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CARL LEAVITT HUBBS

1894—1979

A Biographical Memoir by
ELIZABETH N. SHOR, RICHARD H. ROSENBLATT
AND JOHN D. ISAACS

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Courtesy, Zoological Society of San Diego

Carl L. Hubbs

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October 18, 1894–June 30, 1979

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CARL LEAVITT HUBBS, elected to the National Academy of Sciences in 1952, died on June 30, 1979, at the age of eighty-four. In 1975 he said: "I have been praised, or criticized, as the case may be, for being one of the last of the dying tribe of general naturalists, a disciple of natural philosophy."[1] Such he was, for while his expertise was fishes, he also contributed significantly to our knowledge of marine mammals, archeology and climatology, biography and history of science, evolution and ecology, and conservation.

His earliest known paternal ancestor was Samuel Hubbs, who emigrated from Scotland with two brothers prior to the American Revolution and farmed in the Mohawk Valley, New York State. His son Alexander Hubbs lived out his life in the same area. Alexander's son Daniel moved to Jefferson County, New York, then to Wisconsin in 1850, and to Minnesota in 1856.

Daniel's son Charles Leavitt Hubbs, father of Carl Leavitt Hubbs, was born on June 6, 1843, in Pamelia-Four-Corners, Jefferson County, New York, and moved with his father to Wisconsin. When he was fourteen, Charles began three years

[1] "Biological Oceanography, Geochronology, and Archeology Along the Pacific Coast of Middle America and California," talk given at University of Nevada, Las Vegas, April 17, 1975.

of employment with a book and stationery firm in New York City; in 1859 he joined a brother near Vicksburg, Mississippi, and in 1860 returned to his father's home in Minnesota. There he married and fathered six children before the marriage was dissolved. Following Civil War service with the First Minnesota Infantry regiment, he moved often and tried his hand at various trades: In 1866 he farmed in Missouri, in 1867 he was in the mercantile business in Minnesota, and in 1870 he tried the lumber business in that state. In 1873 he settled for a time in Edwards County, Kansas, as a farmer, dealer in real estate, county surveyor, and proprietor of a newspaper.[2] Carl later noted that during the years in Kansas his father shot from the declining herds at least one buffalo and one pronghorn antelope, and that "as one saving grace he preserved in alcohol the pronghorn's unborn fetus, which he [much later] gave me to be preserved in the Museum of Zoology at the University of Michigan—as probably the only extant specimen of that species from Kansas."[3]

In 1894, with his second wife and their son Leonard Goss Hubbs, Carl's father moved west to work placer claims in Arizona. Carl later recalled:

> Soon afterward, as the placer operation petered out, Dad took off for the Santa Fe Railroad at Williams [Arizona], leaving my mother and my brother, and me, still unborn, to follow by horse and wagon. Less skilled than Dad in the ways of the very scantily populated West, she got lost, and after wandering for three days and nights without food or water finally saw the headlight of the Santa Fe and managed to wave down the engineer before fainting. Soon after she reached Williams, I was ushered into the world on October 18, 1894 by some midwife, two months prematurely. . . . I was soon brought to California and got my first taste of the Mohave Desert. At Daggett Dad ran the water pump for the thirsty Santa Fe en-

[2] *The United States Biographical Dictionary* (Chicago: C. S. Lewis & Co., 1879), pp. 342–43.

[3] "Preservation of Species and Habitats," talk given to Scholia (a San Diego club), October 9, 1973.

gines. I must have been a real desert rat, for I walked freely at eight months and ran away from home at ten months (though I didn't talk until three years old and was diagnosed later as mentally defective). After a short spell in the town of Los Angeles, I was carried in 1896 to San Diego, when the population was about 17,000, with a high percentage of Mexican origin."[4]

Carl's father located an iron-ore property in the desert, which he later sold profitably, and in San Diego he served as an assayer and developed housing property.

In the open country of San Diego's mesas, valleys, and shoreline, Carl and his brother wandered freely:

watching with boyhood interest the burrowing owls . . . catching horntoads for pets, and otherwise communing with nature. . . . For diversion we, or I alone, often paddled our tiny sneak-boat over San Diego Bay, then still in near primeval condition. I recall once chasing a Western Grebe . . . until at last it was exhausted and rose so close that I grabbed it by the neck [and was bitten]. . . . Once near the harbor entrance I saw close by a bull elephant seal, which in my childish fancy I thought to be a walrus.[5]

In later years Hubbs liked to recall that on one childhood trip to the beach of La Jolla (at the north end of San Diego), he had "envisioned a long building sweeping along the slope [where Scripps Institution of Oceanography is now located], containing case after case of magnificent sea shells, by which I, in a bright blue uniform, kept explaining the exhibit to the assembled public."[6]

