MARTIN W. JOHNSON

1893 - 1984

BY EDWARD BRINTON AND JOHN A. MCGOWAN

7

Martin Johnson arrived at the Scripps Institution of Oceanography from the environs of Puget Sound, Washington, in the summer of 1934 to accept Director T. Wayland Vaughan's offer of the position of research associate, specializing in the study of zooplankton. In his distinguished 50-year career he contributed insight and direction to the emergence of biological oceanography as a significant discipline.

Martin Johnson, ca. 1970.

Among those still on the staff when Johnson joined Scripps were some who had worked under founding Director William E. Ritter. The intent of the embryonic marine research station during Ritter's early tenure had been to undertake long-term continuous observations of organisms under conditions of nature, presenting such as facts, unembellished by conditions made by man.[1] Ritter recognized the intense commitment of his some-time contemporary Charles Darwin to field study of "living organismal nature" (fossils also accepted) which clarified the prevailing expression "natural history." Further, Ritter, like Darwin, had reservations about use of the term "biology." Ritter suggests that Darwin either never heard of the word or didn't use it, recognizing that its derivation from the Greek "Bios," which encompassed the body, mind, and psyche of man, alone rendered it vulnerable to pre-conditions of an observer's mind, manifested as hypothesizing or speculation.[2] ("Modeling" then, might have referred only to an art form or a marketing enticement—from which modern scientific usage also tends to deviate.)

Martin Johnson was not one to be immersed in semantics, but he became adept at careful recording of animal form, function of parts, and their living nature. His emerging personal example was consistent with views of Ritter who came to recognize two schools of science, the "naturalist school" and the "laboratory school."[3] But no matter how the early Scripps Institution might change in its future, Ritter was convinced that it should stick to the main principle of being true to nature. And, years later, Johnson gave life and support to the longest-lasting, on-going time series of observations of plankton and other parameters ever undertaken.

Johnson is widely known as one of the three authors of the landmark 1942 text and reference, *The Oceans: Their Physics, Chemistry and General Biology*. His stature in the field was further enhanced by his wartime research, his postwar training of students, and his collaboration with them in describing the pelagic biogeography of the Pacific.

Family Migrations and Homesteading

Though Johnson's early years on the midwestern prairies and later, in the forests of Washington State, were almost without formal education, he considered that these experiences stimulated his interest in "fundamental ecology"—the difference in pasturage and grazing among all forms of life.[4] These were stepping stones.

Johnson's father, Kristian Johnson and his wife Julie came to America in 1880 from the Danish island of Bornholm. The Johnsons first headed for Illinois where they had friends who had migrated from Bornholm. After a year, the Johnsons moved to Wisconsin. Though a skilled blacksmith, Kristian Johnson could never quite give up the idea of farming, Martin Johnson writes in his memoirs. With a newborn son, Alfred, now in tow the stay in Wisconsin was brief. Their first homesteading venture was near the now-extinct village of Chandler, South Dakota. Martin was the last of four children born at Chandler during 1886-1893. Martin later wrote that near Estevan, Saskatchewan, a new farm provided him with what became his first lucid memories of a "home."

Work that ten-year-old Martin could handle included "sod-busting" to help prepare the soil for wheat fields and vegetable gardens. He became adept at clearing out the gophers that riddled the terrain, and learned to handle livestock and ride herd in the off season. Sod-roofed farmhouses and barns were built. He describes the chore of grinding up old buffalo bones to provide calcium for chicken feed.

There was no opportunity for schooling until years later when Martin took a job plowing and milking near Ambrose, a small North Dakota community. In 1907 the entire family moved there, selling the Canadian property and buying a blacksmith shop.

Martin and a brother started school in a one-room school house. Fifty years later, at Scripps, Johnson received a letter from his North Dakota teacher—still teaching but now in the California Central Valley. She apologized that she was afraid all she had done in the Ambrose School was to baby sit. Johnson responded "Maybe, but you knew how to baby sit, while still giving book learning."

