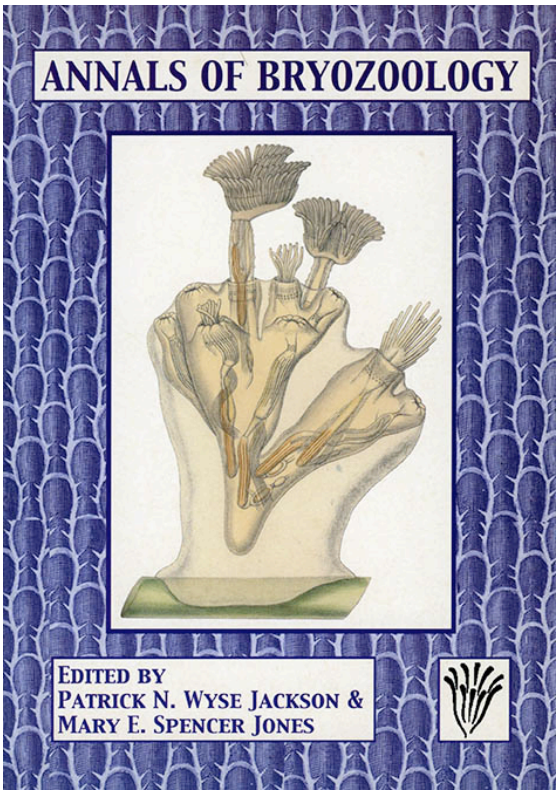

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North-eastern Pacific bryozoology and the American bryozoologists

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1. Early northeastern Pacific scientists
2. Pioneering American scientists of the nineteenth century
    2.1 Timothy A. Conrad (1803-1877)
    2.2 John Boardman Trask (1824-1879)
    2.3 William More Gabb (1839-1878)
    2.4 George Henry Horn (1840-1897)
3. Early twentieth century California scientists
    3.1 Alice Robertson (1859-1922)
    3.2 Raymond Carroll Osburn (1872-1955)
4. Latter twentieth century bryozoologists
    4.1 John Dutcher Soule (1920-2001)
    4.2 Christopher Gardiner Reed (1951-1990)
5. Contemporary bryozoologists
    5.1 June R.P. Ross
    5.2 Dorothy F. Soule
    5.3 Russel L. Zimmer
    5.4 Penny A. Morris
    5.5 Henry W. Chaney
6. Acknowledgements

1. Early northeastern Pacific scientists

The earliest Bryozoa identifications from the Pacific coast of America were cursory descriptions found in the diverse, mostly paleontological, works of T.A. Conrad,[1] J.B. Trask[2] and W.M. Gabb and G.H. Horn,[3] each independent thinkers, perceptive, rugged individualists with disparate fields of interest, two of them physicians. The organizations that provided the earliest of them with their central motivating forces were the Philadelphia Academy of Natural Sciences, the Pacific Railroad Expedition to California and the Mexican Boundary (the Wilkes Expedition) at the time of the Gold Rush and California statehood, the John W. Audubon Expedition, and the US Army during the Civil War.

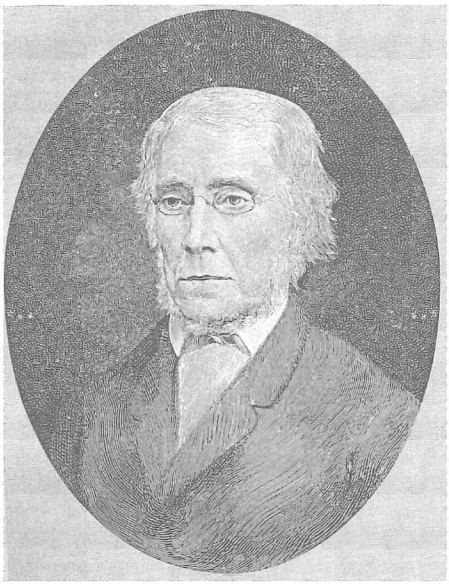

Figure 1. Timothy A. Conrad (1803-1877)

The first American Pacific descriptions were preceded by, or contemporaneous with, the descriptions of a few living species of bryozoans from Baja California by d'Orbigny in 1852 and 1853 and 13 from Mazatlán, Mexico, by George Busk in 1856 and 1857, mostly specimens scraped from the Reigan molluscan collections.

Studies by the British specialist Thomas Hincks in 1882 through 1884 on the "Polyzoa of the Queen Charlotte Islands" were based on collections provided by Dr G.W. Dawson of the Canadian Geological Survey. He provided descriptions of 95 species from British Columbia, many of them new, but as was the fashion of the times, descriptions were brief and illustrations rudimentary in most cases.

Later Dr Charles H. and Elsie O'Donoghue in 1923 to1926 published lists of about 210 species and varieties of bryozoans from the Vancouver Island region and Puget Sound, Washington, but with relatively few illustrations. Their collections were deposited at the Natural History Museum, London, but were only re-located in recent years for comparative studies.

2. Pioneering American scientists of the nineteenth century

2.1 Timothy A. Conrad (1803-1877)

Timothy Conrad (Figure 1), the eldest of ten children, was born near Trenton, New Jersey

at his grandmother's home, but lived in Pennsylvania where his father was founder of a publishing firm. He was educated in private schools, was fluent in Latin, Greek and French, but did not study formally at a college or university. However, his parents' home was a center for discussion for learned friends who were interested in natural history, and as a boy he was president of a juvenile scientific society. Before he was 30, he was recognized as one of the foremost conchologists in the country and granted membership in the Philadelphia Academy of Natural Sciences.[4] His sister, Susan, hand-coloured the 17 plates in his first volume published in 1831.