Hubbs's parents were among a group that objected to a new ruling by the San Diego schools that children must be vaccinated against smallpox. Several families persuaded Katherine Tingley to open a private school (without required vaccination), which she was glad to do as an expansion of the

[4] *Ibid.*

[5] *Ibid.*

[6] "Some Highlights from My 61-year Career in Marine Biology," talk given at Scripps Institution, May 2, 1974.

organization that she headed: the Universal Brotherhood and Theosophical Society. The Society incorporated Egyptian lore, reincarnation, Greek architecture, music and drama, pacifism, and vegetarianism. Young Carl had not been doing well in the public school. The new one, the primary school of the Raja Yoga Academy, appealed to him at first, and he became a keen student; but after three years he rebelled against its militant discipline and was dismissed.[7]

Carl's mother was Elizabeth Goss Johnson Hubbs (she had been married briefly to a man named Johnson before this marriage), the daughter of Leonard Goss, a prominent lawyer of Cincinnati, Ohio. Carl recalled that his mother had told him in his youth that the British naturalist Philip H. Gosse was related to them. Elizabeth Goss had taught art and other subjects. Following her divorce from Charles Hubbs in 1907, she and the two boys returned to the Midwest for a year and stayed with various relatives. Of that time, Hubbs said much later:

> I saw much of nature that I had largely missed before. For the first time in my memory I saw lightning close enough to cause thunder, witnessed the colors of fall, enjoyed a chance to skate on ice, suffered lasting frostbite on breaking through the ice, experienced the reawakening of nature in the spring, dug in the rich Paleozoic fossil beds in Cincinnati, spent the summer on a farm in northern Ohio . . . often wandering away from field work to see new kinds of animals and plants; caught bullfrogs in the new state of Oklahoma, watched tornados come frighteningly close, and successfully disarmed and duly punished a nasty Indian boy who rushed at me swinging a big knife. Great fun being young and observant, preparing for the life of a naturalist.[8]

In the fall of 1908 Hubbs's mother returned to California. She settled in Redondo Beach, and with an associate ran a

[7] "Raja Yoga—Glass Domes Astride Point Loma," talk given to Scholia, May 12, 1970.

[8] "Preservation of Species and Habitats."

private school that enrolled her two sons. Earlier in San Diego young Carl had become much interested in seashells through the guidance of his maternal grandmother, Jane Goble Goss, one of the first women physicians. She made him a "proud partner in her moderately large private shell collection," which was, he said, "one of the greatest thrills of my boyhood. I continued the collection after her death, and at late high-school age spent long hours in the Los Angeles Public Library reading books on conchology to produce an illustrated phylogeny of molluscs—happily lost."[9]

At Redondo Beach, said Hubbs, his school training was

> good and intensive, leaving time for me to add to my shell collection; to fish off the old Redondo wharf when yellowtail were very plentiful and sardines seemed almost to fill the waters; to observe marine life in the tide pools at Rocky Point (I recall most vividly seeing the brilliant red and turquoise-blue young of the garibaldi); to wander over the then-uninhabited Palos Verdes, where I found my first perfect arrowhead and observed Pleistocene fossils and Indian middens.[10]

Carl's mother married Frank Newton, who soon bought a twenty-acre ranch in the San Joaquin Valley, near Turlock, California. There Carl spent most of his high-school years and "plunged into nature study with a vengeance." He became an avid bird-watcher and with great pleasure once accompanied "one of California's greatest and most loved ornithologists," Loye Holmes Miller, on a field trip. His chemistry teacher, impressed with his scientific ability, urged him to attend the University of California at Berkeley to major in chemistry.

Following another family move, Hubbs graduated from high school in Los Angeles in 1912 and continued at junior college in that city. There he came to the attention of George

[9] "Some Highlights from My 61-year Career."
[10] "Preservation of Species and Habitats."

Bliss Culver, a onetime field assistant to David Starr Jordan. Culver surreptitiously transferred Hubbs's interest from birds to fishes, encouraged him to collect the poorly known fishes of the streams of the Los Angeles plain, and persuaded him to attend Stanford University, which had become the center of American ichthyology under the leadership of Jordan.

Charles Henry Gilbert, a close associate of Jordan's and the chairman of the Zoology Department, became Hubbs's true mentor. He assigned his student, as an undergraduate job, the curatorship of the large Stanford fish collection. Hubbs also spent considerable time in the field during his college years, "over the mountains, along the bay, and along the coast," he said. On one of those trips in 1916 in a remote ocean area off southern Monterey County he thrilled at the glimpse of one sea otter, then assumed extinct in the area. Later he found that Joseph Grinnell knew that a small number survived there, but he had kept the knowledge to himself so that the remnant would not be destroyed. In the summer of 1915 Hubbs accompanied John Otterbein Snyder of Stanford in a survey of the fishes of the Bonneville Basin in Utah, and thus commenced a lifelong study of relict desert fishes.