Washington State

Eventually the family moved to the virgin forests of the Pacific slope in Washington State. The young men and boys engaged in logging work, while the elder

Johnson resumed his blacksmith vocation in the camps. Martin became a chocker setter. This led to a disabling leg injury, which occurred while handling a tangled cable. He never recovered full use of the leg but eventually retained only an inconspicuous limp.

While recuperating, he was enrolled in Pacific Lutheran Academy near Tacoma. He found himself to be older than the other students, but this, he believed, aided in completing the four year course in three years.

Many years later in 1966, after the academy had attained the status of Pacific Lutheran University, Johnson was elected Distinguished Alumnus.

Hanging the Web

Summers during these times, and those to follow when Martin was an undergraduate at the University of Washington, were spent working for the Alaska Packers Association at Point Roberts and the Salmon Banks at the San Juan Islands. The pre-season operations of driving pilings and "hanging the web" were followed in July by the actual fishing. Martin's work consisted of building traps, guarding them from pirates, and removing fish to the cannery scows. His "first abiding interest" in marine biology developed there while identifying bottom living animals and examining plankton with a borrowed microscope.

War Time

In the fall of 1918 he enrolled in the University of Washington. The ongoing war prompted him to join the Students Army Training Corps on campus. Subsequent induction into the army led to assignment to the Coast Artillery at Fort Warden.

Johnson had long been fond of music and had participated in local bands in the logging country, playing clarinet, mandolin, or drums. Now, in the barracks, music was the only entertainment, and Martin's mandolin served to accompany such arias as "The Old Grey Mare." Another member of the squad turned out to have been an orchestra leader from Seattle; he was assigned to organize a military band. Martin was the logical choice for clarinetist. The other musicians had never played instruments. With a still troublesome limp, Johnson was not shipped overseas—"Army experience had some practical value, but I lost a full year of study at the university."

The University and Friday Harbor

Returning to the university in 1919, he registered in the curriculum on fisheries. When he discovered that he knew more about building traps and canning than the teachers, he switched to zoology—and he joined the university band.

Upon completing undergraduate studies in 1923, he accepted an opportunity to teach general science at West Seattle High School. A year later he was pleased to be offered the curatorship at the university's Puget Sound Biological Station. This meant moving to Friday Harbor on San Juan Island.

There he was accompanied by his bride Lelia, whom he had met in an ecology course at Friday Harbor. Duties at the station ranged from preparing biological specimens for research and teaching to acting as deputy game warden. Water chemistry and temperature were monitored for records maintained by Dr. Thomas Thompson. Johnson also

contributed to initial studies by Dr. Robert C. Miller on seasonal settling of molluscan wood borers. Subsequent independent research led to Johnson's discovery of seasonal migrations of the destructive wood gribble, *Limnoria lignorum*. He showed that juvenile animals of this isopod crustacean have a migratory period that, in the island area, results in an early spring period of intensive attack on newly submerged untreated timbers such as pilings and boats.

In 1929, just before the collapse of the national economy, he quit his job to complete requirements for his Ph.D., most of which had been met earlier. During this period he was a teaching associate in the zoology department and returned to Friday Harbor for the summer sessions of 1930 and 1931.[4]

The International Fisheries Commission on the East Coast

The economic depression was in full swing in 1931 when Dr. Johnson was invited to join the scientific staff of the Passamaquoddy International Fisheries Commission appointed to investigate the probable effect on the herring fisheries if certain dams, proposed by President Franklin Roosevelt, were constructed across the entrance of Passamaquoddy Bay. Their purpose would be to utilize the high tidal range to provide power to generate electricity. The winter headquarters of the commission were to be at the Woods Hole Oceanographic Institution.