At the Philadelphia Academy he met several wealthy amateur collectors who invited him to come to North and South Carolina and the new state of Alabama to look at the fossils on their extensive lands; he later travelled to Florida and Tennessee. Conrad, who was essentially a loner and never married, existed mostly on the good will of his wealthy patrons. Travelling on a pittance, by sea, on horseback, by wagon or walking, often in ill-health from exploring the coastal swamps unpleasant with a "miasma" of disease, he mapped the famous Claiborne (Alabama) sands, establishing the extent of Tertiary boundaries in the southeastern United States.

Conrad wrote poetry extensively while travelling. He was also involved in contentious disagreements with colleagues who published descriptions of specimens he collected and sent home before he could return.[5]

Conrad never ventured to California, but identified palaeontological specimens collected during the Charles Wilkes Expedition, also known as the Pacific Railroad Expedition to California and the Mexican Boundary, for which he received the great sum of $10. It is from this report[6] that we have the first California record of a bryozoan, one of the most recognizable of the California Pleistocene and Recent fauna, *Idmonea californica* (d'Orbigny, 1853), (= *Diaperoecia*, now *Diaperoforma*).

Conrad served in and then headed the New York State Geological Survey from 1837 to 1842, for which he was paid $1,500 per year, the only real salary he ever had. He invested in railroad stocks which fortuitously made his last years relatively comfortable. The New York survey was something of a fiasco, however, when district palaeontologists dumped their collections on him to identify, at which time he resigned.

Conrad apparently spent several intervals at the Smithsonian Institution but was not paid for those journeys. However, his impact in Washington was important, for in 1838 Conrad was one of those who helped found the now-prestigious American Association for the Advancement of Science (AAAS).

A reclusive figure, Conrad retired to live either at his brother's home in Philadelphia or at his modest retreat in Trenton, New Jersey, but continued to publish through the

Figure 2. John Boardman Trask (1824-1879)

Proceedings of the Philadelphia Academy of Natural Sciences. In 1870-1871 he served as volunteer assistant to the head of the North Carolina geological Survey, living with the family of the State Geologist in Raleigh. It was later reported by the family's small daughter that he subsisted on a diet of bran, biscuits and sour milk.

Conrad's publications totalled 197, including his poetry, and he was a prodigious letter writer, leaving an extensive correspondence with major national and international scientists and scientific institutions of his time. At his death, his small obituary remarked on his modest and unobtrusive life as a scholar, scarcely known outside his family, while he was known and honoured by the great and learned around the world. The only known picture of him is from a photograph poorly retouched by a member of his family.[7]

2.2 John Boardman Trask (1824-1879)

Trask (Figure 2) was born in Roxbury, Massachusetts, in 1823 or 1824[8] and came to California as a physician with the John Woodhouse Audubon party (son of the ornithologist, John J. Audubon), arriving in 1849, the year gold was discovered in California. During his travels he collected botanical specimens, particularly medicinal flora, and fossils. The party travelled from New York to Baltimore by boat, overland to Cairo (Illinois), down the Mississippi River to New Orleans, across Mexico on the Rio Grande, the Gila River and the Colorado River, and on to San Diego and San Francisco. The group was plagued by desertions, and also by cholera, which Trask was able to treat with some success although he was considered an eccentric, probably for his views on sanitation. He settled

in San Francisco permanently.

Trask's education as a physician was typical of the times, wherein he apparently apprenticed to a physician, Dr John Adams McLean, in Norwalk, Connecticut, and then attended Yale College for a year, in 1846-1847. During that period he studied natural philosophy, had access to geological collections and studied mineralogy, botany and chemistry as well as the usual medical subjects taught at that time, also writing a medical thesis. Yale conferred an honorary doctorate on him in 1859.

Trask took the lead in establishing the California Academy of Sciences in San Francisco with seven others in 1853, and described Recent and fossil molluscans from the State in the first volume of the Academy's *Proceedings* in 1855-56.

Trask's small paper on nine new species of zoophytes from San Francisco Bay, five of which were bryozoans, was published by the California Academy.[9] He described the common *Crisia occidentalis*, *Scrupocellaria californica*, *Crisidia gracilis* (now *Filicrisia*; ? = *F. franciscana* (Robertson, 1910), *Menipea occidentalis* (now *Tricellaria*) and *Hippothoa amabilis*.

At a time when most arrivals in California were bent on profiting from the "Gold Rush", it is remarkable that these venturesome men, who were considered as "akin to cranks, pottering with shells and bugs and posies"[10] established the first Academy of Sciences west of the Mississippi in San Francisco. In 1858, Trask and Dr David Wooster established the first medical journal in California, which Trask edited for many years.

Trask began an unofficial geological survey of the Sacramento and San Joaquin valleys and the California coast between the 41st and 42nd degrees north latitude, after the State Legislature had failed to fund it; hence the disputed title given to Trask as the first State Geologist. Trask was initially interested in the mineralogy and mining areas of the State, and in underground water resources, but became entranced with the geological record of earthquakes. He calculated the extent of current earthquakes by using the telegraph to inquire where and at what time local telegraph offices felt the quakes,[11] and is thus considered one of the pioneers in California seismology.[12]

Trask served in the Civil War as a contract officer with the rank of Acting Assistant Surgeon, mainly at Alcatraz Island, the Presidio and Alameda County, California, and then signed up for duty in Washington, D.C. His treatment of patients with cholera and diarrhea was considered radical, as he experimented with doses of bismuth (precursors of modern digestive nostrums). His complaints about lack of camp sanitation standards and his insistence on discharging wounded and depressed soldiers rather than returning them to the lines led to increasing disagreements with the military and he requested cancellation of his contract.

