Mineralogy, Paleontology, Conchology, and Zoology. Curators for these departments were honorary appointments, serving without pay."

Many important monographic studies, covering taxa other than mollusks, were conducted or published under the auspices of the Academy during the first half century of the institution's existence (see Fig. 4). Included here were Trask's 1857 paper on "zoophytes," thirteen treatments on crustaceans by William Neale Lockington (1875–1878), an account of marine annelids by Herbert

P. Johnson (1897), a treatment on gordioid nematomorphs by Thomas H. Montgomery (1898), six works on oligochaetous annelids by Dr. Gustav Eisen (1888–1900), studies on entoprocts by Alice Robertson (1900), and a large monograph on crustaceans by Samuel J. Holmes (1900).

Other notable invertebrate studies published by the Academy in the latter half of the nineteenth century included Robert E.C. Stearns (1873b–d) on nudibranch mollusks, pennatulacaean coelenterates, and shelled gastropods; William Healey Dall (1873) and James G. Cooper (1894) on shelled molluscs; William Emerson Ritter (1893) on tunicates (Fig. 4M), and William G.W. Harford (1877a, b) on crustaceans of the San Francisco Bay area.

William Neale Lockington (1840–1902)

William Lockington (Fig. 2B) became a member of the California Academy of Sciences in 1873. In 1881, the Academy Council appointed him as Curator of Ichthyology and Crustacea. He was a prolific author of many papers in invertebrate zoology, including sponges and echinoderms, but mainly crustaceans. In fact, Lockington, together with Samuel J. Holmes, can be considered as the pioneers of California crustacean taxonomy. Lockington also published on vertebrates, including sharks and rays, California market fishes, snakes, and birds. Three other papers of diverse interests, read by him at Academy meetings between 1877 and 1880, were entitled, "On the Evolution of Nerves and Nerve Tissue," "Claims of Zoology," and "Is Evolution Immoral?" He also published on subjects other than strictly scientific ones: *Day-Dreams* (1880) and *Walks Round San Francisco* (1878).

Some of his work in ichthyology sparked controversy when Theodore Gill, Professor of Zoology at George Washington University, accused Lockington, as he had on a previous occasion the Academy's William O. Ayres, of describing old species as new. The Academy's museum director, William Harford, defended the works of Lockington and Ayres at the Academy meeting of 21 November 1881. He also noted that Ayres had been so outraged by the controversy that he quit working in ichthyology altogether! (Leviton and Aldrich 1997:239).

Lockington was also a prolific collector, and added significantly to the Academy's collections of reptiles, fishes, and crustaceans, in the 1870s and 80s. He died at Worthing, Sussex, England at the age of sixty-two.

William G.W. Harford (1825–1911)

William Harford (Fig. 2A), as noted earlier, took over the curatorship in conchology from Robert Stearns (Fig. 1D) in 1867, and served as the Academy's museum director from 1876–1886. Among other contributions, Harford (1877a, b) described a new genus and three new species of crustaceans from Angel Island and Tomales Bay.

The best description of Harford's life is the brief but delightful account by Dall (1911b:8):

> We regret to record the death in Alameda, California, March 1st, of W.G.W. Harford, well known to all Pacific Coast naturalists. Mr. Harford was in his eighties and, up to a very recent date, in the possession of all his faculties. He had been the associate of the Trask, Veatch, Voy, Newcomb, Stearns, and other pioneer Pacific Coast naturalists, and for a long time kept 'bachelor's hall' in a small shack on Telegraph Hill, with the late beloved botanist Dr. A. Kellogg; practically realizing the Scotch ideal of high thinking 'on a little oatmeal.' He was long a curator at the Academy of Sciences, San Francisco, and earned a precarious livelihood by collecting seeds, plants and other objects of Natural History, and by minor appointments at the University and other scientific institutions. He was especially interested in Conchology and was appointed naturalist to the U.S. Coast Survey expedition to Alaska in 1867 under the direction of Professor George Davidson, his report is

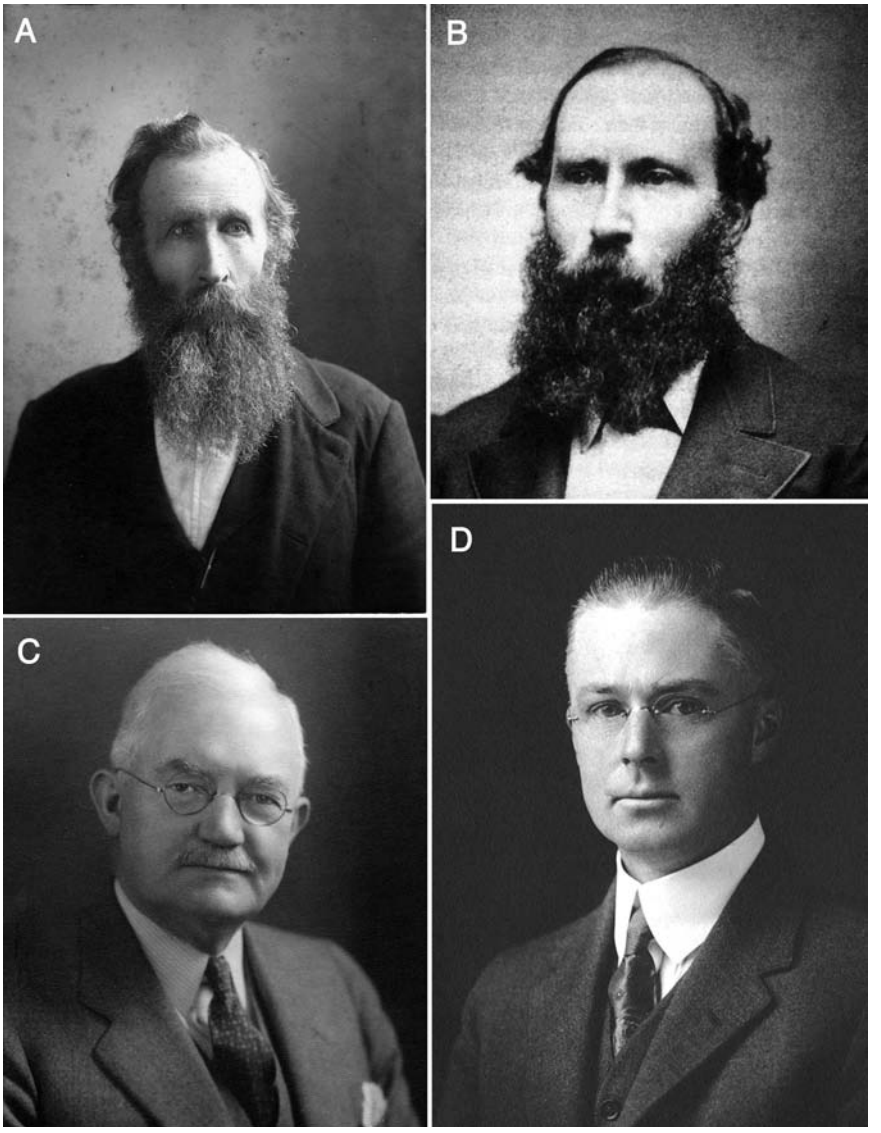

FIGURE 2. A. William G.W. Harford. B. William Neale Lockington. C. Frank Mace MacFarland, Professor of Histology, Leland Stanford Junior University. D. Walter Kenrick Fisher. Photographs courtesy California Academy of Sciences.

printed in the *Annual Report of the U.S. Coast Survey for 1867*, Appendix 18.

He printed little and his life was devoted to helping others in their researches. Over six feet in height, of a Lincolnian gauntness, and a pioneer style of luxuriant beard and bushy eyebrows, his familiar figure will be missed by the old members of the California Academy, to whose meetings he was perennially faithful.

Gustav Augustus Eisen (1847–1940)

Regarding invertebrate zoology, two significant administrative events took place at the Academy after the founding of Stanford University's Hopkins Marine Station in the early 1890s.

Dr. Gustav Eisen (Fig. 3) was appointed Curator of Marine Invertebrates in 1899, even though the founding of the Department of Invertebrate Zoology did not take place until 1914.

Gustav Eisen was born in Stockholm, Sweden in 1847. He graduated from the University of Uppsala in 1873, then came to California to participate in a biotic survey of the state sponsored by the Swedish Academy of Sciences. "So impressed was the young explorer with the wilderness beauty and untold possibilities for scientific exploration in this state that he decided to make California his home." (Anonymous 1940:3). Eisen became a member of the Academy in 1874, a Life Member in 1883, and an Honorary Member (the Academy's highest honor) in 1938. In 1893, the Academy appointed him Curator of Archaeology, Ethnology, and Lower Animals. This unusual title reflected the eclectic interests and expertise of the appointee, a testimonial to his varied interests. Sometime prior to 1899, his title was changed to Curator of Marine Invertebrates.

A man of great Humboldtian interests, Gustav Eisen published extensively on art and art history, archeology and anthropology, agronomy and horticulture, history of science, geography and cartography, cytology, and protozoology, as well as marine invertebrate zoology. His publications dealt with specific subjects as diverse as the blood cytology of the California slender salamander, cultural history of the raisin industry, history of Academy expeditions to Baja California, biological studies of figs and caprifigs, the history of the use of glass in art, descriptions of Asian art collections, the history of the use of beads in art, developmental stages of parasitic protozoans, and the

FIGURE 3. Gustavus Augustus Eisen. A. Eisen late in life. B. Eisen (right) examining specimens. C. Eisen, from a painting by Wilford S. Conrow. D. Eisen in middle age. Photographs courtesy California Academy of Sciences.

systematics and anatomy of oligochaetous annelids. Eisen was also responsible for the introduction and propagation of the Smyrna fig and the alligator pear (avocado) to California.

> Few men in a lifetime have either the opportunity or ability to explore the many fields of knowledge in which Dr. Eisen is perfectly at home. Fewer still in this modern age of specialization have those rare qualifications which permit them to attain world renown in an amazing number of diversified fields. His task has been far more difficult, moreover, than that of the great scholars of the sixteenth and seventeenth centuries, by reason of the vast increase in human knowledge. (Anonymous 1940:3).

Along with such luminaries of late nineteenth and early twentieth century conservation as John Muir and Theodore Roosevelt, scientists such as English naturalist Alfred Russel Wallace and the Academy's Gustav Eisen voiced strong opinions regarding the destruction of the largest trees in the world, the Giant Sequoias or Big Trees (*Sequoiadendron giganteum*) and the Coast Redwood (*Sequoia sempervirens*), endemic to California's Sierra Nevada and north coast. Wallace and Muir spent a day together in the redwoods during Wallace's visit to California in 1887. His visit also included travels in the Rocky Mountains of Colorado with Academy curator-to-be Alice Eastwood. Reflecting on his day with Muir and his California travels, Wallace wrote,

> Neither the thundering waters of Niagara, nor the sublime precipices and cascades of Yosemite, nor the vast expanse of the prairies, nor the exquisite delight of the alpine flora of the Rocky Mountains — none of these seem so unique in their grandeur, so impressive in their display of the organic forces of nature, as the two magnificent 'big trees' of California. Unfortunately these alone are within the power of man totally to destroy, as they have been already partially destroyed. Let us hope that the progress of true education will so develop the love and admiration of nature that the possession of these altogether unequalled trees will be looked upon as a trust for all future generations, and that care will be taken, before it is too late, to preserve not only one or two small patches, but some more extensive tracts of forest, in which they may continue to flourish, in their fullest perfection and beauty, for thousands of years to come, as they have flourished in the past, in all probability for millions of years and over a far wider area.

Similarly, Muir wrote,

> Any fool can destroy trees…It took more than 3,000 years to make some of the trees in these western woods…Through all the wonderful, eventful centuries since Christ's time — and long before that — God has cared for these trees, saved them from drought, disease, avalanches, and a thousand straining, levelling tempests and floods; but He cannot save them from fools — only Uncle Sam can do that (Raby 2001:246).

Eisen and the Academy that he represented are in fact credited with early preservation efforts.

> Awed by the grandeur and magnificence of the Sequoias or Big Trees growing in limited numbers along the western slopes of the central and southern Sierra Nevada, and consumed by the desire to protect them for all time against the incursions of commercial lumbermen, Dr. Eisen worked for many years to bring about their conservation. In this worthy effort he asked and received the full support of the California Academy of Sciences, of which he became a member in 1874 and was a Curator from 1893 to 1900. To both the man and the institution is due much credit for the ultimate establishment of Sequoia National Park — a monument to the pioneers of conservation in the West. (Anonymous 1940:3).