Upon Johnson's departure from Seattle, Dr. Thompson in his cultivated New York vernacular advised "Now Mätin, when you get to woiking among those benighted easterners and do something good, tell them that you are from the University of Washington." Professor Kincaid added "and if you do something not so good, tell them that you are from California."

The transit eastward was on a freighter by way of the Panama Canal. Numerous plankton samples were collected from water pumped into the ship's cooling system. This material from both temperate and tropical zones later contributed to clarifying some copepod taxonomic problems and to a published paper.

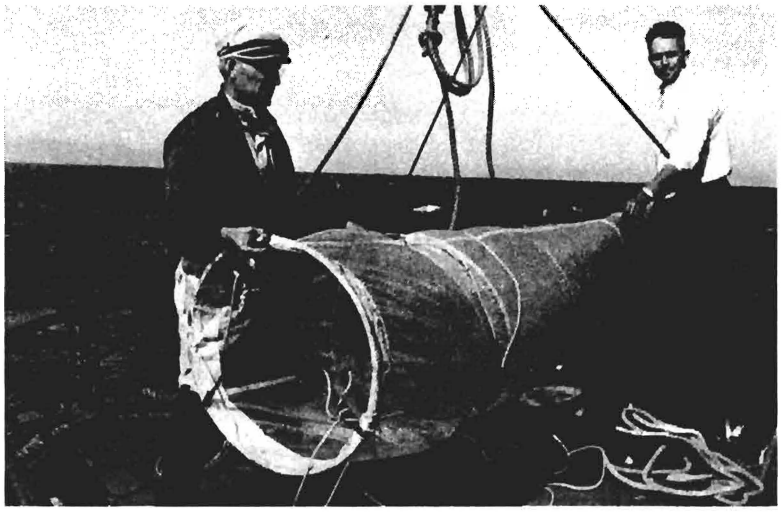
At Woods Hole several oceanographic cruises were dispatched to examine the Gulf of Maine and the Bay of Fundy. The vessel was a small U.S. fisheries boat. Net hauls and water samplings were made with a hand winch at which a couple of deck hands helped. The seas were rough, but the samplings proved adequate. Dr. Trygve Braarud, a phytoplankton specialist from the University of Oslo, worked with Johnson. The two became close friends. Johnson's graduate students in the 1950s remember well Braarud's visits to Scripps Institution of Oceanography.

In June 1933 the commission disbanded. Its final report was not favorable to building the dams as planned.[4]

At Woods Hole Oceanographic Institution, Johnson had become acquainted with Director Henry B. Bigelow, a Harvard professor. Bigelow's voluminous 1926 tome *Plankton of the Offshore Waters of the Gulf of Maine* had been singularly important to Johnson. Later it became a required reference for his graduate students at Scripps. His utterance "see BIGELOW!" still reverberates in the psyches of some of those students.

Scripps Institution of Oceanography

Early in his tenure as Scripps director, geologist Thomas Wayland Vaughan, who studied sedimentary deposits, foraminifera, and corals, was looking for someone working on biological problems who would also be interested in oceanography. Vaughan spoke of the difficulty to Dr. Bigelow of Harvard who replied "there ain't no such animal in the USA. You must either import him or bring him up." This exchange antedated the "bringing up" of Martin Johnson at the University of Washington and Johnson's subsequent contacts with Bigelow during the International Fisheries Commission work. The admonition turned out to be correct.



Martin Johnson and Earl Myers with plankton net aboard R/V *Scripps*, 1935. Photo by Eugene C. LaFond.