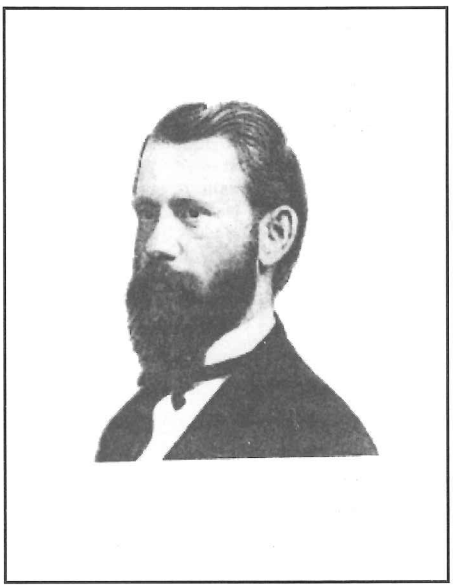

Figure 3. William More Gabb (1839-1878)

Figure 4. George Henry Horn (1840-1897)

Trask returned to San Francisco to practice medicine and gradually disappeared from scientific circles until his death at the age of 55 in 1879, which went almost unremarked locally. However, he had been given recognition by various European and American scientific societies and had honorary degrees from Italian and German colleges, awarded for discoveries in organic chemistry, mineralogy, microscopy and medical botany.[13] The rigors of his extensive travels and explorations probably shortened his life.

Trask's collections and records deposited at the California Academy of Sciences were lost when the Academy building, donated by James Lick, was destroyed in the fires that followed the earthquake of 1906.[14] Lick is better known for the observatory named for him.

2.3 William More Gabb (1839-1878)

William Gabb (Figure 3) was born and raised in Philadelphia, Pennsylvania, and was acquainted early on with the Philadelphia Academy of Natural Sciences. He attended Philadelphia High School, from which he received a B.A. degree in 1857, a different concept of high school from modern standards. He then determined to specialize in geology and palaeontology, studying under James Hall in Albany, New York. He returned to his home in Philadelphia, but later spent some time at the Smithsonian Institution in Washington.

In 1861 Gabb was selected to serve as Paleontologist for the Geological Survey of

California; at 22 years of age he was considered to be the foremost authority on Cretaceous marine paleontology in America, with 22 papers already published. He would have known Timothy Conrad and his future collaborator, George H. Horn, at the Philadelphia Academy of Sciences[15] and may have known Horn in high school.

Gabb remained in California for six years, covering hundreds of miles on horseback with his companion, William H. Brewer. It was from this period that descriptions of six species of Bryozoa were published, *Semitubigera tuba* (now *Tubulipora*), *Crisia serrata* (now *Crisia serrulata*), *Phidolopora labiata* (? = *P. pacifica* (Robertson, 1910), *Idmonea californica* Conrad 1855 (= *Diaperoecia,* now *Diaperoforma*), and *Lichenopora californica* (Gabb and Horn, 1862), probably *Disporella californica* now. Geological results were published by the Geological Survey of California in 1864 and 1869.

Gabb went on to explore and map the peninsula of Baja California in 1867, travelling the length by mule and traversing its width 10 times. He combined research in geology, topography, natural history, palaeontology and ethnology in his reports. He then made several trips to Santo Domingo in the Caribbean, and explored Costa Rica, creating detailed maps of the lands he explored.

Gabb apparently fought "consumption" (tuberculosis) and "coastal fever" (possibly this was malaria), until pneumonia ended his life in Philadelphia at the young age of 47 years. He left a written legacy of 88 publications.[16]

2.4 George Henry Horn (1840-1897)

George H. Horn (Figure 4) was born in Philadelphia in 1840, and received his education at Central High School, where he received a Bachelor of Arts and Masters degrees. He then received his medical degree from the University of Pennsylvania in 1861. Horn enlisted in the U.S. Army as an Assistant Surgeon in 1863, and was sent to California, where he was promoted to Surgeon. He remained in the Army until 1866, spending time in Arizona and New Mexico as well as California. Interested in natural history in his youth, he became an expert in Coleoptera. He encouraged the foot soldiers in collecting wherever he was posted as Surgeon, thus procuring extensive collections and many rare specimens.[17]

On Horn's return to Philadelphia, he established an obstetrical and gynocological practice, and was considered an expert in difficult cases. He never married, working long hours on his entomological collections at night, and retaining a principal interest in the California fauna. He was long connected with the Philadelphia Academy of Natural Sciences where he served in various positions, and was a prominent member of the American Philosophical Society and the American Entomological Society.

Figure 5. Alice Robertson (1859-1922)

Horn's collaboration with William Gabb[18] on Bryozoa was probably as illustrator, at which he was considered skilled,[19] but not artistic.[20] He published about 240 papers, only six of which were not entomological. Most were monographic, and he briefly described about 240 genera and 1,550 species. He was always interested in evolutionary relationships.

Horn's early death at the age of 57 from apoplexy was attributed to the intense schedule he kept in his medical practice, coupled with the extensive work he put into his monographic studies of Coleoptera. The latter which made him a worldwide authority in this group.