Hubbs received an A.B. from Stanford in 1916 and began a semester of graduate work. Gilbert spoke highly of him: "My assistant Hubbs is going to be all that one could wish for. He has the proper attitude towards the work and is endlessly keen."[11]

The peripatetic president of Stanford, David Starr Jordan, had returned to the campus after a long absence, and during that semester Hubbs collaborated with him. A few years later Jordan described Hubbs as "the ablest student I have had for the last thirty years. . . . There is no one now

[11] Letter from Gilbert to John Babcock, October 10, 1916.

doing systematic work on fishes that has as keen an insight, or as accurate a mind, as Hubbs, and he is tremendously industrious."[12]

Hubbs retained a lifelong awe of the monumental man who long dominated American ichthyology, and in the late years of his own productive life sometimes voiced his regret that he would never be able to equal the written output of the prolific Jordan.

Early in 1917 Hubbs accepted the position of assistant curator in charge of fishes, amphibians, and reptiles at the Field Museum of Natural History in Chicago. He was awarded an M.A. from Stanford that June, in absentia. The following year he married Laura Clark, a fellow student who had received her B.A. in 1915 and M.A. in 1916 at Stanford, where she was teaching freshman mathematics.

Of his Chicago years Hubbs said: "After three busy years of service there, 1917–1920, involving also research and a bit of graduate work at the University of Chicago, I was abruptly fired for blatant insubordination. My indiscretion I must admit resulted in part from having been lined up for an appointment at the University of Michigan."[13]

That appointment, from 1920 to 1944, became a highly productive one for Hubbs. He was curator of the fish division in the University of Michigan Museum of Zoology, he advanced from instructor to assistant, associate, and full professor, he was awarded a Ph.D., he instituted research projects, and he published prodigiously.

In a program of upgrading the caliber of its faculty, the Zoology Department of the University of Michigan suggested to Hubbs that he should obtain a Ph.D. According to his later recounting, he pointed to his shelves of publications and sug-

[12] Letter from Jordan to Roy Chapman Andrews, February 19, 1924, when Hubbs was working with Jordan on a collection of fishes from Japan.

[13] "Preservation of Species and Habitats."

gested that any of several of them would constitute an appropriate dissertation. Thus, his paper of 1926 was selected: "The Structural Consequences of Modifications of the Developmental Rate in Fishes Considered in Reference to Certain Problems of Evolution." He was awarded the Ph.D. in 1927, at a ceremony that he was too busy to attend.

Hubbs increased the fish collection of the Museum of Zoology through his own field work, from collections made by staff and students of the university, and by simple begging. With his family he collected in the intermontane basins of the American West during eight summers from 1922 to 1943. From a long excursion in the Orient in 1929, following his participation in the Fourth Pacific Science Congress in Java, Hubbs shipped back to the museum five tons of specimens. During 1935 he collected in remote areas of Guatemala, as one of a series of expeditions sponsored jointly by the Carnegie Institution of Washington and the University of Michigan.

Hubbs readily agreed to identify collections sent to him by other institutions, and as a result the museum was given many specimens. Collectors routinely sent him additional material; for example, his wife's sister Frances N. Clark, who served many years with the California State Fisheries Laboratory, provided him with many West Coast fishes. Robert Rush Miller has estimated that during Hubbs's tenure at the University of Michigan Museum of Zoology, the collection of fishes was increased from about five thousand to nearly two million specimens.[14] The emphasis was on freshwater fishes, especially those of North and Central America.

Laura Hubbs, in addition to raising three children, also worked in the Museum of Zoology as a cataloger. Together the Hubbses undertook a study of hybridization in various

[14] "A Tribute to Carl L. Hubbs," presented at annual meeting of American Society of Ichthyologists and Herpetologists, July 30, 1979.

fishes—in nature and in the laboratory. In the course of this work they discovered the matroclinous, gynogenetic reproduction of the all-female fish species *Poecilia* (formerly *Mollienisia*) *formosa*, the "Amazon molly." In earlier researches they had also developed—through carefully annotated genetic crosses—hybrid specimens of sunfishes (Centrarchidae) that were similar to so-called species in nature, and thus Hubbs was able to untangle taxonomic confusion in that family. Detailed analysis of natural hybrids led him to conclude that interspecific hybridization was especially frequent in freshwater regions that had been disturbed by Holocene climatic changes.