Eisen, with the full support of the Academy, also worked for the preservation of Mountain Lake in San Francisco's Presidio military reservation, attempting to save it intact from potential distur-

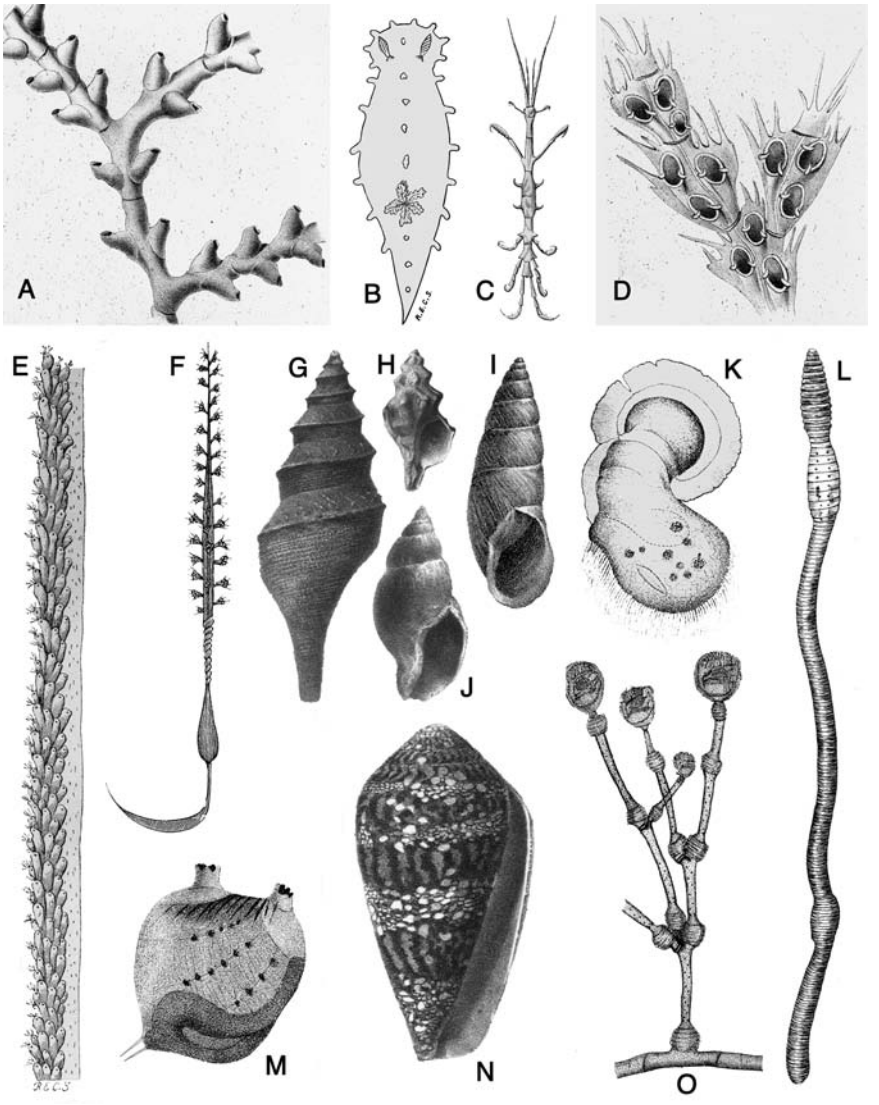

FIGURE 4. Illustrations of invertebrates from early scientific publications by the Academy. A. *Sertularia anguina* Trask, 1857 (Coelenterata: Hydrozoa); from Trask, 1857. B. *Triopa carpenteri* Stearns, 1873, a junior synonym of *Triopha catalinae* (Cooper, 1863) (Mollusca: Nudibranchia); from Stearns, 1873b. C. *Caprella spinosa* Lockington, 1874; (Crustacea: Amphipoda); from Lockington, 1874. D. *Menipea occidentalis* Trask, 1857, a synonym of *Tricellaria occidentalis* (Trask, 1857) (Bryozoa: Cheilostomata); from Trask, 1857. E. *Verillia blakei* Stearns, 1873, a possible synonym of *Halipteris willemoesi* Köllker, 1870 (Coelenterata: Pennatulacea); from Stearns, 1873d. F. *Virgularia ornata* Fisher, 1874, possibly a species of the genus *Halipteris* (Coelenterata: Pennatulacea); from Fisher, 1874. G. *Pleurotoma circinata* Dall, 1873 (Mollusca: Gastropoda); from Dall, 1873. H. *Muricidea subangulata* Stearns, 1873 (Mollusca: Gastropoda); from Stearns, 1873. I. *Bulimulus inscendens* Binney, 1861 (Gastropoda: Pulmonata); from Cooper, 1894. Shell. J. *Sipho hallii* Dall, 1873 (Mollusca: Gastropoda); from Dall, 1873. K. *Licnophora macfarlandi* Stevens, 1901 (Protozoa: Ciliata); from Stevens, 1901. L. *Pontoscolex corethrurus* (Muller) (Annelida: Oligochaeta); from Eisen, 1900. M. *Perophora annectens* Ritter, 1893 (Chordata: Urochordata: Ascidiacea); from Ritter, 1893. N. *Conus dalli* Stearns, 1873 (Mollusca: Gastropoda); from Stearns, 1873c. O. *Gonypodaria ramosa* Robertson, 1900 (Entoprocta: Pedicellinidae); from Robertson, 1900.

bance or destruction by government road-building proposals in 1895 (Leviton and Aldrich 1997:355).

The 1906 Earthquake

Two severe earthquakes, thirty-eight years apart, threatened the existence of the Academy as an institution during its early history. The first occurred on 21 October 1868 (see Aldrich et al. 1986; Rodda and Leviton 1983), and the second, far more destructive due to the ensuing fire and larger size of the city, took place on 18 April 1906 (Hittell in Leviton and Aldrich 1997:467–476; Leviton and Aldrich 2006).

The great earthquake and fire of 1906 that devastated the city of San Francisco almost entirely destroyed the Academy's natural history collections and library. Fortunately, through the dedication of the Academy's staff and the generous support of other scientific institutions, a new Academy was built from the ruins over the succeeding decade. Institutions such as the Smithsonian, the Academy of Natural Sciences of Philadelphia, Stanford University and the University of California donated entire journal runs, and valuable books and monographs, to help in the recovery of the Academy as a valued scientific institution. Later, priceless natural history collections were transferred to the Academy from other institutions such as Stanford University and the University of California at Berkeley. In addition, during the time of the earthquake, the seed of the new collections had arrived undamaged in San Francisco Bay on board the schooner *Academy*, which provided the basis for the rebuilding of the Academy collections. The *Academy* had recently arrived from an expedition to the Galápagos Islands, where it left its geographic namesake in the name of the Bay at Puerto Ayora on Isla Santa Cruz — Academy Bay.

1906 to 1960

The citizens of the city of San Francisco soon voted for an amendment to the city charter that allowed for the building of a new museum to be situated in Golden Gate Park at the site of the 1893 Mid-Winter Fair. The newly completed buildings were occupied by staff in 1915 and first opened to the public in 1916. This original part of the post-earthquake Academy was comprised of Bird Hall, North American Hall, and the sites of the whale courtyard and the Department of Invertebrate Zoology and Geology.

The rebuilding of the collections of recent and fossil invertebrates was undertaken in the Department of Paleontology under the auspices of the Curator of Paleontology Frank Marion Anderson (Fig. 1F). Anderson initiated a program of the recollection of fossil invertebrates from the North American Pacific region. A type collection was also rebuilt, which included fossil and recent invertebrates. The largest conchological collection in western North America, the Henry Hemphill collection, was donated to the Academy in 1914. This represented the largest collection of recent invertebrates received by the Academy following the 1906 earthquake. Also in 1914, the Department of Invertebrate Zoology was formally established. In the *Report of the Director of the Museum for the Year 1915*, it is stated, "This department was re-established only a year ago, and only a small allotment was made for its use. This fund has been expended in part in starting the making of a synoptical series of the marine invertebrates of the California coast." (Miller 1960b).

Walter Kenrick Fisher (1878–1953)

Walter K. Fisher (Fig. 2D) was named Curator of the Department of Invertebrate Zoology in 1917. Fisher was an Assistant Professor of Zoology at Stanford University at the time, and a naturalist and author who published primarily on echinoderms. He occupied the position of Curator

until his death in 1953. Although he was initially paid a small salary, the position subsequently became honorary and, following his death, the Department of Invertebrate Zoology became largely inactive. "During his tenure as curator, his (Fisher's) contributions were monumental. His monographic studies of the Asteroidea, Holothuroidea, and Hydrocorallina were benchmarks in the field, and are still the definitive bases from which any taxonomic study of these groups proceeds. Much of the material used in these studies is now housed in the Academy collections." (Anonymous, ca. 1985).

Frank Mace MacFarland (1869–1951)

Close relationships between local universities and the Academy developed during the first half of the twentieth century. Several research associates as well as curatorial staff jointly held academic positions or were affiliated with nearby institutions of higher learning. This is a tradition that still flourishes today. One of these noteworthy individuals who proved to be of great importance in the development of the field of invertebrate zoology at the Academy was Frank M. MacFarland (Fig. 2C). MacFarland was also a Stanford Professor and an invertebrate zoologist. He served as the Academy's Corresponding Secretary in 1924, then as Vice President until he was elected President of the Academy in 1934. He held this post until 1946. MacFarland also served as acting Academy Director from 1934 to the beginning of Robert Miller's directorship in 1938. The Academy's invertebrate collections grew substantially during MacFarland's working relationship with the institution due largely to his interest and respected standing in the academic community. His extensive research collection of opisthobranch mollusks housed at the Academy served as a basis for an important component of the invertebrate collections. It was later augmented by Curator Terrence Gosliner (Figs. 16B, 17C) from the 1980s to present, and has become one of the largest and most significant collections of its kind in the world.

In 1966, MacFarland's important manuscript on the opisthobranch fauna of the Pacific North America was published posthumously as a hardbound *Memoir* by the Academy (Figs. 5A–C) (MacFarland 1966).

Robert Cunningham Miller (1899–1984)

By 1938, when Robert C. Miller (Figs. 6, 9C) became Director of the Academy, the recent invertebrate collections had been fragmented and were under the custody of three separate Academy departments: Paleontology, Ichthyology, and the Steinhart Aquarium. The wet collections were consolidated in 1960 in the newly reactivated Department of Invertebrate Zoology, whereas the dry collections of recent corals, mollusks, brachiopods, and echinoderms remained under the curation of the Department of Geology (known as the Department of Paleontology until it was renamed in 1953).

Miller held the position of Academy Director for twenty-five years. He was a marine invertebrate zoologist and ornithologist from the University of California. Miller encouraged the acquisition and collection of invertebrates for the Academy, as well as the publication of research regarding invertebrates. Most importantly, he also recognized the necessity of a regional center as repository for invertebrate research collections. Miller's efforts were fundamental in making the Academy the primary repository of invertebrate collections in western North America. With the reactivation of the Invertebrate Zoology Department in 1960, Miller was named as Curator and Allyn Smith, who had been in the Department of Geology, was reassigned and appointed Associate Curator of Invertebrate Zoology.