3. Early twentieth century California scientists

3.1 Alice Robertson (1859-1922)

Alice Robertson, of Scottish ancestry, was a pioneer in America as a woman in science.[21] Records of her early life have not been found, other than that she was born in Philadelphia, according to *American Men of Science*.[22] We have no information as to when she went to California, but she received her B.S. in 1898 when she was almost 40 years old, her M.S. in 1899, and her Ph.D. in 1902, all from the University of California, Berkeley (UCB). She continued at Berkeley as Assistant in Hygiene for Women in 1902-1904, and Assistant in Zoology from 1904 to 1906. During her affiliation with Berkeley, she produced some of her best bryozoan research.[23]

Robertson left Berkeley in 1906 to become an instructor in Zoology at Wellesley College in Wellesley, Massachusetts, and served as an Associate Professor and Chair of the Zoology Department from 1909 until she left due to ill health in 1919 [reputed to have

been from the worldwide influenza epidemic]. During her Wellesley years her publications continued from Berkeley.[24] Her research was painstaking and her illustrations accurate. At Wellesley she was regarded as an excellent and kindly teacher, with a hearty sense of humour and widely ranging interests in literature and politics.[25]

After a year's illness, Robertson spent some months at the University of Washington laboratory at Friday Harbor on Puget Sound. She then returned to the University of California, Berkeley, where she was associated with their Department of Public Health. She was also a zoology assistant with the Marine Biological Association of the San Diego's marine station, which was then directed by a UCB faculty member on a rotating basis (now UCB's Scripps Institute of Oceanography). Although her health was fragile, she continued her research and published a report on a collection of Bryozoa sent to her from the Bay of Bengal in 1921. She died unexpectedly in hospital following surgery, in 1922.

Robertson's publications on the Bryozoa of the west coast of North America from Alaska, and from Puget Sound to southern California[26] provided the only accurate descriptions of fauna with detailed illustrations prior to the monographs of Osburn.[27] Those of earlier investigators were limited in descriptions or lacked adequate illustrations. She made detailed embryological studies of the cyclostome genus *Crisia* for her dissertation.[28]

Unfortunately, Robertson's type specimens and collections were subsequently lost at the California Academy of Science in San Francisco. Untrained volunteer personnel placed all specimens labelled with the same species name, regardless of who had identified them or where the specimens were collected, in the same container to save space and money when new containers were purchased. The loss of her types has presented considerable difficulty for later investigators.

3.2 Raymond Carroll Osburn (1872-1955)

Raymond Osburn was born in the small town of Newark, Ohio. He was the first of the west coast Bryozoa research men who had not been born in the eastern United States and was not a geologist, palaeontologist or physician. He obtained his Bachelor of Science in 1898, his Master of Science in 1900, and an Honorary D.Sc. in 1949 from Ohio State University in Columbus.[29] His Ph.D. was awarded by Columbia University, New York in 1906 for work on the origin of verebrate limbs, particularly those of primitive sharks.

Osburn taught at Fargo College (North Dakota), at Barnard College in New York City, and at Connecticut College for Women before becoming Associate Director of the New York Aquarium under the famous director, Henry Fairfield Osborn. In 1917, he returned to Ohio State University, where he served as Chairman of Zoology and Entomology until

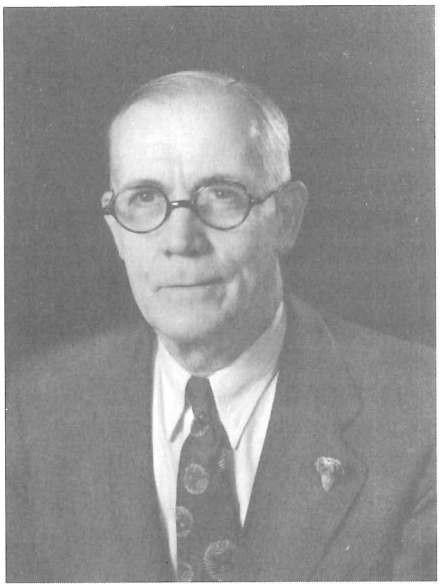

Figure 6. Raymond Carroll Osburn (1872-1955)

his retirement in 1942, and as summer Director of the Franz Theodore Stone Laboratory of Ohio State on Lake Erie, from its establishment in 1918 until 1937.[30]

Osburn had already retired from a distinguished career when he was invited in 1945 to come to the University of Southern California (USC) Allan Hancock Foundation as a Research Associate to study their extensive collections of eastern Pacific Bryozoa. Most of their collections were from 10 research cruises, with more than 1500 biological dredge stations and 2000 bottom samples, carried out by Captain G. Allan Hancock's ship *Velero III* in Oregon, California, Baja California, the Caribbean, Galapagos Islands and Peru. Although Hancock was a self-taught captain, licensed for any ship on any sea, he always employed a fulltime captain on all cruises. He later commissioned building of a research vessel, *Velero IV*, which made hundreds of research cruises in southern California before being decommissioned and taken to Alaska as a fishing vessel.

Hancock, a Los Angeles landowner and oil developer (the famous La Brea tar pits were on his ranch), had extensive agricultural operations in Mexico and had sailed often aboard his own freighter or his yachts. In the 1930s, he was persuaded by the California Academy of Sciences to undertake trawling for fishes, and a USC biology professor, Dr Irene McCulloch, asked if her graduate students might accompany them to collect invertebrates.

In 1939 the Captain completed a four-storey research building at USC to house his collections, and in 1945 purchased most of the defunct Boston Society of Natural History library, providing extensive literature that was crucial to Osburn's studies.