In 1934 Vaughan wrote Johnson in Seattle offering a research associate position at $100.00 per month, saying "We have on the institution's staff a few people who are not sea-going. I do not intend to add to the staff anybody else who will not work on water." Johnson was glad to get the low salary . . . in view of the then nation-wide depression, and "the sea-going stricture was not a deterrent to me."[4] He proceeded to consult with students Roger R. Revelle, geologist, and Richard H. Fleming, chemist, regarding seagoing facilities and what cruises, if any, were pending. There were ten researchers on the staff at the time, most of whom essayed brief ventures off San Diego in a 64-foot purse seiner, *Scripps*. Not long after, this vessel was destroyed in a dockside explosion. By 1937, a 105-foot converted sailing yacht was purchased for the institution by Robert P. Scripps and renamed *E. W. Scripps* in gratitude for the family's continuing favors. This was an all-weather vessel. "Johnson demonstrated his enthusiasm with a jaunty sketch of the ship on his 1937 Christmas Card for the institution's bulletin board."[5] Grids of stations in the Southern California Bight were occupied for physical, chemical, and biological observations during 1938 to 1941, the latter a strong El Niño year (though at that time not so designated). Longer multi-disciplinary surveys along the California Current and in the Gulf of California in 1939 provided Johnson zooplankton samples with which to begin serious study of the faunas of the easternmost Pacific. *E. W. Scripps* became a "work-horse" for the next 20 years.

Johnson became involved with fisheries biologists in developing practical quantitative plankton sampling methods. These activities presaged the enormous CalCOFI systematic investigations of the California Current, which have defined its ecology and hydrography

since 1949, and have contributed to management of fisheries by the National Marine Fisheries Service and the California Department of Fish and Game.

THE OCEANS: Their Physics, Chemistry and General Biology, by Sverdrup, Johnson, and Fleming, 1942

In 1936 the faculty at Scripps introduced a course in general oceanography in which it was "customary for those giving lectures to join the students as auditors in a following lecture given by some other faculty member." Thus the key principle, the interdisciplinary nature of oceanography, had early beginnings at Scripps and was clearly given more than lip service. From this was established the fundamental concept that each graduate student at Scripps, no matter what his discipline, should take core courses in physical oceanography, marine chemistry, biological oceanography, and marine geology. Both Director-to-be Harald Sverdrup and Johnson felt strongly about this issue, and their views prevailed from the late 1930s until recently when it was decided that the sheer intellectual demands of certain subdisciplines are so great that many students in those fields no longer are required to familiarize themselves with the remainder of oceanography.

To follow through on their ecumenical notions and to provide a textbook for their courses, Harald Sverdrup, Martin Johnson, and Richard Fleming collaborated on a book customarily called simply, *The Oceans.* It was, and still is, unique. Published in 1942[6] it initially received little attention, and some of that was not particularly complimentary. An early review in the *New York Times* read as follows: "...this book shows that oceanographers have gone down in the ocean deeper, stayed down longer, and come up drier than any other sailors." It is true that the writing style is distinctly reserved, Scandinavian, and in stark contrast to today's bated-breath, discovery-a-minute, public-relations mode of expression. Nevertheless, the book has been in print and in demand for sixty years.

It has long been known that the part of *The Oceans* dealing with physics is a masterful descriptive synthesis thanks mainly to Sverdrup. However, several of the biological chapters, for example "Organisms and the Composition of Sea Water" and "Animals in Relation to Physical-Chemical Properties of the Environment," although presented in low-key fashion, are also excellent syntheses and contain many unexpected nuggets. Buried in one paragraph is the observation that **it is very difficult to separate *in situ* changes from advective events when studying dynamic processes in the ocean**: some contemporary luminaries have failed to learn this little lesson.

World War II–The Deep Scattering Layer

The "Deep Scattering Layer" is probably Johnson's major wartime contribution. The use of acoustics, or underwater sound was (and still is) the main method of detecting submarines and water depth. However, many properties of the ocean itself interfere with the transmission of sound. This interference sometimes made submarine detection a very difficult job. An especially serious problem was an extensive sound reflection that appeared to be coming from mid-depths. Research engineers spent a lot of Navy time and money trying to determine the source of these signals. Some thought it was an artifact in the internal circuitry of the echo sounders.