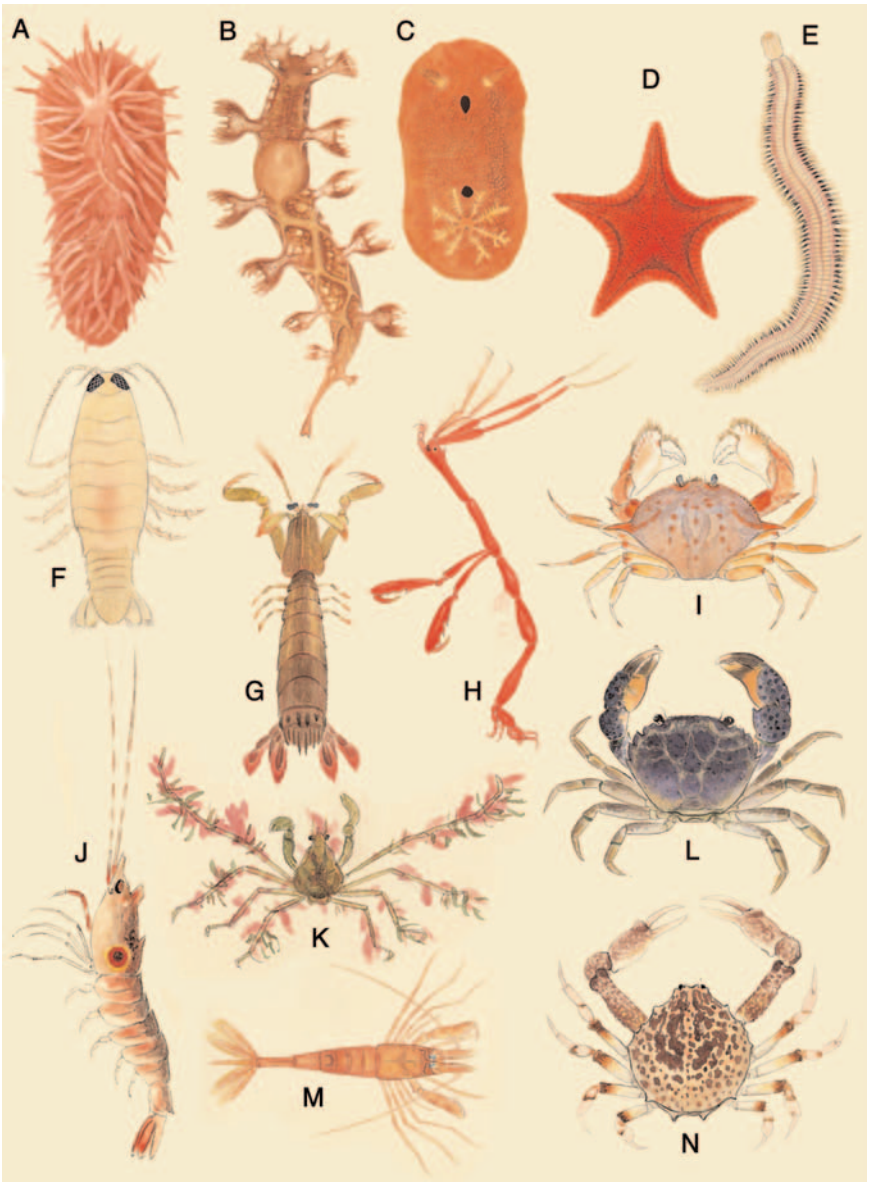

FIGURE 5. A–C. Water color illustrations of nudibranchs from MacFarland, 1966. A. *Okenia rosacea*. B. *Hancockia californica*. C. *Aldisa sanguinea*. D-N. Water color illustrations of marine invertebrates from the Templeton-Crocker expedition of 1932, to southern California and Baja California; courtesy California Academy of Sciences archives. D. Goniasterid sea star (*Mediaster aequalis*). E. Nephtyid worm (Annelida: Polychaeta: Nephtyidae). F. Flabelliferan isopod (*Aega* sp.). G. Peacock mantis shrimp (*Hemisquilla ensigera*). H. Skeleton shrimp (*Caprella* sp.). I. Calappid crab (*Platymera gaudicaudii*). J. Target shrimp (*Sicyonia penicillata*). K. Decorator crab (*Podochela* sp.). L. Xanthid crab (cf. *Panopeus* sp.). M. Caridean Shrimp (*Crangon* sp.). N. Leucosiid crab (*Randallia ornata*).

FIGURE 6. Robert Cunningham Miller, 1940s and 1950s. A. Miller as Director in his office at the Academy. B. Miller examining material from the Continental Shelf Survey on board the U.S. Navy's research vessel *Mulberry*, 1949. C. Miller on a field trip with students; to the right of Miller in a white T-shirt is Welton L. Lee (future Chairman of the Academy's Department of Invertebrate Zoology) as a teenager. D. Miller as Director of the California Academy of Sciences. Photographs courtesy California Academy of Sciences.

1960s

Reactivation of the Department of Invertebrate Zoology (1960)

Professor Donald P. Abbott of Hopkins Marine Station wrote Academy Director Robert C. Miller on 22 January 1963,

> When you wrote me some years ago of your plans for reactivating the Department of Invertebrate Zoology at the Academy, I was wholly in favor of the idea…I am very happy

> to hear that you have plans to provide the personnel and facilities, for there is most certainly a need for a central West Coast depository for collections of marine invertebrates, and the need will grow in the near future. Moreover, the Academy is the logical spot for such a depository.

In 1960, Academy Director Robert C. Miller, in his *Report to the Science Council on the Status of the Department of Invertebrate Zoology*, wrote,

> It is my recommendation that the Department of Invertebrate Zoology be reactivated, for the following reasons:
>
> The invertebrates include all of the phyla of the animal kingdom except one.
>
> There is no recognized central collection or repository of invertebrates (other than insects) on the Pacific Coast.
>
> There exists a definite need of such a collection and repository.
>
> The Academy, with a present collection of invertebrates, outside of any other department, numbering 5,000 lots and probably 50,000 specimens, has an excellent nucleus for such a repository. The collection includes a number of types of Ritter's Ascidians, Robertson's Bryozoa as restudied by C.H. O'Donohough [*sic*; O'Donoghue], and other miscellaneous types. The Director is in a position to add a large collection of marine woodboring mollusks from various parts of the world.
>
> For reasons about to be mentioned, the Department of Invertebrate Zoology can be reactivated at a minimum of expense for the present and several years into the future.
>
> It is likely that considerable financial support can be secured from the National Science Foundation and other sources.

The mid-twentieth century was a period of blossoming interest in marine biological research along the central coast of California, made possible by the economic boom of the post World War II era. No less than four major research facilities were opened between 1948 and 1966, following the lead of Stanford University's Hopkins Marine Station, which was founded in 1892. The four marine laboratories were Pacific Marine Biological Station of the College of the Pacific at Dillon Beach (1948) , Bolinas Marine Station of the College of Marin (1963), Bodega Marine Laboratory of the University of California (1966), and Moss Landing Marine Laboratories of the California State Universities (1966). The Academy's Department of Invertebrate Zoology & Geology acquired the Hopkins Marine Station collections, including those of Ed Ricketts (Fig. 7) and Donald Abbott in the latter half of the 1970s.

A significant part of this expanded interest in Pacific coast marine biology was the reactivation of the Academy's Department of Invertebrate Zoology in 1960. In announcing the reestablishment of the Department of Invertebrate Zoology, Academy Director Robert C. Miller wrote in the Annual Report for 1960,

> During the late 1890s the Academy established a Department of Invertebrate Zoology. In recent years, however, this Department has been relatively inactive…In recognition of the importance of invertebrates (animals without backbones) which embrace the greater part of the animal kingdom, the Academy has reactivated this Department. The Board of Trustees believes that the Academy can play an important role by building up a large, well organized research and reference collection of aquatic invertebrates, emphasizing those found from Alaska to Central America. No such research collection now exists anywhere on the Pacific Coast. The Academy's collection will constitute a central repository for all research material in this broad field of science. Reactivation of this Department has been enthusiastically endorsed by neighboring colleges and universities which have indicated that a strong Department of Invertebrate Zoology at the Academy will fill an important gap

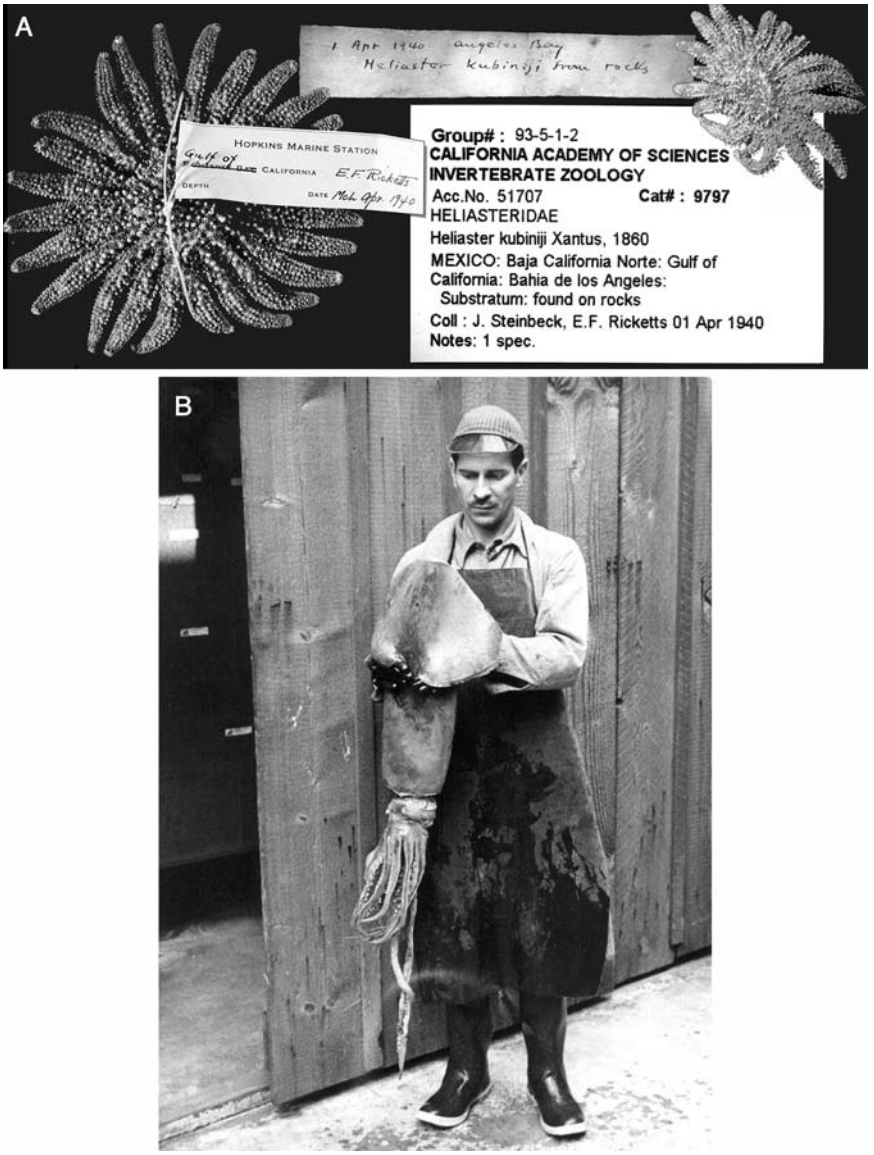

FIGURE 7. A. Two dried specimens in the Academy's invertebrate collection of the sea star *Heliaster kubiniji*, collected by Ed Ricketts and John Steinbeck in the Sea of Cortez, Mexico, 1940. B. Edward F. Ricketts with a jumbo squid (*Dosidicus gigas*) at Cannery Row, Monterey, California, circa 1940 (photo by Ralph Buchsbaum, courtesy Vicki Buchsbaum Pearse).

> now existing in the natural sciences…The Trustees named Dr. Robert C. Miller, Curator, and Allyn G. Smith, Associate Curator, of the Department. (Fig. 9C) (Miller 1960a).

Similarly, Richardson (1968:33) reported,

> It was then decided that the Department should be reactivated, a decision caused by the ever-growing interest in 'inner space'— the sea — the newest frontier in scientific research, the purpose being 'to standardize and systematize the Academy's collection of preserved Recent marine, land and freshwater invertebrates in order to make it available

> for research. For the following three years, such work as could be done in the department was done single-handedly by Allyn G. Smith, the Associate Curator. It was…decided that an appeal would be made to the National Science Foundation for a grant which would develop the department further as a centralized depository for type and other definitive biological material. To complete the job of recurating the collection and arranging it in systematic order for research, tools and personnel would be necessary…the first grant was made for a period of two years (1963–1965) and subsequently a second (1965–1967) for substantial amounts plus approximately 10% of the total from the CAS' own coffers for equipment and supplies…There were three men involved in the four-year project: Allyn G. Smith, Principal Investigator…Dr. Charles R. Stasek [Fig. 13B], who was responsible for the technical phases of the project…and Dustin Chivers, Technical Assistant, whose duties were more or less straight curatorial work.

In the same article, Richardson bluntly describes the rather austere state of the department prior to implementation of the grant, "Physically, the Department started with not much, with sort of left-over space provided, unpainted stacks, no running water, and lit by a single electric globe between the stacks. There was no proper microscope and little in the way of other curatorial equipment. The first grant took care of all this."

Allyn Goodwin Smith (1893–1976)

With respect to the development of invertebrate zoology at the Academy, Allyn G. Smith was assuredly the right person at the right time (Figs. 8A, 9). Born in Connecticut in 1893, Allyn came with his parents to Redlands, in southern California, when he was in grade school. At the age of seventeen, while on vacation in Pacific Grove, California, he met conchologist Josiah Keep (Fig. 1E) and accompanied him on a collecting trip in the Monterey Bay region. This event motivated Smith to become a shell collector. Shortly thereafter, Smith met and worked with malacologist S. Stillman Berry in Redlands. Berry most likely played an influential role in Smith's future specialty interest — the chitons (also known as polyplacophorans or amphineurans) (Howard 1969).

Smith received a B.S. degree in electrical engineering from the University of California at Berkeley in 1916. He later served as a lieutenant in the aviation section of the Signal Corps of the U.S. Army during World War I (Fig. 9B).