Osburn, with the aid of USC graduate students, also assembled a prodigious array of collections donated or on loan from various sources: the U.S. National Museum "Albatross' Fish Survey stations; the Alaska Crab Investigation; Prof. George E. and Nettie MacGinitie of the U.S. Navy's Arctic Marine Laboratory at Point Barrow, Alaska; the Pacific Biological Station at Nanaimo, British Columbia; the Oceanographic Laboratory (University of Washington) at Friday Harbor, Washington; Pacific Marine Station, Dillon Beach, California; Robertson's collections from the California Academy of Sciences; E. Alice Blagg's collection (unpublished) from Hopkins Marine Station (Stanford University), Pacific Grove, California; the Los Angeles County Museum of Natural History; Kerckhoff Marine Station (California Institute of Technology), Corona del Mar, California; Scripps Oceanographic Institution (University of California), La Jolla, California; and the Galtsoff Collection of the U.S. Fish and Wildlife Service from Panama. Most earlier collections were from shallow waters, making the *Velero* biological dredge samples particularly important.

Osburn retired for the second time in 1952, at the age of 80. The results of his studies were published in three volumes, *The Bryozoa of the Pacific Coast of America*,[31] for which he was awarded the Daniel Giraud Elliott Medal by the U.S. National Academy of Sciences in 1953, two years before his death.

Osburn's interests were wide ranging, from evolution, fisheries and insects to bryozoans. His early interest in Bryozoa began in summers spent at Woods Hole, Massachusetts, and publications covered Labrador, Newfoundland, Nova Scotia, the Canadian Arctic, Hudson Bay, and the Caribbean between 1912 and 1947 prior to undertaking the west coast studies.

A strong supporter of scientific societies, Osburn held many important posts. He was President of the American Microscopical Society, the American Limnological Society, the Ohio Academy of Sciences and the Ohio Chapter of Sigma Xi; he was Secretary of the American Fishery Society; Vice President of the Ecological Society of America; and active in may others. He also was for years the editor of the Bryozoa Section of *Biological Abstracts*.

Osburn's avocations were wide ranging as well; he and his wife, Mary Hubbell Osburn, whom he met while teaching in Fargo, were musicians, sometimes indulging friends and students in piano-violin duets, and he wrote lengthy poetic commentaries on all sorts of subjects. Although they had no children, they quite enjoyed the offspring of graduate students, being Uncle Ray and Aunt Mary to them, and the tall, slim gentleman dressed up as Santa for the annual Christmas party. John Soule was Osburn's last graduate student.

4. Latter twentieth century bryozoologists

4.1 John Dutcher Soule (1920-2001)

Born in Moline, Illinois, John Soule (Figure 7) graduated from Western Military Academy in Alton, Illinois and received a Bachelor of Arts from Miami University, Oxford, Ohio in 1942. He served four years in the US Army, as a medical field and laboratory officer in the Philippines and the occupation of Hiroshima-Kure, Japan. Soule came as a post-war graduate student to the University of Southern California (USC), where he met and studied under R.C. Osburn, receiving a Master of Arts in 1948 and a Ph.D. in 1952. He held a post-doctoral fellowship at the California Institute of Technology Kerckhoff Marine Laboratory in 1958 and 1959 under Dr. George Beadle.

Soule taught Histology and Pathology at the USC School of Dentistry for 41 years where he chaired the Histology Department for 14 years, was chair of Basic Sciences for many terms, and served on occasion as Assistant Dean for Admissions. He conducted research on histological stains, inventing Soule's Gold Chloride stain, studied comparative development of dentition in lower vertebrates, and did early studies on bioadhesives secreted by marine invertebrates including bryozoans, particularly as they applied to coral reef stabilization.[32]

Soule was the first bryozoan researcher in the USA to do extensive histological studies on post-larval development of Ctenostomata, discovering that the sequential development of musculature demonstrated the diphyletic nature of the group. Previously, the Ctenostomata had been separated into four divisions based mainly on adult anatomy or polypide development. He studied muscle sequences in six genera of Carnosa and 13 genera of Stolonifera, comparing them with anascan and ascophoran genera.[33] He wrote the Ctenostomata section in Osburn's monograph.[34]

After extensive histological studies on burrowing bryozoans[35] he became convinced that the Penetrantiidae were more aligned with the cheilostome line than with ctenostomes (*sensu stricto)*, in keeping with the concept on the union of the two groups at the ordinal level expressed by Lars Silén, with whom the Soules consulted.[36] He coauthored several other papers on burrowing bryozoans including one on Cretaceous burrowers with E. Voigt.

Soule authored or co-authored over 100 publications on bryozoans and other topics. His research included zoogeographical and faunal studies of Bryozoa in California and Baja California. Using scanning electron microscopy, he and his wife, Dorothy, and others described new species of Hawaiian Smittinidae, Watersiporidae and Thalamoporellidae worldwide, new genera of tropical Cleidochasmatidae, Cribrilariidae, and other groups, and returned to faunal studies of the Santa Barbara Channel, California, with revisions of

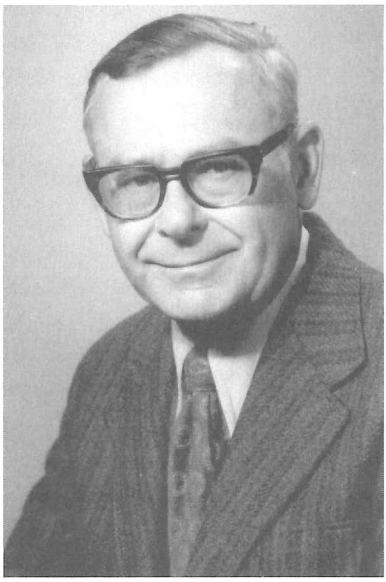

Figure 7. John Dutcher Soule (1920-2001)

west coast species formerly attributed to Atlantic-Boreal or Mediterranean-Red Sea species.[37] They emphasized the generic and specific differences found in supposed cosmopolitan species, and the importance of recognizing true species diversity as it relates to species diversity calculations for environmental impact evaluations, especially in areas proposed for development.