But Drs. R. J. Christensen, C. F. Eyring, and R. W. Raitt of the Echo-Ranging Section of the University of California Division of War Research asked Martin Johnson to investigate the problem because they had heard him lecture about deep layers of zooplankton and because of his earlier success in recognizing signals produced by snapping shrimp. It occurred to Johnson that "... if the layer was composed of organisms, it should behave as many marine animals do, especially the plankton, and undergo diurnal migrations. ..."[7] He reasoned that the layer should begin an upward ascent around 5:30 pm (after engineers' normal quitting time) and migrate downward again around 6:00 am (before shipboard work has normally started). This formed the basis for an hypothesis, which Johnson formulated before a test was done, at sea, on the night of June 26-27, 1945. As a result, the biological nature of the deep scattering layer was established. This led the way for detailed studies aimed at determining how it varied in time and space and, indeed, why it existed at all. This became of interest far beyond the confines of the Navy, for such scattering layers are now known to be among the most prominent biological features of the world's oceans.

Loye Holmes Miller playing guitar and Martin Johnson playing mandolin in the galley of R/V *E. W. Scripps*, Gulf of California Expedition, 1939.

The Underwater Sound Mystery

In 1942 Johnson was asked to work with the University of California Division of War Research at the U.S. Navy Electronics Laboratory on Point Loma in an effort to identify certain ambient underwater noises that interfered with listening and other sonar operations carried on by the Navy. The subsequent research was carried out on *E. W. Scripps* and on sound scouting surveys on Navy vessels.

At first Johnson was as mystified as anyone. Suggestions of both physical and biological natures were offered as causes of the sound. The areas Johnson found to be characterized by the particular noise further suggested that the types of habitats and the animals confined to them ecologically (if animals were the cause) must eventually provide the answer.[7] With these leads, animals that might be suspect were collected and tested in aquaria. Early suspects included snapping shrimp (family Alpheidae); they seemed to fit habitat and geographic distribution requirements, but their rarity in areas approachable for collection, and

the supposed infrequency of individuals to snap their large claw, cast doubt on their likelihood of producing such a bedlam of noise as could be heard over some rocky reefs and coral bottoms.

There were also some serious conflicting aspects in any hypothesis that demanded only a rocky or coral bottom. Severe high-frequency crackling was found in some shallow water areas where the bottom was muddy, and some deep water areas, with bottoms similar to noisy areas, were silent. These anomalies later indicated depth of water was a critical environmental factor to be considered.

Finally, after weeks of frustration, Johnson happened to observe a small group of marines at practice at Camp Callan rifle range (now a part of the upper UCSD campus). The overall sound produced in rapid gunfire by 10-15 marines closely simulated the mysterious underwater crackling that needed identification. This led to his realization that it would not take an overwhelming number of snapping shrimp within hearing range to produce the type of rapid crackling that in nature had an overall sound intensity of 30 or more decibels. With this information as a stimulus, he managed to collect about a hundred specimens of snapping shrimp for testing as a population in an aquarium. It was soon learned that the animals are very difficult to collect because of their secretive habits of living in ready-made burrows in heavy shell incrustations, on fouled or sandy bottoms with eel grass, and from about zero tide level to about 30 meter depth.

In the aquarium tanks, the population produced a good number of isolated snaps of their claw, when disturbed. With this encouragement the next step[7] was to predict where the crackling would or would not likely be found in nature. Predictions turned out to be highly successful as a result of:

1) identification of the cause of the noise.
2) knowledge of the animal's habitat requirements.
3) mapping of the known ranges of snapping shrimp.
4) reference to charts giving bottom types and depths.

Scripps's Dr. Francis P. Shepard aided by compiling bottom charts in Asian waters where predictions were likely to apply.

Thus was put to rest rumors that these alien noises were skullduggery by the enemy to camouflage submarines' hideouts or to overall confuse the U. S. Navy operations—unless one were to believe that the snappers had enemy ties.