In the early 1920s, Smith worked as Chairman of the Technical Department for the University of California Extension at Berkeley. From 1925–1954, he was Administrative Superintendent of Personnel for Pacific Telephone and Telegraph Company. He served as Research Associate in Conchology from 1938 to 1956 in the Academy's Department of Paleontology/Geology. After retirement from his thirty-two year corporate career on 1 January 1957, he served as Research Malacologist and Assistant to the Director of the Academy from 1957 to 1960. When the Department of Invertebrate Zoology was reactivated in 1960, Smith was appointed Associate Curator and acting Chairman, and then in 1963 as Department Chairman. He served the Department well as Chairman until 1968, and then again from 1971 to the time of his retirement from the Academy in 1972. From 1968 to 1971, Victor A. Zullo (Fig. 8C) chaired both the Geology and Invertebrate Zoology Departments.

During his terms as Department Head, Smith succeeded in revitalizing the Department, overseeing rapid growth in the collections, and later stating, "The Department of Invertebrate Zoology, although the youngest of the Academy's research departments, is one of the fastest growing. Looking ahead, it should take whatever steps are needed to place itself in the position of making the maximum possible contribution toward biological research, including the training of taxonomists and systematic biologists in the invertebrate field…Working with undergraduates and gradu-

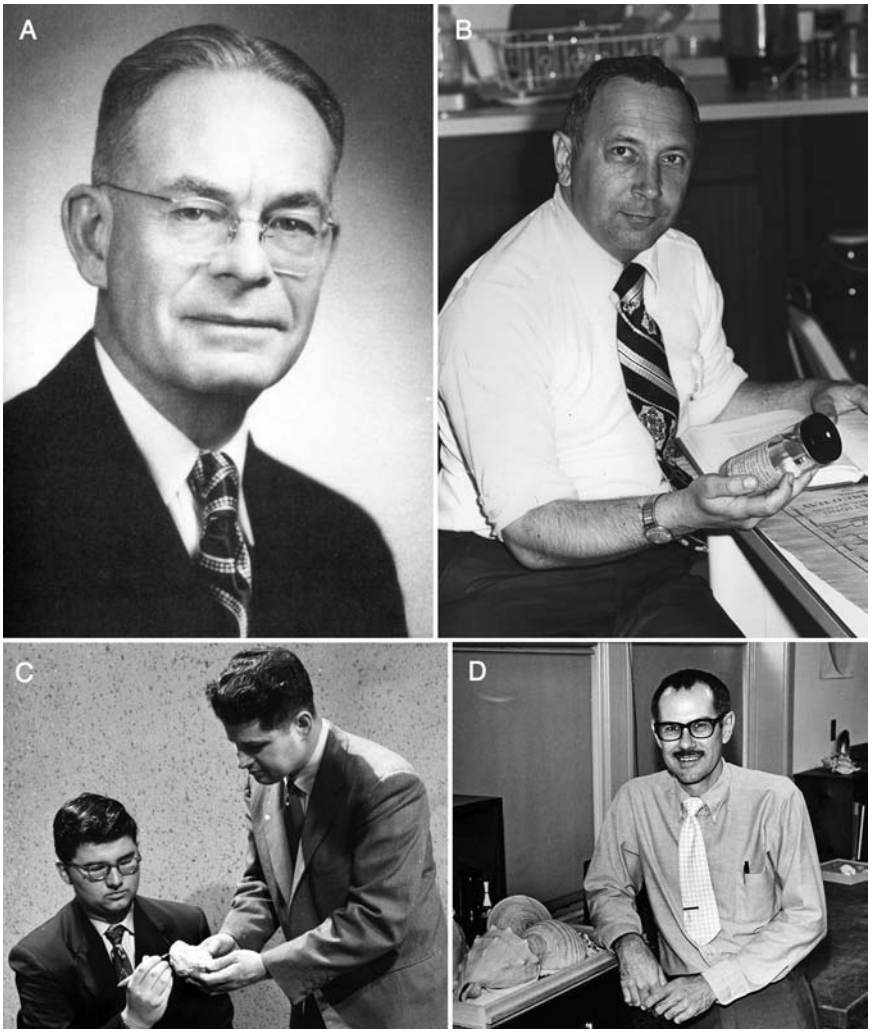

FIGURE 8. A. Allyn G. Smith, 1955. B. Welton Lee, 1976. C. Victor A. Zullo with Earl S. Herald on the television program *Science in Action*, 1960's. D. Peter U. Rodda, ca. 1971. Photographs courtesy California Academy of Sciences.

ate students in zoology, the Academy can promote such training and research and thereby develop as a vital center for such work." (Smith 1964). In 1963, a grant from the National Science Foundation was awarded to the department to standardize curation of the collections and to deal with a large backlog of material as well as rapidly accumulating new material. Charles R. Stasek (Fig. 13B) was hired as Research Biologist and Dustin D. Chivers (Figs. 9A, 10, 15A–C) was hired as Curatorial Assistant to help Smith accomplish these tasks.

In 1964, Smith participated in the Galápagos International Scientific Project, which was sponsored by the National Science Foundation, the Belvedere Scientific Fund, and the University of California, among others. While in the Galápagos Archipelago, Smith made a substantial collection of terrestrial and marine invertebrates for the Academy's Invertebrate Zoology Department.

Allyn Smith authored over one hundred scientific papers. Perhaps two of his most noteworthy publications were the Amphineura section in Moore's *Treatise on Invertebrate Paleontology*

FIGURE 9. A. Dustin D. Chivers and Allyn G. Smith, ca. 1963. B. Allyn Smith (on the right) in his U.S. Army uniform during World War I, ca. 1918, with malacologist S. Stillman Berry (at far left). C. Robert C. Miller and Allyn G. Smith, August 1960. Photographs courtesy California Academy of Sciences.

(1960), and *Land Mollusca of Baja California* (1990). Biographies of Smith are by Howard (1969), Miller (1977), and Emerson (1977).

Dustin Dale Chivers (1935–1995)

Dustin Chivers's (Figs. 9A, 10A–C, 15A–C) thirty-two year career in invertebrate zoology at the Academy as Curatorial Assistant and Senior Curatorial Assistant, spanned the time of the department's reactivation and rapid collections growth during the 1960s and 1970s. Smith (1964) stated,

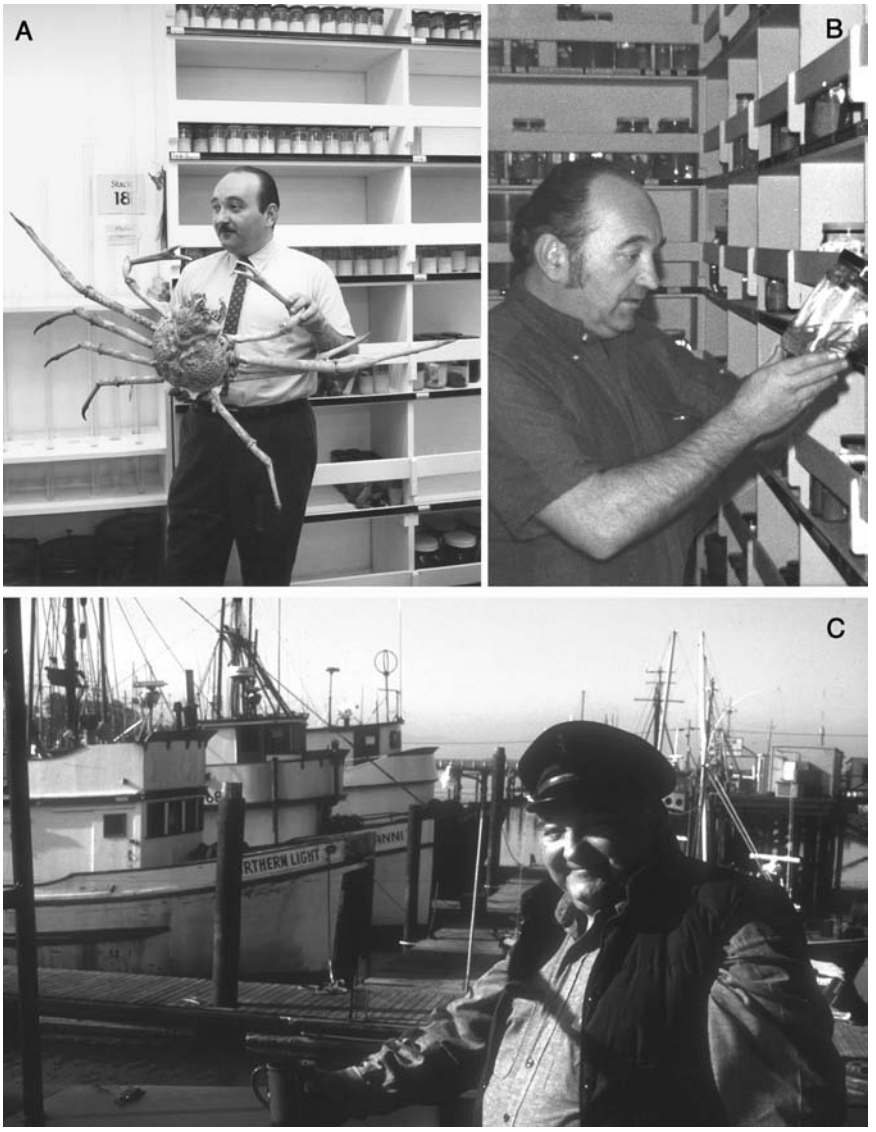

FIGURE 10. Dustin D. Chivers ("Dusty"). A. Chivers with a spider crab, 1966; Photograph courtesy Department of Invertebrate Zoology and Geology, California Academy of Sciences. B. Chivers in the Academy's invertebrate collection, 1980; Photograph courtesy Department of Invertebrate Zoology and Geology, California Academy of Sciences. C. Chivers at Moss Landing Boat Harbor, California, 1992; Photograph courtesy Gary C. Williams.

> Mr. Chivers joined the Department under the NSF grant in September 1963 after working for a period with the California Department of Fish and Game in the Marine Resources Division. He is a graduate of San Francisco State College, majoring in zoology, and has served as a Supervisor of the Academy's Student Section. He is a competent SCUBA diver and collector, with a considerable and growing knowledge of invertebrate systematics and curatorial methods."

Known to his friends and associates as "Dusty," Chivers is remembered for his quick-witted

sense of humor and charismatic personality. He was an adept spokesman regarding museum public relations, as well as an important contributor to the department's marine invertebrate collections. Rodda (1995) reported,

> In addition to his museum duties Dusty added significantly to the collections. He was an important member of the Academy expeditions to the Sea of Cortez in 1964, 1965, 1978, and 1979. During his time at the Academy, the Department of Invertebrate Zoology grew enormously, becoming one of the world's premier invertebrate collections. Dusty had an astonishingly large and extensive personal knowledge of invertebrates, especially marine invertebrates from the west coast of North America, and he was broadly knowledgeable about animals and plants generally. He shared his knowledge with all who asked, freely and with pleasure. He was especially helpful to young, budding biologists who benefited greatly from his expertise in marine biology and museum techniques.

Examples of his enthusiastic outreach to young people include two of the department's present curators, Terrence Gosliner and Gary Williams, both of whom, as teenagers, owe much to Dusty's mentorship.

Franz Benno Steiner (1923–1975)

During the mid-1960s the invertebrate collections began accumulating material from the tropical Indo-Pacific. This represented a trend that continues to the present time. In fact, the majority of new material acquired by the department in the 1990s was from the Indo-Pacific. This trend has influenced the research focus of the department, which has shifted from mainly an eastern Pacific focus (1853 to the 1970s) to an Indo-Pacific one (1980s to present). From the mid-sixties to 1975, these field research efforts were due to the work of a single individual, Franz Steiner (Fig. 13C). Steiner was a field associate of the department from 1966 to the end of 1975. His extensive invertebrate collections from the tropical Indo-Pacific, particularly the Indian Ocean, which date back to the late 1950s, are considered very important components of the department's holdings. The geographical scope of his field work was impressive and included Sinagapore, Thailand, South Korea, Japan, Taiwan, Vietnam, Indonesia, Philippines, East and South China Seas, Malaysia, Pakistan, India, Sri Lanka, Saudi Arabia, Kenya, Tanzania, and South Africa. Steiner also donated Atlantic and Mediterranean material, particularly that of Morocco, Libya, Ivory Coast, Gambia, Venezuela, Brazil, and the Falkland Islands, as well as Eastern Pacific material — Peru, Chile, and El Salvador.