Soule held joint appointments as Professor of Biological Sciences and Curator of Bryozoa of the Hancock Foundation, was a Research Associate of the American Museum of Natural History, The Santa Barbara Museum of Natural History and the Natural History Museum of Los Angeles County. He was a Fellow of the American Association for the Advancement of Science, the California Academy of Sciences and the Southern California Academy of Sciences. He served several terms as councilor and was a past president of the International Bryozoology Association and was an officer in several other scientific societies. He has been listed in *Who's Who in America, Who's Who in the West* and *American Men and Women of Science*. He was also the recipient of numerous teaching awards, teaching about 200 new dental students each year for 41 years. The Computer Learning Center at the USC Dental School is named for him.

Soule met his future wife when they were undergraduates at Miami University (Ohio), and they have two daughters, five grandchildren and one great grandson. They began collaborating on Bryozoa in 1961, although she had previously done illustrations for him. At the time of his death from Parkinson's syndrome in June 2001 at age 80, he had two joint papers in press and several in preparation.

Henry W. Chaney, now at the Santa Barbara Museum of Natural History, was his last doctoral student, and Soule served on doctoral committees of several USC graduate students who have published on bryozoans. These were Robert Woollacott of Harvard University, William Banta of American University in Washington, DC and Michael Temkin of St. Lawrence University in New York.

4.2 Christopher Gardiner Reed (1951-1990)

The first of the bryozoologists born on the west coast, Chris Reed was born in Seattle, Washington in 1951, and grew up on Vashon Island, Washington and in Milwaukee and Lake Oswego, Oregon, giving ample opportunity for his interest in wildlife of all sorts, including a pet skunk.[38]

Reed attended Washington State University for a short time and then transferred to the University of Washington, where he completed his Bachelors and Doctoral degrees. His dissertation was on the reproductive biology, larval morphology and metamorphosis of the ctenostome *Bowerbankia gracilis*. His postdoctoral work was with Robert M. Woollacott at Harvard University on the morphology and mechanics of metamorphosis of coronate bryozoan larvae.

Hired by Dartmouth University in 1982, he remained there until his untimely death in 1990. His career was distinguished by summer fellowships at Woods Hole, Massachusetts, and characterized by excellence in teaching. He was an exciting and dynamic lecturer, yet a kind and approachable person. Reed was awarded the Gross Taylor and Cornelia Pierce Williams Assistant Professorship chair for distinguished teaching, and in 1989 the J. Kenneth Huntington Memorial award as Dartmouth's outstanding teacher, when he was awarded tenure. His research was productive also, for he published 36 papers, some coauthored with R.M. Woollacott and R.L. Zimmer on bryozoan larvae and with others on brachiopod, nemertean and polycheate larvae.[39]

Zimmer stated that "Chris would be remembered for discoveries of intercoronal and juxtapapillary cells, the median band of mesoderm, and the dual polypide and cystid rudiments of bryozoan larvae; for his exciting studies on bryozoan metamorphosis including the elucidation of the roles of ciliary reversal, muscles and myoepithelial cells in the rapid morphogenetic movements of early metamorphosis; and for the elegance of his electron micrographs, the detail of his drawings, and the clarity of his writing."[40]

In 1986 Reed learned that he had cancer of the lymph system and he waged a courageous battle, with radiation, chemotherapy and an autologous bone marrow transplant that followed an unsuccessful international search for a bone marrow donor. He was married during this period to Paula Borden and had a daughter, Erica. Chris maintained a joy of life and sense of humour in spite of his ordeal, continuing to inspire (and tease)

students, friends and colleagues throughout his short life span. He died shortly before his 39th birthday.

5. Contemporary bryozoologists

5.1 June R.P. Ross

In contrast to earlier bryozoan researchers, June Ross came to the western United States from Australia, by way of the east coast. June was born and raised in Australia. She received her Bachelor of Science in 1953, her Ph.D. in 1959, and a Doctor of Science in 1974, all from the University of Sydney in Australia.

June arrived in the USA in 1957 as a Research Fellow of the Peabody Museum at Yale University, where she was an American Association of University Women grantee and held the first of several National Science Foundation grants. From 1960 to 1965 she was a Research Associate at the University of Illinois, working on Middle Ordovician ectoprocts from New York State and Ordovician and Silurian ectoprocts from the central states. She then moved to Western Washington State University in Bellingham, Washington, serving there first as a Lecturer and as a Research Associate, becoming an Associate Professor in Biology in 1967 while studying Recent and fossil ectoproct phylogeny. She became a Professor in 1970, and is also a Research Associate of the University of Washington.

In addition to Biology and Zoology courses, June's teaching duties have included Evolution, Oceanography, History of Science, Electron Microscopy, Population Biology, and Human Populations and Natural Resources.