Operation Crossroads at Bikini Lagoon

In 1946 Martin Johnson was asked by the U. S. Navy to join a number of Scripps oceanographers in making observations at Bikini atoll near Eniwetok in the Marshall Islands in the western Pacific. These were to be made before and after the atomic bomb test blast. Johnson's role was to determine the composition of the plankton and, to a lesser extent, the benthos within and outside the lagoon during a spring preparation period and an August follow-up. The intent was to relate plankton dispersal direction to flow direction in and out of the lagoon.

The samples obtained during March to May were characterized by: (1) a number of zooplankton species not found outside the lagoon except at a point of outflow, considered endemics, and (2) species that regularly occur both inside and outside the lagoon, maintained

within by flow entering over eastern reefs. Depth distributions showed that most lagoon species live in eastward-flowing near-bottom water both day and night, counter to incoming flow of the surface layer at an eastern sector and tend to be entrained within the lagoon.

This was compensated by high concentrations of the indicator species in outgoing water over a relatively deep sector of the reef, serving to flush the lagoon's contents.

Expectations of comparable observations following the August blast were "pulverized with the ascending ball of fire and billowing cloud of incandescent vapor boiling skyward," as Johnson described it from an observation point 18 miles from the lagoon. Later, briefly stated, "no appreciative effect was observed on the abundance of plankton. The snapping shrimp (presumed to be burrowed in the coral mat) were silenced only in the immediate area beneath the underwater explosion."[7]

After World War II

Scripps and the science of oceanography grew rapidly after World War II, and Martin Johnson felt that an increase in graduate student enrollment was "especially important." One of the postwar projects in which he played a significant role was the establishment of the California Cooperative Oceanic Fisheries Investigations and its branch at Scripps, the Marine Life Research Group. Through the latter, Johnson managed to obtain funds for a group of graduate students whom he put to work studying the California Current and its plankton populations. The emphasis was on determining which species of zooplankton were present and how their abundances varied in space and time.

During the early years the survey cruises were monthly and many extended from Cape Mendocino in the north to Punta Eugenia in Baja California, Mexico. Each yielded many dozens—sometimes hundreds—of plankton samples. These were preserved in large Mason jars and took up a lot of room in the Ritter Hall basement. By the mid-fifties Johnson and his students were overwhelmed and curatorships were established to organize the collections.

Only zooplankton were studied (and larval fishes, by the National Marine Fisheries team) because other categories or kinds of organisms could not be reliably and quantitatively sampled at that time (1949). It was typical of him to set students to work on such fundamental research as determining the nature and life histories of the fauna rather than, say, energy flow through (mostly unknown) trophic levels, a field which even then was considered high fashion.

Throughout the 1950s, while his graduate students pursued these basic studies on various taxa of the larger zooplankton, Johnson worked on copepods, describing several new species and life history stages of other crustacea. No graduate student was spared the duty of sorting out the widely drifting larvae of California lobsters and sand crabs (*Emerita* and *Blepharipoda*) from hundreds of plankton samples, thereby contributing to Johnson's uniquely comprehensive studies of larval dispersal.

The zooplankton fauna of the California Current became known, and patterns of abundance were determined. This information was published in a series of Ph.D. theses, atlases, and papers. One of the results of these studies was the determination that under certain circumstances, much of the plankton fauna of the California Current seemed to be made up of a mixture of species that had larger populations in other water masses outside of

the system. The central North Pacific or western portion of the California Current is one of the few places where many of these species frequently co-occur. Thus the discovery of a vast amount of stirring and mixing of populations led to the speculation that much population biology and community diversity, here, was to be understood in terms of the physics of water movement, rather than biological function such as food limitations, energy flow, or competitive interrelationships between populations. This was such a heretical idea at the time (1954) that Johnson and his students felt more data, particularly descriptive data, were required before pursuing it.