Steiner was born in Hamburg, Germany and as a citizen of the United States, attended Temple University in Philadelphia, Pennsylvania, worked as a merchant marine radio operator, and was an enthusiastic amateur conchologist. Much of his accumulated invertebrate collection of an estimated 15,000 lots is now housed at the Academy. He traveled and collected extensively in Europe, Africa, Asia, the West Indies, and South America, as well as the Indo-Pacific (Abbott 1973–74:453).

Invertebrate zoologist Jakob Verseveldt from Leiden's Nationaal Natuurhistorisch Museum (formerly the Rijksmuseum van Natuurlijke Historie) named a new species of coral reef soft coral (*Cladiella steineri*) for Steiner that Steiner had discovered and collected in Thailand in 1971 (Fig. 13D). Verseveldt (1982:147) states, "I name the species after Mr. Franz B. Steiner, collector of the specimens. Mr. Steiner was a radio officer for the American President Shipping Lines. He was an avid shell collector, but he also collected large series of benthic invertebrates for the Department of Inveretebrate Zoology of the California Academy of Sciences, San Francisco."

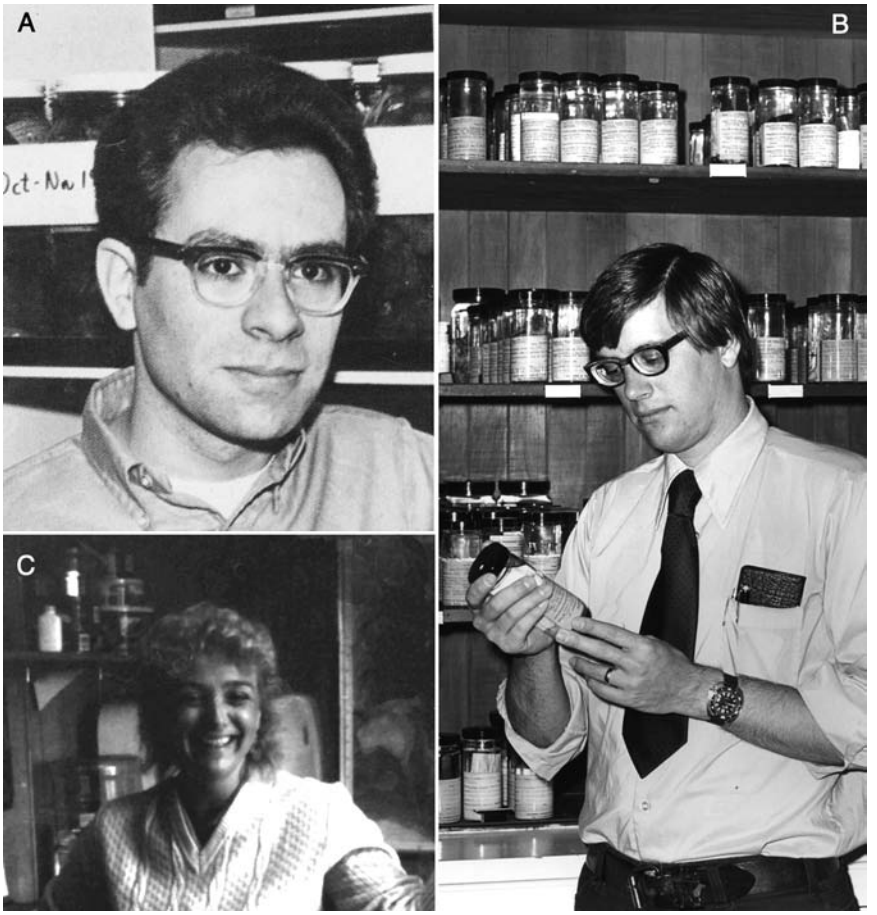

FIGURE 11. A. James T. Carlton, 1973; Photograph courtesy James T. Carlton. B. James Sutton, ca. 1976. C. Elizabeth Kools, January 1986. Photograph courtesy Department of Invertebrate Zoology & Geology, California Academy of Sciences.

1970s TO 2003

Between 1968 and 1971, Victor A. Zullo (Fig. 8C) was appointed Acting Chairman of the Department of Invertebrate Zoology as well as Chairman of the Department of Geology, succeeding Allyn Smith and G Dallas Hanna, respectively. Allyn Smith was again appointed Chairman of the Department of Invertebrate Zoology in 1971, while Peter U. Rodda (Fig. 8D) assumed the chairmanship of the Department of Geology. Allyn Smith retired a year later on 30 June 1972. Dustin Chivers was designated Acting Chairman and Assistant Curator during a transitional period of 1972–73.

James T. Carlton (Fig. 11A), who has served as an Academy Associate since 1969, is an eminent authority on introduced invertebrates of North American estuaries. Carlton served as Senior Scientific Assistant (1971–72) and Technical Assistant (1972–1973) in the Academy's Department of Invertebrate Zoology, and continues as a Research Associate. After this period of employment at the Academy in the early 1970s, Carlton obtained his doctorate at the University of California, Davis. He is currently Professor of Marine Science at Williams College, Massachusetts, and Director of the Maritime Studies Program of Williams College and Mystic Seaport. In 1975, he co-

edited Light's Manual with U.C. Berkeley zoology professor Ralph Smith (see Smith and Carlton 1975). Carlton is now editing the fourth edition of this important book, tentatively entitled, The Light and Smith Manual: Intertidal Invertebrates of the California and Oregon Coasts.

Welton L. Lee (Figs. 6C, 8B, 15E), a specialist in sponge systematics, was appointed Chairman and Curator of the Department of Invertebrate Zoology on July 1, 1973, to occupy the post vacated by Allyn Smith. Lee received his doctorate from Stanford University in 1965 and was Assistant Professor of Biology and Director of the Undergraduate Research Participation Program at Hopkins Marine Station, before coming to the Academy in 1973. As a teenager, Lee participated in the Academy's Junior Academy program (Fig. 6C).

During Lee's chairmanship of the 1970s, major managerial programs were implemented to modernize the Department and its collections. These efforts and priorities included the establishment of polices regarding future growth of the collections, major redesign of curatorial procedures, and provision for expertise in invertebrate systematics regarding the regional fauna. Concerning the latter, the first San Francisco Bay Project was initiated to develop a bibliography and consolidated reference collection of San Francisco Bay estuarine invertebrates, as well as the production of identification manuals (Light 1978; Lindberg 1981). A good deal of this effort was financed through private grants, as well National Science Foundation, Sea Grant, and Packard Foundation funding. James Sutton (Fig. 11B) was hired as project director and Research Biologist (1973–1978) for the San Francisco Bay Invertebrate Reference Collection Project.

Also during his chairmanship of the department, Lee became the Academy representative to the Association of Systematics Collections, and was elected Chairman of the ASC Council on Standards where he organized the production of a major document on the need and use of voucher specimens. In addition, Lee (pers. comm.) reports, "I was also asked by NSF to chair a joint NSF/ASC Committee which first documented the Status, Needs and Resources of 'all' U.S. Museum Invertebrate Collections. A major document was produced showing the strengths of all of these collections and a paper published with the results of our study. I was particularly proud of this accomplishment as it was produced at a time when NSF funding for Systematics was not consistent with the needs of Museum collections. I might add that Bob Van Syoc (Fig. 12D), then a Curatorial Assistant, worked with me on this venture and did an absolutely magnificent job."

Lee wrote two important NSF grants, which were awarded — first in 1979 to curate the huge backlog of material accumulated primarily as a result of Franz Steiner's field collecting around the world (particularly the Indo-Pacific), and second in 1981, to curate the ever growing dry mollusk collection that had been recently acquired.

Rodda (1987) reports,

> In 1980 the care of the dry-preserved mollusk shells was transferred from the Department of Geology to the Department of Invertebrate Zoology. Rehousing and recuration of this large collection began soon after aided by the first of a series of grants from the National Science Foundation. To support the increased mollusk collection activity Barry Roth (Fig. 12C), curatorial assistant in Geology, was transferred to Invertebrate Zoology and was appointed Senior Scientific Assistant for Malacology and Acting Assistant Curator. The same year Daphne Fautin (Fig. 12A), an authority on sea anemones, was appointed Assistant Curator, the second curator-level position in Invertebrate Zoology.

Largely due to Lee's vision, initiative, and leadership during the 1970s and 1980s, the Academy's Invertebrate Zoology Department became a modern, internationally recognized institution with collections of global scope and importance. A major accomplishment of his term was the award of a five-year National Science Foundation grant for compacterization of the invertebrate and large fossil collections between 1986 and 1989.

FIGURE 12. A. Daphne Fautin Dunn, 1987; Photograph courtesy Department of Invertebrate Zoology & Geology, California Academy of Sciences. B. Charles R. Stasek, ca. 1964/65. C. Barry Roth, 1980's; Photograph courtesy Elizabeth Kools. D. Robert J. Van Syoc, 1987; Photograph courtesy Department of Invertebrate Zoology & Geology, California Academy of Sciences.

During the early 1980s, three teams of outside consultants studied the state of research and collections at the Academy and made recommendations to the administration for improvement. In 1982, as a result of these assessments, the Departments of Geology and Invertebrate Zoology were administratively combined into one department. The new entity was at first named the Department of Invertebrate Biology and Paleontology (IBP), but was soon changed to the Department of Invertebrate Zoology and Geology (IZG).

Relevant to this, Rodda (1987:19) states,

> With the arrival in 1982 of new Executive Director Frank Talbot, several important changes were initiated. The Departments of Invertebrate Zoology and Geology were combined physically and administratively under Chairman Welton Lee. Stronger emphasis was

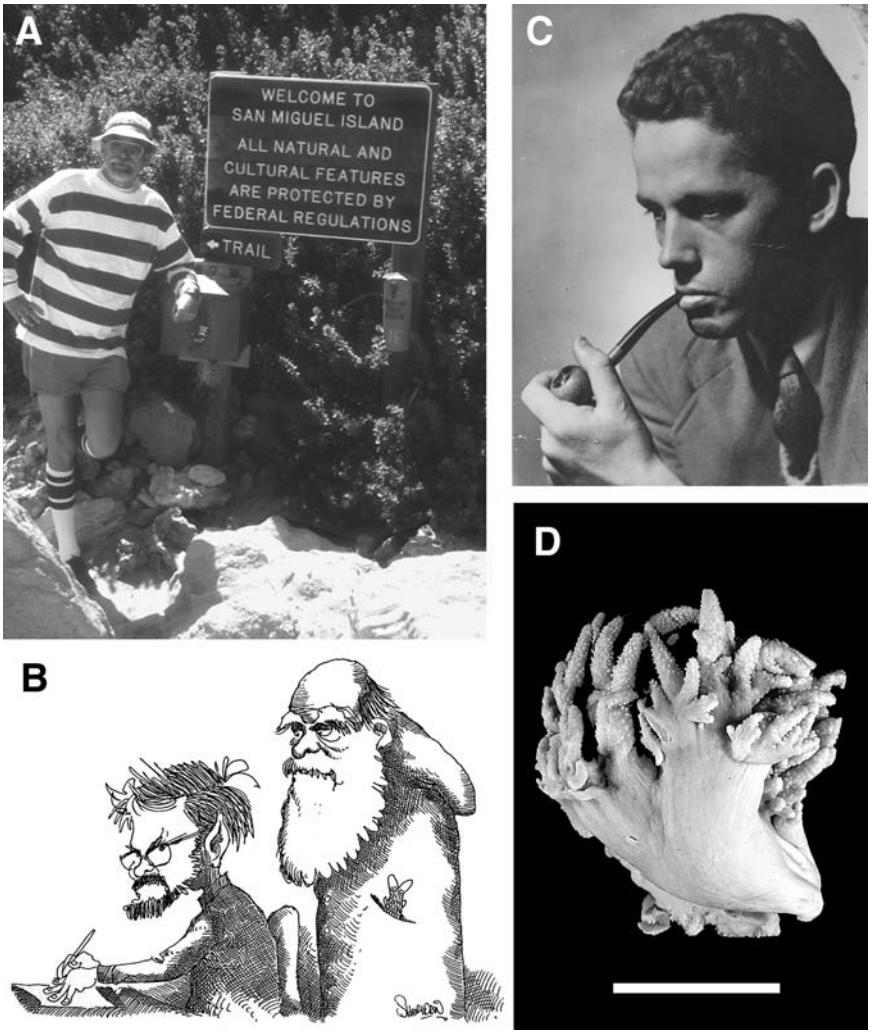

FIGURE 13. A. Michael T. Ghiselin, Channel Islands, California, 1991; Photograph courtesy Gary C. Williams. B. Darwin looking over the shoulder of Mike Ghiselin; cartoon by Sheridan Anderson, ca. 1971; courtesy David Lindberg, University of California, Berkeley. C. Franz B. Steiner, date not known; Photograph courtesy Department of Invertebrate Zoology and Geology, California Academy of Sciences. D. Holotype (CASIZG catalog #030117) of the soft coral *Cladiella steineri* Verseveldt, 1982; type locality Thailand; scale bar = 40 mm.

placed on research productivity, and a system of departmental collections managers was instituted to free curators to pursue research goals. In Invertebrate Zoology and Geology, Robert Van Syoc (Figs. 12D, 17C), a former Curatorial Assistant, was appointed Collections Manager to oversee all invertebrate and geological collections other than diatoms and minerals. These two units continued under the care of Honorary Curator Margaret Hanna and Mineralologist Jean DeMouthe, respectively. Also in 1982, Terrence Gosliner (Figs. 16B, 17C), a malacologist and authority on marine opisthobranch mollusks, was appointed Assistant Curator, a new permanent position; recognizing the great imporance of the large molluscan collections. Now with a staff of fourteen, Invertebrate Zoology and Geology became the largest unit in the Academy's Research Division.