June has spent time at numerous research stations, including Friday Harbor Laboratory (University of Washington), the Lerner Laboratory in Bimini (American Museum of Natural History), the University of Georgia, Roscoff Marine laboratory in France, Scripps Institute of Oceanography in La Jolla (University of California), and in Japan and China as well as at industrial laboratories

June hosted the 7th International Bryozoology Association Conference at Bellingham in 1986.[41] She was president of the IBA in 1992-1995.

June's scientific interests have ranged widely: from Palaeozoic to Recent bryozoans to foraminifera, fusulinids, corals and entomology; to plate tectonics, calcification, evolution, ecology and palaeoecology; and to sea level changes, sedimentology, biostratigraphy, biogeography and palaeobiogeography. The geographic coverage ranges through time virtually worldwide, from Pangea through the Tethys, to Asia, Australia, the United States, Canada, the Middle East, and Europe.

June's publications include 138 titles beginning in 1957, some co-authored with her husband, Charles A. Ross.[42] Other co-authors include Mathew Dick, who was her Masters student and is now on the faculty of Middlebury College, Middlebury, Vermont. She has written sections for Encyclopaedia Brittanica, McGraw Hill and Encyclopedia of Science and Technology.

June is listed in *Who's Who in the West, Who's Who in America and American Men and Women of Science*. Her other interests include community planning for low income housing, family planning and medical service, and the League of Women Voters.

5.2 Dorothy F. Soule

Born and raised in Lakewood, Ohio on Lake Erie, Dorothy Soule received her Bachelor of Arts in 1945 from Miami University, Oxford, Ohio, where she met John Soule when she was a freshman and he a senior zoology laboratory assistant. They married after her second year when he was in the US Army. They had two children while John attended Graduate School at the University of Southern California (USC) after World War II. She received her Master of Arts from Occidental College in Los Angeles in 1963 and her Ph.D. from Claremont Graduate University in Claremont, California in 1969 while their daughters were attending university. They have five grandchildren and one great grandson.

Dorothy taught embryology and comparative anatomy as an undergraduate at Miami University during World War II, when many faculty were drafted and married women were not asked their age. She moved to California when husband John shipped out to the Pacific theatre and became a Research Associate at USC in the Biochemistry Department of the Medical School. She later taught comparative anatomy and microbiology labs at Occidental College, zoology, invertebrate zoology and embryology at California State College, Los Angeles and physiology at California College of Medicine before returning to USC's Allan Hancock Foundation in 1965 to do field and laboratory research on tropical Pacific bryozoans with John Soule.

Dorothy has authored or co-authored over 150 publications, beginning in 1947. Her byrozoan papers have emphasized morphology and speciation, zoogeography of tropical oceans worldwide and temperate eastern Pacific fauna, post-larval development and natural and manmade environmental impacts on species diversity.[43]

Dorothy is a Research Professor of Marine Biology and Curator of Bryozoa, and was an Adjunct Professor of Environmental Engineering for 24 years. She served as Associate Director of the federal Sea Grant Program at USC for several terms and is on their advisory board. She is a Research Associate of the Natural History Museum of Los Angeles County and the Santa Barbara museum of Natural History, and is a Fellow of the Southern California Academy of Sciences.

In response to national and state legislation on environmental quality in 1970, she established Harbors Environmental Projects at USC, bringing together multidisciplinary teams of marine biologists, oceanographers, geologists, microbiologists and environmental chemists from USC and other local universities to assess the impacts of public and private coastal sewage and industrial waste discharges, fish processing waste management, oil spills, a tanker explosion, use of dispersants, and coastal zone planning and management.

Part of the Environmental Impact Report (State of California) or Environmental Impact Statement (Federal) process is to determine species diversities by various methods. This led the Soules to reevaluate so-called cosmopolitan species of bryozoans. Examination by scanning electron microscopy led to identification of multiple new genera and species, and restricted distribution for former cosmopolitan species. Consulting and research gave them opportunities to collect bryozoans widely in the Pacific Islands. Bryozoan publications have emphasized morphology elucidated by scanning electron microscopy, speciation and worldwide distribution of several tropical and subtropical families.

Dorothy established, contributed to, and edited 30 volumes *of Marine Studies of San Pedro Bay* on southern California marine environmental quality, and she is an editor of the *Irene McCulloch Foundation monographs* published with the Hancock Institute for Marine Studies. She served on the National Academy of Engineering Panel on Deep Sea Mining, the National Science Foundation Panel on Systematic Resources, the National Marine Fisheries Advisory Board, the Environmental Protection Agency Science Advisory Board Task Group on Marine Monitoring, the National Academy of Sciences-National Research Council Panel on Monitoring in Southern California, the Association of Systematics Collections Council on Environmental Quality, and chaired the National Marine Fisheries Anchovy Management Panel. She also served on several local Los Angeles Harbor and Marina del Rey planning and management task groups. She has been listed in *Who's Who in America* and *American Men and Women of Science.*

Dorothy is active as a speaker on marine biology, IndoPacific bio-geo-politics and El Niño/global warming for USC's Emeriti Center outreach program and serves on boards of several University and other organizations.

5.3 Russel L. Zimmer

Russel Zimmer is also a midwesterner, born in Springfield, Illinois in 1931. Russ graduated from Blackburn College at Carlinville, Illinois in chemistry and mathematics but moved west to earn his Masters of Science in Zoology at the University of Washington in Seattle in 1956 and his Doctorate in Zoology there in 1964. He then served two years in the U.S. Army at Fitzsimmons General Hospital in Denver, Colorado, doing experimental vascular surgery research.