More data were obtained. Because many of the species found in the California Current obviously had populations outside of it, broader-scale sampling was clearly necessary to establish the extent, if not the stability, of the range patterns of species and their abundances. Roles of immigration and emigration across the diffuse limits of the California Current could then be better assessed.

Much of the Pacific was studied, with chemist Warren Wooster leading several of the expeditions. The resulting broad scale pictures of individual species distributions, though combining different years of observations from cruises covering different regions, appeared more orderly and patterned than in the California Current.

That the major patterns were interpretable in terms of Sverdrup's water masses is yet another piece of the evidence of the predominant role of physics in regulating the biology of the ocean. This approach anticipated by almost a decade the rebirth of interest in biogeography among terrestrial ecologists. The large-scale patterns and the proximal reasons for their existence developed by Johnson and his students have stood the test of time.

These studies and his work on the life histories of planktonic animals were specially cited by the National Academy of Sciences in 1959 when it awarded to Johnson the Alexander Agassiz Medal, one of the highest awards to which an oceanographer can aspire. Other works cited were his wartime dual discoveries of the cause of the "Deep Scattering Layer," and the role of "snapping shrimp" in causing confusion for submarine communications, the finding that drifting developmental stages of the California spiny lobster are distributed in the California Current in such a way that they indicate a current much more complex in course than that according to charts, and, not least, his co-authorship of *The Oceans*.

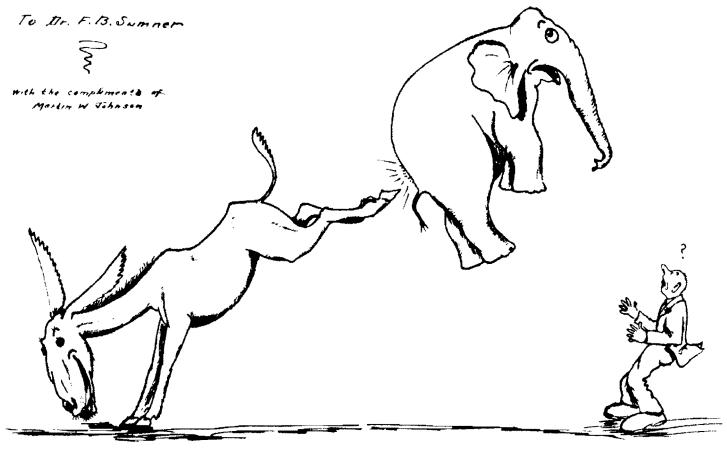
The continuing seasonal and year-to-year examination of species populations and their ranges in the California Current have shown changes of widely varying extent—extreme as during the El Niño period of 1957-1959 and since the 1970s—consisting of mesoscale (at least) ecological changes bordering on ecosystem shifts. The condition of perpetuity in zooplankton studies in these waters would have made Martin Johnson proud.

Margaret D. Knight, Johnson's scientific assistant of many years, was often his collaborator on studies of development in the Decapoda (Crustacea). Her recognition of the importance of observing morphological detail, and of thoroughness in portraying it, developed during her long association with Johnson's methods. This carried over into her emergence as a resourceful researcher on larval development in the Euphausiacea.

During formal retirement in the 1970s and early 1980s, Johnson returned to his interest in larval development of the many Pacific species of lobsters. His descriptions of differing sequences of development of these leaf-like "phyllosoma" larval stages continued to

include his illustrations of exceptional quality. (He was more than illustrator:his caricatures and doodles—often during meetings—might have become legend had he cared to publicize them.)

Martin Johnson was, in spite of his tough, adventurous childhood and youth, a quiet, diffident, dignified man. God had not granted him the precious gift of gab, and his lectures and seminars, for the most part, did not sparkle. His private conversations were at first acquaintance quite formal, even somewhat strained. But he was, in reality, quite an emotional man with a great sensitivity and awareness of the human condition and a great intuitive feeling for what were important scientific problems and which were not. He was a good mandolin player, did fine pencil and chalk sketches, and was an excellent wood carver. It was in his carving and sketching that he expressed the creative side of his personality not evident to the casual observer.