Between 1982 and 1984, the new administrative attitudes toward research productivity and promotion, unfortunately resulted in some decisions regarding research personnel that proved both highly controversial and traumatic for the institution. Ultimately, this led to Welton Lee's departure from the Academy, a loss to the department and to the institution. Nonetheless, Lee continued his sponge research as a departmental Research Associate.

Regarding subsequent events, Rodda (1987) continues,

> Peter Rodda was appointed Chairman of Invertebrate Zoology and Geology succeeding Welton Lee who devoted his full-time to research on sponges. By this time, the combined Departments occupied the entire research wing of North America Hall, an area that in 1916 housed all Academy research departments, the library, and the administrative offices!…In 1985, Invertebrate Zoology and Geology received a two-year award from the National Science Foundation to computerize the type collections and to establish shared computer data bases with the Department of Paleontology, University of California, Berkeley.

Michael T. Ghiselin (Fig. 13A–B) — evolutionary biologist, Darwin scholar, former zoology professor at the University of California Berkeley, and MacArthur Foundation Fellow — joined the staff of the Academy's Invertebrate Zoology and Geology Department as Senior Research Fellow in 1983. Ghiselin received his doctorate from Stanford University in 1965 and served two post-doctoral fellowships — one with Ernst Mayr at Harvard University and another at Woods Hole Oceanographic Institution. His research concerns major aspects of evolutionary biology, chemical defense in opisthobranch gastropods, and various aspects of the history and philosophy of science. Ghiselin established the Center for the History and Philosophy of Science at the Academy in June of 1992. This recently established academic component of the Academy has resulted in important international collaborations, conferences, and publications (see: Pinna and Ghiselin 1996; Ghiselin and Pinna 1996; Ghiselin and Leviton 2000, 2004; Jablonski and Ghiselin 2005).

Elizabeth Kools (Fig. 11C) was hired as a Curatorial Assistant in Invertebrate Zoology in February of 1984. She has been largely responsible for organizing the efforts of our dedicated volunteers in curation of the Department's holdings of molluscan shells, among other curatorial duties.

In 1989, J. Patrick Kociolek was appointed the Hanna Chair of Diatoms, which was established that same year. He served as IZG department chairman from 1990–1992 and later became the Academy's Director of Research and then the institution's Executive Director (1997–2007).

Malacologist and Senior Curator Terrence M. Gosliner (Figs. 16B, 17C) served in Academy administration as the Academy's Director of Research on three occasions (1990–1993, 1997–2000, and 2005–2006), as Acting Director of Public Programs from 2000–2005, and as Academy Provost (2000–2006). The systematics of opisthobranch mollusks comprise his primary research endeavor.

Gary C. Williams (Figs. 16A, 17C) was appointed Post-Doctoral Fellow in Invertebrate Zoology in February of 1991, and then as a curator of Invertebrate Zoology (coelenterates) in 1992. Williams served as IZG department chairman from 1995–1998 and again from 2004–2008. His research specialty concerns the systematics and evolutionary biology of octocorallian coelenterates.

Building on the initial efforts of Franz Steiner in the Indian Ocean, curators Gosliner and Williams largely changed the focus of the invertebrate zoology field collecting at the Academy from the eastern Pacific to the tropical Indo-Pacific in the 1990s (Fig. 16). Their collaborative field work, involving the use of SCUBA, included Indo-Pacific islands and archipelagos such as Madagascar, the Philippines, Palau, New Guinea, Indonesia, and Palmyra Atoll.

Also in 1992, Richard Mooi (Fig. 17A) was appointed as a curator of Invertebrate Zoology (echinoderms). Mooi served as IZG department chairman from 1992–1995 and from 1998–2001. His research specialty concerns the phylogenetics and systematics of echinoderms, particularly echinoids.

Peter Rodda retired in 1997 and was succeeded in 1999 by Peter Roopnarine (Fig. 17D) as a curator of Geology. Roopnarine served as IZG department chairman from 2001 to 2004. His research interests include the evolutionary biology of Neogene marine mollusks and thermal springs gastropods, as well as the micro-evolutionary dynamics of Devonian conodonts.

Scientific Publications

Since the beginning of the publication of scientific studies at the Academy in 1854, major contributions have been made in the fields of invertebrate zoology and invertebrate paleontology. The *Proceedings of the California Academy of Natural Sciences*, volumes 1–3, were produced between 1854 and 1868. During the latter year, the name was changed to the *Proceedings of the California Academy of Sciences*, beginning with volume 4 of series 1, and this continues to the present day in series 4 of the *Proceedings* (series 4, volume 58 in 2007). Concerning this title change, Robert Stearns, the Academy's Curator of Conchology, stated, "The word Natural in the title of the Academy was dropped, upon the adoption of a new constitution in the annual meeting in January, 1868, since which time, and commencing with Volume IV, the title has been 'The California Academy of Sciences'." (Stearns 1873).

The Galápagos Islands

Academy scientists have conducted research in the Galápagos Archipelago for a century, a tradition that continues today. After the museum was destroyed in the 1906 earthquake and fire, the new collections began with specimens brought back from the 1905/06 Galápagos Expedition on board the schooner *Academy*.

Thornton (1971:18) describes this important event in the Academy's history,

> The most extensive survey of the archipelago ever undertaken was that of the expedition of the California Academy of Sciences, whose director, like Agassiz, was an opponent of the theory of evolution. Under Rollo Beck's leadership, the party sailed in the 85-foot sailing schooner *Academy* (after which Academy Bay on Indefatigable is named), and remained in the Galápagos for twelve months during 1905–6. Many young American biologists on board this vessel, such as E.W. Gifford, F.X. Williams, J.R. Slevin, and J.S. Hunter, subsequently became noteworthy scientists. The collections they made were the most comprehensive ever, and remained so until recent years. During the visit, the 1906 San Francisco earthquake occurred, destroying the Academy's museum and most of its collections; however, the material secured by the expedition was of such scope and value that the institution's position as a leading research-center was quickly restored. Since then the academy's interest in the scientific aspects of the archipelago has become traditional; its Galápagos collections are the largest in the world and its publication on Galápagos biology include many important scholarly works. The academy is generally considered the center of the research into the archipelago's natural science.

The Academy's 1932 expedition to the Galápagos Archipelago sponsored by Templeton Crocker (Fig. 14), left three fitting geographical names as a result of their explorations: Academy Bay at Puerto Ayora (Santa Cruz Island), California Cove (Fernandina Island), and Mt. Crocker (Santa Cruz Island). Germane to this, Slevin (1959:23) reports,

> In May, 1932, Captain Garland Rotch of the yacht *Zaca*, while on the Templeton Crocker Expedition of the California Academy of Sciences to the Galápagos Islands, made two sketch surveys of anchorages not yet charted. One of these was on the northeast side of Narborough Island and he called it California Cove. The other was Academy Bay,

FIGURE 14. The Academy's Templeton Crocker Expedition, 1937–1938. A. The Schooner *Zaca*. B. On board the *Zaca*. C. Templeton Crocker examining a haul taken on board the *Zaca*. Photographs courtesy California Academy of Sciences.

Indefatigable Island, locally known as Puerto Presidente Ayora, although Academy Bay is its official name.

The 1932 Expedition also pioneered a trail from Academy Bay into the highlands of Isla Santa Cruz that cut through all the elevational life zones and made access to good study sites possible (Smith 1972:7).

The 1964 Academy Expedition to the Galápagos was part of the Galápagos International Scientific Project (GISP). This major endeavor was sponsored by the Academy through the Belvedere Scientific Fund, the University of California, and the Charles Darwin Foundation, with financial and material assistance from the Republic of Ecuador, the Unites States Navy, the National Science Foundation, Shell Oil Company, and the California Maritime Commission (Smith 1972:7). Academy scientists taking part in this expedition included invertebrate zoologist Allyn Smith and

entomologist David Q. Cavagnaro. Cavagnaro Crater, approximately 1.6 km northwest of Mt. Crocker in the highlands of Santa Cruz Island, was named for the latter during this expedition.

Thirty years later, the 1994 Academy Galápagos Marine Expedition (Fig. 17C) on board the MV *Mistral*, produced many new taxa and records in invertebrate zoology and ichthyology. Taking part in this expedition, which utilized collecting by SCUBA, were Academy scientists Terrence Gosliner, John McCosker, Robert Van Syoc, Gary Williams, and underwater photographer/author Paul Humann.

The best but most often ignored example of adaptive radiation or archipelago speciation in the Galápagos Islands is not that of Darwin's finches (with a mere thirteen species) or the asteracean plant genus *Scalesia* (with twenty one taxa), but rather land snails with one hundred species, a quarter of which occur on the single island of Santa Cruz (Neil E. Fahy, pers. comm.). The single genus *Naesiotus* alone, has sixty eight described species, most of which are represented in the Academy's invertebrate collections. Academy scientists who have extensively collected Galápagos land snails include Washington H. Ochsner during the 1905/06 Expedition, and Allyn Smith during 1964 GISP Expedition. Academy publications resulting from these and earlier efforts include Dall (1917), Dall and Ochsner (1928), and Smith (1972). In addition, one hundred and two Pliocene fossil invertebrate species collected mainly by Academy scientists Joseph R. Slevin in 1927 and Leo G. Hertlein in 1931/32, are listed by Hertlein (1972).

Expeditions and Historical Collections

A summary of some of the Academy's historically significant invertebrate collections, and the expeditions that produced them, or the institutions or individuals that donated them, are as follows. Collections made in the 1890's were destroyed in the earthquake and fire of 1906.

Academy sponsored expeditions or other expeditions and surveys in which Academy scientists participated

1. Academy expeditions to Baja California by Gustav Eisen, botanists Katharine and Townshend Brandegee, and Walter Bryant, 1892 and 1893.

2. Academy expedition to the Galápagos Islands 1905–06 on board the schooner *Academy*.

3. Academy expedition to the Sea of Cortez, Mexico, in 1921, on board the 22-ton gasoline schooner *Silver Gate*.

4. Expedition to the Revillagigedo Islands in the Mexican Pacific, on board the mine sweeper U.S.S. *Ortolan*, 1925.

5. Various cruises sponsored by Templeton Crocker (Fig. 14C) on board his yacht *Zaca* (Fig. 14A–B) between 1932 and 1938; California coast and to Mexico, Baja California, the Galápagos Islands, Easter Island, and the Pacific coast of South America. The yacht was a 118-foot schooner, and its name is derived from the Samoan word for "peace". The *Zaca* was later acquired by Hollywood movie actor Errol Flynn (1909–1959) and gained the reputation as a rather notorious party boat. In 1952, Warner Brothers released a film titled *Cruise of the Zaca*, directed and narrated by Flynn. The film was a travelogue and documentary based on footage filmed in 1946.