Zimmer came to the University of Southern California (USC) in Los Angeles in 1960 as an Instructor, successively becoming an Assistant Professor, Associate Professor and Professor. From 1968 to 1976 he served as Director of USC's Catalina Marine Science Center on Santa Catalina Island (now the Philip K. Wrigley Marine Science Center). He subsequently served on many university and departmental committees and as Vice Chair and Chair of the Department of Biological Sciences. Most summers he returned as a Visiting Professor at the University of Washington laboratories at Friday Harbor on Puget Sound, and spent a year as Visiting Professor at Harvard University. Russ retired from teaching in 2001 but continues to be involved in research at Friday Harbor and in university activities.

Zimmer's dissertation and research concerned reproductive biology and development of phoronids, with interest in other lophophorates including bryozoans focusing on embryogenesis, metamorphosis, larval photoreceptors,[44] and on phylogenetic relationships. With his former graduate student, Robert M. Woollacott, Professor of Organismic and Evolutionary Biology at Harvard University, he published developmental and physiological studies.[45] Perhaps their most outstanding collaboration was in their *Biology of Bryozoans*[46] which was a compilation of articles by bryozoan biologists on the state of information at that time. He has contributed articles to a number of edited volumes on metamorphosis and invertebrates as well. Other former graduate students of bryozoans include William C. Banta, Professor of Biology at American University, and Michael Temkin of Saint Lawrence University. Other invertebrate (non-bryozoologist) students included Gary J. Brusca (now deceased), author of a prominent American invertebrate biology textbook, and diverse students who have published on diatoms, barnacles, polychaetes, abalone, cumaceans, copepods, phoronids and decapods.

Zimmer was honoured by his former students and colleagues at a symposium dedicated to him at the American Society of Zoology national meeting in December, 2001, organized by his last doctoral student, Scott Santagata, now a post doctoral fellow at the University of California, Los Angeles (UCLA).

Zimmer married Cheryl Hildebrand, whom he met at USC, in 1967; she was fluent in French and willing to translate obscure manuscripts. She cheerfully helped Russ in dealing with students, faculty and many visitors at the then-new Catalina Marine Science Center when the faculty facilities in those years were a collection of decrepit trailers. They have two sons born during the Catalina experience. The only public school was an hour's bus ride on a dirt mountain road to the little town of Avalon on Santa Catalina Island. The island is only about 30 miles from megalopolis Los Angeles by small boat or an adventurous helicopter ride, but far away in lifestyle.

5.4 Penny A. Morris

Penny Morris was born and educated in California. She holds a Bachelor of Arts from California State University, Los Angeles (1964), a Master of Arts in marine biology from San Francisco State University (1972), and a Ph.D. in palaeontology from the University of California, Berkeley (1975). Her undergraduate interest in bryozoan taxonomy came in a course taught by Dorothy Soule, for whom she continued to work on environmental projects at the University of Southern California between degrees. Dorothy also served on her dissertation committee at UC Berkeley under J. Wyatt Durham. Penny also worked as a Research Assistant in the Woods Hole Systematics-Ecology Program and at the University of Massachusetts, Amherst, in Botany. She participated in research and collecting cruises to the Mediterranean and to Baja California during these years.

Penny lived in Sumatra and other Asian countries where her husband, David Smith, was employed in the oil industry, and her two daughters were born abroad. On her return to the United States, she taught various biology, botany, geology and paleontology courses at North Harris College from 1984 to 1989, and from 1988 to the present at the University of Houston-Downtown.

Her research interests have ranged from the California *Celleporina* and *Hippothoa*[47] to bryozoan faunas in California,[48] Baja California, thermal vent fauna off Newfoundland, and Warrawoona Group fossils in Australia. Studies, including substrate relations with algae, hermit crabs, molluscs,[49] bacteria and rock, have led to research on organic biomarker molecules in specimens from Mars and the signals of organic matter in evaporates. The latter investigations resulted in NASA grants and included fieldwork in the Dead Sea area.

Penny is interested in minority education and research opportunities in Space science, and organized a community outreach programme funded by NASA in collaboration with Hispanic Serving group and a coalition of historically black universities.

5.5 Henry W. Chaney

Henry Chaney was born in the San Francisco area and raised in Santa Barbara, California. He receive a Bachelor of Arts from Claremont McKenna College, Claremont, California in 1976, a Masters of Science from the University of Oregon in Eugene, Oregon in 1977, and a Ph.D. at the University of Southern California in 1983. His major undergraduate professor was a former student of Dorothy Soule at California State University, Los Angeles, and he recommended that Chaney undertake doctoral studies with John and Dorothy at USC in Bryozoa although he was already known as a malacologist. His dissertation research was on histocompatability in *Thalamoporella californica* colonies.

After post-doctoral research positions at USC, Henry was appointed to the Howard-Berry Chair in Malacology at the Santa Barbara Museum of Natural History and is now also the Director of Collections and Research there. He oversaw construction and the equipping of a new building to house the invertebrate collections, and has implemented obtaining significant invertebrate collections from donors and from public agencies following environmental evaluations in California.

An expert SCUBA diver, Chaney has travelled widely in the tropical Pacific, western Australia, the Indian Ocean, Egypt and Saudi Arabia. He has published on tropical molluscs, and has been a co-author on Bryozoa with the John and Dorothy Soule.[50]

Chaney has served variously as President, Vice President and Treasurer of the Western Society of Malacologists, Secretary of the California Malacozoological Society and on other organization boards. He is also President of the Irene McCulloch Foundation and Director of the Terra Marine Research Foundation.

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