Political cartoon, ca. 1932 by Martin Johnson. In the U.S. presidential elections of 1932-1940, MWJ voted for the Republican candidates while Francis Bertody Sumner favored FDR. The professors wagered a dime on their candidates, and when FDR won, Johnson drew this sketch of a donkey kicking an elephant in the rear. A dime was inserted in the drawing, and the drawing was presented to Dr. Sumner.

In spite of his basic humanness, he did not suffer all fools gladly. There were events, situations, and individuals of which he definitely disapproved. But never did he use his position and stature to impose his views. He was completely and utterly above academic politics, at which, in any event, he would have been a failure.

He continued to visit his laboratory, nearly until the time of his death in 1984 at the age of 91. It saddened him that, finally, he could no longer do justice to the microscopical work required in study of specimens that continued to be sent in from the far reaches of the globe. But he remained cheerful and clearly delighted in joining or initiating a laugh—usually at the expense of a former colleague, or about a nomenclatural twist that only an inner circle of friends could appreciate.

An outstanding trait, all who knew "D. J." will agree, was his absolute honesty and integrity. He was simply incapable of deviousness, this traceable, perhaps to hard work and hard times in a large family on the prairie. His life and the milieu in which he worked corresponded to an era of great growth in oceanography—one of openness and cooperation.

Appendix

Martin W. Johnson's Zooplankton Students, the Taxa of Their Ph.D. Studies in the California Current, and Their Subsequent Scientific Positions

Brian P. Boden	euphausiids	Scripps Researcher, Bermuda Biological Station, Co-Director
Thomas E. Bowman	amphipods, copepods	Smithsonian Inst., Curator of Crustacea
Leo D. Berner	pelagic tunicates	Texas A&M, Professor
Carl M. Boyd	galatheid shrimp	Univ. of Halifax, Nova Scotia, Professor
John S. Bradshaw	living foraminifera	Univ. of San Diego, Professor
David Arthur	copepods	Research in Australia
Edward Brinton	euphausiids	Scripps, Research Biologist
William D. Clarke	deep sea mysids	Lockheed Co., Oceanographic Researcher
Robert Bieri	chaetognaths	Antioch College, Ohio, Professor
John A. McGowan	pelagic mollusks	Scripps, Professor

Bui-Thi Lang	calanoid copepods	Viet Nam, Ecological Conservation
J. Bennet Olson	cyclopoid copepods	Ohio, College Professor

Dr. Johnson also served on doctoral committees of numerous students concerned mainly with other aspects of oceanography.

Footnotes

1. Ritter, W. E. Letter to University of California President Barrows. Scripps Institution of Oceanography. Archives. 1922.

2. Ritter, W. E. Reason, Emotion, Morals, and Religion in the Darwinian Theory of Evolution. In *Science, Philosophy and Religion, A Symposium. Conference on Science, Philosophy and Religion on Their Relation to the Democratic Way of Life, Inc.*, Chapter 17. New York, 1941.

3. Ritter, W. E. The Marine Biological Station of San Diego, Its History, Present Conditions, Achievements, and Aims. *University of California Publications in Zoology*, v.9, no.4, 1912. pp.137-248, pls. 18-24, and 2 maps.

4. Johnson, M. W. Autobiographical Notes. Scripps Institution of Oceanography. Archives. Unpublished. n.d.

5. Shor, E. N. *Scripps Institution of Oceanography: Probing the Oceans 1936 to 1976.* Tofua Press, San Diego. 1978.

6. Sverdrup, H. U., M. W. Johnson, and R. Fleming. *The Oceans, Their Physics, Chemistry and General Biology.* Prentice Hall, New York. 1942.

7. Johnson, M. W. *Those Were the Days; We Are the People.* Scripps Institution of Oceanography. Archives. Unpublished. 1980.