6. Continental Shelf Survey between 1949 and 1950 (Figs. 6B, 17B), using the U.S. Navy net-tender *Mulberry*, which collected at a variety of depths up to 3660 meters. This two-year series of cruises pertained primarily to central California offshore geological research under contract with the Office of Naval Research

7. Academy expedition to the Sea of Cortez in 1953 on board the yacht *Orca*, sponsored by J.W. Sefton, Jr. of San Diego. Among the participants in this expedition were two Academy cura-

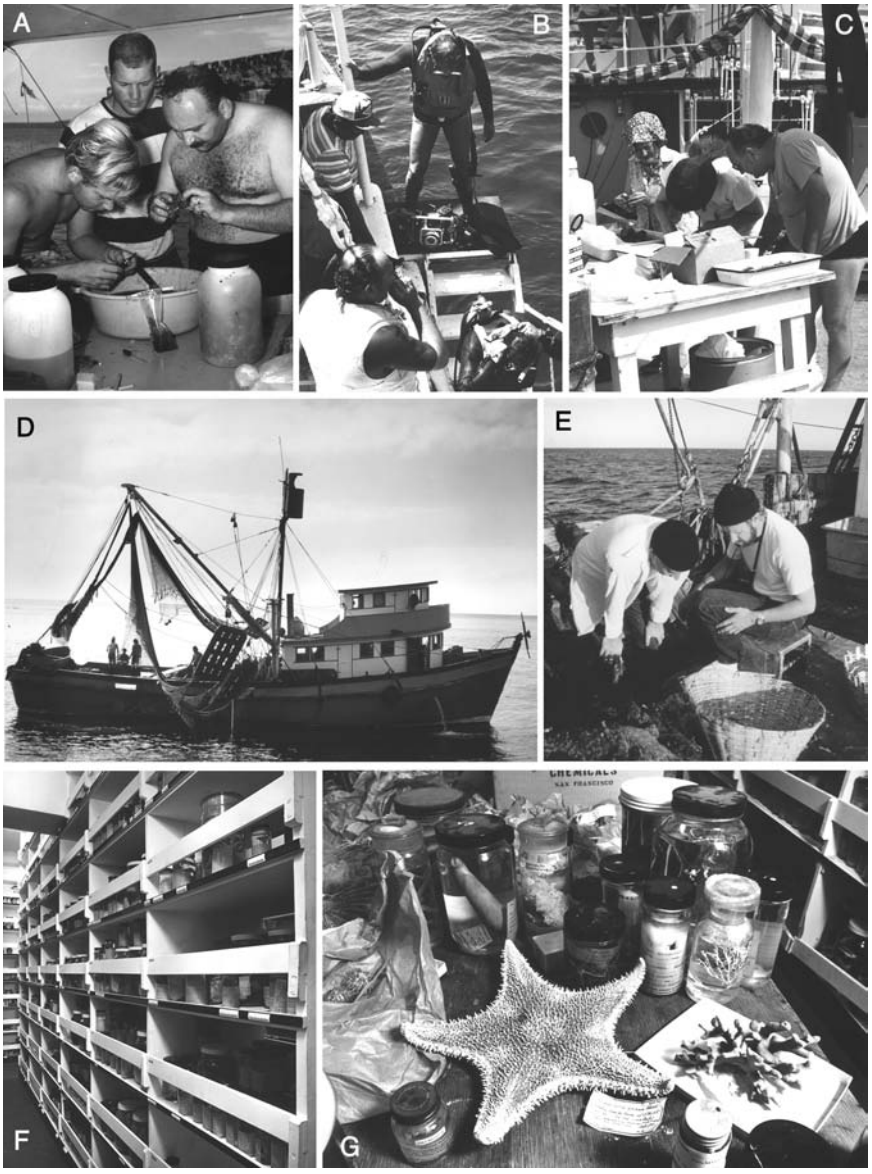

FIGURE 15. A–E. Field research, Gulf of California, 1965–1979. A. Sea of Cortez Expedition, 1965; left to right: Bruce Marquardt, Ken Lucas, Dustin Chivers. B–C. Baja Expedition on board The *Marisla*, 1979. D–E. Gulf of California Expedition, 1976. D. Baja California Shrimper. E. On the working deck, Welton Lee at left. F–G. The Academy's marine invertebrate collection, circa 1983/84. Photographs courtesy California Academy of Sciences, Department of Invertebrate Zoology and Geology.

tors, G Dallas Hanna and Joseph R. Slevin, and two Stanford graduate students who were to come to the Academy shortly thereafter, Paul H. Arnaud and Alan E. Leviton.

8. Mainland Baja California and Gulf of California island expeditions, sponsored by the Belvedere Scientific Fund, between 1958 and 1964, in which Allyn Smith, Alan Leviton, Academy entomologist Hugh Leach, Stanford botanist and Academy President, Ira Wiggins, and Academy

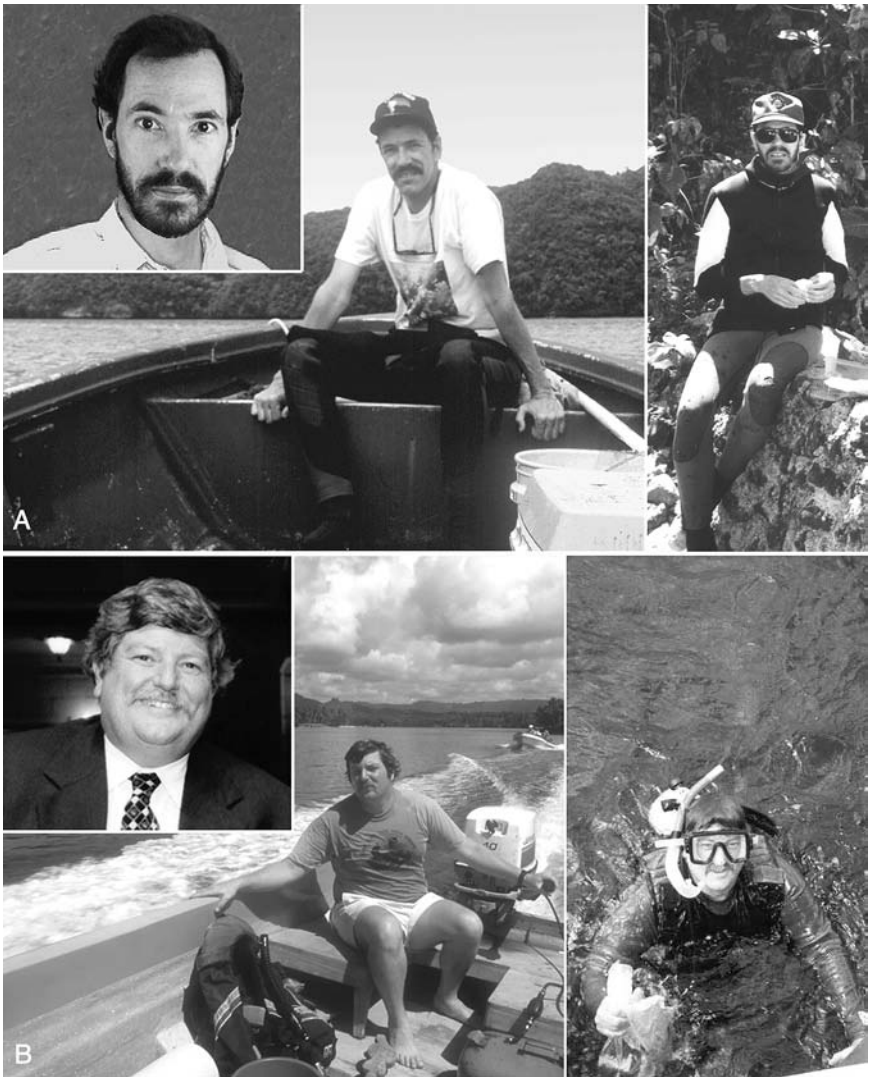

FIGURE 16. Field research in the Indo-Pacific, 1989–1997. A. Gary C. Williams: 1992 (inset), Photograph courtesy California Academy of Sciences; Palau, Micronesia, 1996 (center), courtesy Gary C. Williams; Maricaban Island off southern Luzon, Philippines, 1995 (right), Photograph courtesy David K. Mulliner. B. Terrence M. Gosliner: 2002 (inset), Photograph courtesy California Academy of Sciences; Madang region, Papua New Guinea, 1989 (center), Photograph courtesy Terrence M. Gosliner; Bohol Strait, Philippines, 1997 (right), Photograph courtesy David W. Behrens, CASIZG Research Associate.

Trustee Kenneth Bechtel participated. The 1964 expedition to various islands in the Gulf produced an hour length documentary film entitled, *The Sea of Cortez*. Scientists participating in this expedition included Academy Director George Lindsay, Academy invertebrate zoologist Dustin Chivers, Steinhart Aquarium Superintendent Earl S. Herald, vertebrate biologist Ray Bandar, Stanford University botanist Ira Wiggins, and Academy ornithologist/mammalogist Robert T. Orr.

9. Various expeditions by Academy Entomology Curator and natural history photographer Edward S. Ross, to Baja California, the Mexican mainland, the west coast of South America,

FIGURE 17. Field research, 1949–2004. A. Richard Mooi on board the *Polarstern*, Antarctic Peninsula, 2001; Photograph courtesy Susie Lockhart. B. Emptying the dredge on the deck of the U.S.S. *Mulberry*, Continental Shelf Survey, 1949; Photo collection of the California Academy of Sciences. C. The 1994 Academy marine expedition to the Galápagos Islands; from left to right: Terrence Gosliner, John McCosker, Gary Williams, photographer and author Paul Humann, and Robert Van Syoc; Red Beach with sea lions, Rabida Island; Photograph courtesy Terrence M. Gosliner. D. Peter Roopnarine, Gulf of Thailand, 2005; Photograph courtesy Peter Roopnarine.

Madagascar, Africa, India, Pakistan, and Australia, between 1938 and 1964. In addition to his other duties, Ross diligently collected terrestrial and freshwater mollusks, as well as some marine invertebrates for the Academy's invertebrate zoology collections.

10. The 1964 Galápagos International Scientific Project, in which the Academy was a major participant.

11. Academy Gulf of California Expeditions on board the *Marisla* in 1965 (Fig. 15A), and the *San Agustin II* in 1966.

12. Academy Gulf of California Expedition in 1976 on board a Baja California shrimper. Academy invertebrate zoologists Welton Lee and Dustin Chivers participated in this expedition (Fig. 15D–E).

13. Academy expedition to Baja California on board the *Marisla* in 1979 (Fig. 15B–C). Academy invertebrate zoologist Dustin Chivers took part in this cruise.

14. Academy expeditions between 1987 and 1998 in cooperation with the Christensen Research Institute (CRI) in Madang, Papua New Guinea, and the Coral Reef Research Foundation of Palau (CRRF) and National Cancer Institute (NCI), by Academy curators Terrence Gosliner and Gary Williams.

15. Academy expeditions to various parts of the tropical western Pacific, including the Philippines, Indonesia, the Solomon Islands, Palau, Guam, Midway Island, and Palmyra Atoll by Academy curators Terrence Gosliner and Gary Williams, between 1992 and 2001.

16. Academy Galápagos Marine Expedition in 1994 by invertebrate zoologists Terrence Gosliner, Gary Williams, and Robert Van Syoc, ichthyologist John McCosker, and underwater photographer/author Paul Humann (Fig. 17C).

Important Acquisitions from Various Agencies or Individuals

1. The Henry Hemphill conchological collection, the largest of its kind in western North America, was donated to the Academy in 1914.

2. California State Department of Fish and Game fisheries research investigations; California coast; 1940 to the 1960s; primarily deep-water marine invertebrates.

3. Invertebrates collected during World War II in the South Pacific by Dr. Wilbur M. Chapman.

4. Department of Zoology, University of California, Berkeley; extensive collection of invertebrates, some dating back to before 1900. Allyn Smith (1964:2) comments, "This collection, containing some irreplaceable type specimens, was headed for destruction for lack of space to house it and competent personnel to care for it. In 1948 the Academy agreed to provide the space and the required curatorial care for its permanent preservation in the interests of future scientific study."

5. Cephalopod mollusks collected during the expeditions sponsored by the George Vanderbilt Foundation to the Central and South Pacific between 1951 and 1954.

6. The Frank M. MacFarland (Fig. 2C) western North American opisthobranch mollusk collection acquired by the Academy in 1961. The collection was made by Professor MacFarland during his assiduous lifetime study of this group. The collection contained many undescribed taxa.

7. A collection of mollusks from the Pacific coast of Baja California made by Colonel Lee O. Miles. This collection was originally deposited with the Dillon Beach Marine Station of the University of the Pacific in 1962, but was later transferred to the Academy.

8. The Stanford University and Hopkins Marine Station collections were transferred to the Academy between 1963 and 1972. Smith (1964:4) describes the Stanford acquisition,

> A very large collection of preserved invertebrates formerly housed in the Natural History Museum at Stanford University [was] deposited with the Academy for permanent preservation and scientific study in 1963–64. This acquisition contains material from various Stanford expeditions as far back as the Hopkins-Stanford Expedition to the Galápagos Islands in 1897–98 participated in by R.E. Snodgrasss and Edmund Heller. It also contains a large series of starfish acquired by Dr. Walter K. Fisher (Fig. 2D), many invertebrates from Pt. Barrow, Alaska, and an extensive collection of crustaceans. Many type specimens are included…Addition of the Stanford Collection, estimated at ten tons of material, comes close to doubling the size of the Academy's holdings, which was already extensive. As a result, the Academy is rapidly becoming well known as a centralized depository for preserved invertebrates that can be used for scientific research by specialists and qualified students. No other institution on the Pacific Coast now has so large and so representative a collection, which is being made available for future study; and so far as known, none is

> attempting to build up and maintain one for a similar purpose. Scientists working in the field of aquatic biology must therefore rely more and more on the Academy as being about the only source of such scientific material available to them.

The October 1972 *Academy Newsletter* describes the acquisition of the Stanford University Hopkins Marine Station collections,

> A major collection of marine invertebrates of the Pacific Ocean, built up over the past half-century by leading Pacific Coast marine biologists, that had been in storage at Hopkins Marine Station in Pacific Grove, has recently been transferred to the research collections of the CAS' Department of Invertebrate Zoology…The collection, totaling more than 4,000 lots and ranging back to the mid-19th century, is judged to be of tremendous scientific and historical interest, and includes the specimens upon which many classic Pacific coast marine invertebrate studies were based. The collectors comprise a kind of 'who's who' among pioneer biologists of the coast, including David Starr Jordan, W.D. De Laubenfels, William Healey Dall, Alexander Agassiz, Libbie Hyman, S.F. Light, and many others, as well as specimens (Fig. 7A) collected by E.F. Ricketts (Fig. 7B) and John Steinbeck in the Sea of Cortez. The former is 'Doc' in Steinbeck's novel 'Cannery Row'…Included in the material are many unique specimens of marine animals rarely seen by marine biologists. And there is non-invertebrate material among which is a three-inch humback whale embryo!

An internal Academy report (Anonymous, ca. 1985) describes the Stanford and Hopkins acquisitions during the early 1970s, "During this period, the remaining collections of Stanford University were transferred to the Academy. This included a teaching and reference collection from the Hopkins Marine Station at Pacific Grove, which was soon discovered to be scientifically unique and one of the most historically important collections of west coast Invertebrata. The collection contains many specimens collected as early as the mid-19th century. Many type specimens of the ostracods described by Tage Skogsberg, and thought to be lost to science, were discovered. Well over 100 primary and secondary asteroid types of W.K. Fisher were also ''rediscovered.' Many specimens bore a California Academy of Sciences label; the synoptic collection begun by the Academy in 1914 and accumulated by W.K. Fisher had finally 'come home' to the Academy."

9. Various expeditions of Franz B. Steiner (Fig. 13C), between the late 1950s and 1975, produced a wealth of marine invertebrate material for the Academy collections, mostly from the tropical Indo-Pacific, but also from the Atlantic and eastern Pacific.

Conclusion

To summarize, the California Academy of Sciences has had a strong interest in the field of invertebrate zoology since the institution's inception in 1853. This early research interest began with molluscan shell collections from the Pacific Coast of North America. A Department of Invertebrate Zoology was not established until 1914, eight years after the earthquake and fire of 1906 that wiped out the Academy's research collections. Walter K. Fisher, an eminent specialist on asteroid echinoderms, became the first Curator of the department, although Gustav A. Eisen was named Curator of Marine Invertebrates in 1899, fifteen years before a formal department was created. The original department gradually became inactive and poorly funded, but in 1960 it was formally reactivated. The department was combined with the Department of Geology (formerly Paleontology) in 1982.

Since the 1906 earthquake, the Academy's invertebrate zoology collections have grown rapidly to over half-a-million-specimen lots of recent invertebrates of worldwide scope, but with a geo-

graphical emphasis on the Pacific Basin. Taxa with the largest representation are sponges, coelenterates, mollusks, crustaceans, echinoderms, and tunicates. In addition, a large collection of fossil invertebrates — mostly mollusks — is curated and housed in the Department of Invertebrate Zoology and Geology.

With the advent and growth of the Internet since 1995, the electronic informational revolution has radically changed the way information is recorded and accessed. As with any rapid technological advance, the benefits do not come without costs. One aspect that is obviously serious and worrisome to historians is what can best be called *the deletion of history*. Prior to the mid-1990s, documentation of occurrences, events, and administrative details relevant to an institution such as the California Academy of Sciences was generally kept in the form of original letters, or copies thereof, in departmental files or institutional archives. Now, much of this type of documentation is, doubtless, deleted as "old e-mail messages" even before hard copies are made and filed. And while speaking of e-mail messages in the electronic information age, as we look to the future, we face a whole new set of problems, especially for those of us interested in knowing something of our past as a window into the future. The magnitude of the problem that this loss of voucher materials will create for future historians attempting to document research of post-mid-nineties events is likely to be enormous.

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Appendix 1

Chronology of Events Relating to the History of Invertebrate Zoology at the California Academy of Sciences

1853 (16 May) — California Academy of Sciences formally founded by adoption of the constitution, in a San Francisco office on Clay Street between Montgomery and Kearney.

1853 — Three curators-at-large without appointed specialties were added to the Academy staff: A. Kellogg, E.R. Campbell, H. Gibbons. A resolution was submitted inviting women to participate in the Academy.

1853–1906 — Contributions to the invertebrate collection were made by such notables as Alexander and Louis Agassiz, William Healey Dall, Addison Emery Verrill, Harry Beal Torrey, Samuel J. Holmes, William Emerson Ritter, Gustav Eisen, and William Neale Lockington.

1854 — In September, the Academy first publishes its *Proceedings* (Volume 1).

1867 — The Academy meets in new rooms at 622 Clay Street.

1874 — The Academy establishes its first public museum: the First Congregational Church on DuPont Street.

1875 — The number of Academy research departments had grown to six. Two of these involved marine invertebrates and were headed by: W. M. Lockington (Curator of Crustacaea, Radiates and Ichthyology) and William G.W. Harford (Curator of Conchology).

1885 — Three curators were appointed to handle their specialties, including Dr. William Orville Ayres as Curator of Zoology.

1891 — The Academy moves into larger quarters on Market Street.

1892 — Academy expedition to Baja California with Gustav Eisen.

1893 — Dr. Gustav Eisen appointed Curator of Archaeology, Ethnology, and Lower Animals.

1899 — Dr. Eisen's title was changed to Curator of Marine Invertebrates.

1905/06 — Year long Galápagos Expedition on board the schooner *Academy*.

1906 — Destruction of the Academy's research collections, library, and exhibits by the San Francisco earthquake and fire.

1906–1950 — Contributions to the invertebrate collection were made by various researchers including David Starr Jordan, Walter Kenrick Fisher, William Beebe, Sol Felty Light, and Libbie Henrietta Hyman.

1914 — Establishment of the Department of Invertebrate Zoology with the initial goal of making a synoptical series of marine invertebrates of the California coast.

1917 — Dr. Walter K. Fisher named Curator of the recently created Department of Invertebrate Zoology. He was at first paid a small salary, but in later years the position became honorary, and the Department became inactive.

1921 — Invertebrate collections made during the Academy's Baja California Expedition.

1932 and 1937–38 — Invertebrate collections made during the Academy's Templeton-Crocker Expeditions to Baja California, the Galápagos Islands, Easter Island, and the west coast of South America (see Figs. 6D-N).

1934–1939 — Dr. Frank Mace MacFarland served as acting Director of the Academy.

1938 — Dr. Robert Cunningham Miller, a marine biologist, became the Academy's Director. At that time, part of the recent invertebrate collection (mainly dried mollusks) was under the custody of the Department of Geology (known as the Department of Paleontology between 1925 and 1953).

1938–1959 — Curation of the recent invertebrate collection was by Dr. G Dallas Hanna (Curator of Geology) and Dr. Leo G. Hertlein (Associate Curator of Geology) with the assistance of three research associates: A.M. Strong, Mr. Allyn G. Smith, and Mr. Clifford C. Church. The rest of the invertebrate collection (mostly wet material preserved in alcohol or formalin) was divided and curated by Dr. W.I. Follett (Curator of Ichthyology) and Dr. Earl S. Herald, Curator of Steinhart Aquarium.

1940 — A large collection of marine invertebrates made during the expedition to Baja California by marine biologist Edward Ricketts and novelist John Steinbeck was eventually acquired by the Academy in 1963 and 1972. The events of this expedition formed the basis for their jointly authored book, *The Sea of Cortez*.

1948 — The Academy acquires the U.C. Berkeley Department of Zoology invertebrate collection.

1949 — Continental shelf survey conducted by the Academy for the Office of Naval Research under the direction of G Dallas Hanna, on board the U.S.S. *Mulberry* for dredging operations along the California coast.

1959 — The two wet collections were physically merged, resulting from new construction, and moved to a research collection room in North American Hall, previously occupied by a large herpetological collection.

1960 — Reactivation of the Department of Invertebrate Zoology by the Board of Trustees on 1 July with Dr. Robert C. Miller appointed as Curator. Mr. Allyn G. Smith, formerly a Research Malacologist in the Department of Geology, becomes the Associate Curator.

1963 — A two year NSF grant awarded to standardize and systematize the Academy's collection of preserved Recent marine, land and freshwater invertebrates in order to make it available for research. This was followed by a two-year extension from NSF.

1963 — Dr. Charles R. Stasek is appointed research biologist.

1963 — Dustin Chivers appointed technical assistant.

1963 — The invertebrate collection of the Natural History Museum of Stanford University is transferred to the Academy.

1966 and 1971 — Allyn G. Smith is appointed Chairman of the Academy's Department of Invertebrate Zoology.

1966 — Dr. Donald P. Abbot offers most of the Hopkins Marine Station invertebrate collection to the Academy.

1966 — Posthumous publication by the Academy of Frank MacFarland's Studies of Opisthobranchiate Mollusks of the Pacific Coast of North America (see Figs. 6A-C).

1968-1971 — Victor A. Zullo serves as Chairman of the Department of Invertebrate Zoology.

1972 — Allyn Smith retires as Associate Curator and Chairman of Invertebrate Zoology. Dustin Chivers is made acting Assistant Curator with James T. Carlton as half-time curatorial assistant.

1972 — Most of the Hopkins Marine Station invertebrate collection (excluding the tunicates) is transferred to the Academy.

1973 — Dr. Welton L. Lee is appointed Chairman and Curator of Invertebrate Zoology.

1980 — Dr. Daphne G. Dunn (Fautin) appointed as a Curator of Invertebrate Zoology.

1980 — Dr. Barry Roth, Acting Assistant Curator for Malacology, is transferred from the Department of Geology to the Department of Invertebrate Zoology.

1982 — The Academy's Departments of Invertebrate Zoology and Geology are combined both administratively and physically on 1 July, with Dr. Peter U. Rodda (Curator of Geology) as Chairman.

1982 — Dr. Terrence M. Gosliner appointed a Curator of Invertebrate Zoology (malacology).

1982 — Robert Van Syoc appointed collection manager for invertebrates and fossils.

1983 — Dr. Michael T. Ghiselin (evolutionary biologist and MacArthur Fellow) joins the Academy staff and is later appointed Senior Research Fellow in Invertebrate Zoology.

1984 — Jean F. DeMouthe appointed collection manager for Mineralogy.

1984 — Elizabeth Kools appointed curatorial assistant in Invertebrate Zoology.

1984 or 85 — Donald Abbot's tunicate collection transferred to the Academy from Hopkins Marine Station.

1989 — Dr. Patrick Kociolek appointed Hanna Chair of Diatoms.

1990 — Dr. Gary Williams appointed Post-Doctoral Fellow in Invertebrate Zoology, and as a Curator of Invertebrate Zoology (coelenterates) in 1992.

1992 — Dr. Rich Mooi appointed as a curator of Invertebrate Zoology (echinoderms).

1999 — Dr. Peter Roopnarine appointed as a curator of Geology.

2003 — Sesquicentennial of the California Academy of Sciences.

2004 — The Academy moves to temporary quarters in downtown San Francisco at 875 Howard Street while its buildings and museum in Golden Gate Park, that had been deemed seismically unsafe, are demolished and new buildings are constructed at the same site.

2008 — The Academy begins the move back to the the Park to occupy its newly constructed cluster of museum buildings.

Appendix 2

Department Chairs

Department of Paleontology (became the Department of Geology in 1953)

1903–1916	Frank Marion Anderson
1917–1919	Roy Ernest Dickerson
1919–1968	G Dallas Hanna
1968–1971	Victor A. Zullo
1971–1981	Peter U. Rodda

Department of Invertebrate Zoology (established 1960)

1960(63?)–1968	Allyn G. Smith
1968–1971	Victor A. Zullo
1971–1972	Allyn G. Smith
1973–1982	Welton L. Lee

Department of Invertebrate Zoology and Geology (established 1982)

1982–1987	Peter U. Rodda
1987–1990	Terrence M. Gosliner
1990–1992	J. Patrick Kociolek
1992–1995	Rich Mooi
1995–1998	Gary C. Williams
1998–2001	Rich Mooi
2001–2004	Peter Roopnarine
2004–2008	Gary C. Williams