In 1930 the Institute for Fisheries Research was established to formalize the cooperation between the University of Michigan and the Michigan Department of Conservation. Hubbs was instrumental in setting up the Institute and served as its director for the first five years. Its programs included making biological inventories of lakes and streams, mapping lakes, investigating fish mortalities and water pollution, studying the age and growth of fishes and predation on them, and developing methods of improving lake and stream habitats. This led Hubbs into testing some techniques that he later questioned, such as introducing mosquitofish (*Gambusia*) for mosquito control and using poisons broadly to eliminate "trash fish."

In June of 1939 Hubbs was asked to serve as a field representative of the Department of the Interior to look into the administration of fish and wildlife in Alaska. After a brief interview with the irascible Secretary Harold Ickes in Washington, Hubbs spent the summer traveling throughout the territory, interviewing fishermen and game managers. He uncovered irregular conduct by some officials, illegal fishing operations, controversies over regulations, Japanese monopoly of the king-crab fishery, pollution from canneries, and

peculiarities in the bounty on Dolly Varden as predators on trout. As a result of his report, several officials were fired, the bounty on bald eagles was discontinued, and an American fishery for king crabs was subsidized.[15]

Hubbs's publications while at the University of Michigan—in excess of 300—were almost entirely on fishes from throughout the world. In his 1922 paper, "Variation in the Number of Vertebrae and Other Meristic Characters of Fishes Correlated with the Temperature of Water During Development," he proposed an explanation for the effect of temperature that has been modified but not yet superseded. He devoted time in 1923 to helping David Starr Jordan analyze the largest collection of fishes from Japan ever made (according to Jordan), and their memoir was published in 1925. With Karl F. Lagler, Hubbs compiled a "Guide to the Fishes of the Great Lakes and Tributary Waters," first published in 1941 and revised several times.

While many of his papers were taxonomic, others summarized his studies of variation and its causes. Primary publications concerned groups that continued to interest him later, such as the lampreys, the catastomid fishes, and the subfamily Oligocottinae. A major series of papers was on the systematics, distribution, and habits of fishes of the order Cyprinodontes. Long-term studies on the fishes of isolated Great Basin waters culminated in the 1948 publication, "Correlation between Fish Distribution and Hydrographic History in the Desert Basins of Western United States," coauthored with Robert Rush Miller. Hubbs's interest in this subject never waned, and in 1974 with colleagues he published the monograph, "Hydrographic History and Relict

[15] "Investigations in Alaska in 1939 as Field Representative, Department of the Interior: An Historical Review of Natural Resource Problems In Alaska," talk given by Hubbs at University of Alaska, April 8, 1976.

Fishes of the North-Central Great Basin" (Hubbs, Miller, and Hubbs).

During his years at Michigan, Hubbs also began his service and devotion to the American Society of Ichthyologists and Herpetologists. As editor of its journal *Copeia* from 1930 to 1937, he increased publication to a quarterly cycle; as secretary in 1929 and 1930, he increased the society's membership considerably. He served as president of the society in 1934 and in 1946, and was reelected in 1947. Chiefly through his urging, the society became increasingly active in conservation of fishes, amphibians, and reptiles, beginning with the fish fauna of isolated desert springs. Hubbs became the first chairman of the society's Committee on Nomenclature. He also established a regional committee on nomenclature through the auspices of the University of Michigan Museum of Zoology to advise on local problems that could then be referred to the International Commission on Zoological Nomenclature. This led to considerable correspondence with other taxonomists and to his later participation in other scientific societies such as the Society of Systematic Zoology.

During the summer of 1943, at the invitation of Director Harald U. Sverdrup, Hubbs visited Scripps Institution of Oceanography. There he gave seminars and wrote two short papers with aquarium curator Percy S. Barnhart. The suggestion of the visit had come from Francis B. Sumner, whose retirement was imminent; Sumner was a geneticist who was then studying the causes of color changes in fishes. In September Sverdrup asked Hubbs if he would consider an offer from Scripps. "Your field of research would fit into our program admirably," wrote Sverdrup, "and your coming here would strengthen the general position of the Institution."[16]

[16] Letter from Sverdrup to Hubbs, September 1, 1943.

Hubbs declined. The staff at the University of Michigan museum had been severely depleted by wartime absences, and he was much needed there, but he made it clear that he was interested in moving to the West Coast at some later time.[17]

In May of 1944 Hubbs reopened the correspondence with Sverdrup, with the comment that "of several possible openings on the Coast I believe that one at Scripps might prove most alluring."[18] He was looking for a good base for research, what he called "a set-up that will make for real accomplishment."[19] Many of his prewar students were in military service, as were his two sons, and his daughter was married, so the time seemed suitable for a move.

Sverdrup held out a tentative offer (contingent on approval by the administration of the University of California), and Hubbs accepted, even though the salary at Scripps would be slightly less than he was making at the University of Michigan.[20] He also knew that his wife could not be employed at Scripps ("I recognize that many institutions have a rule or policy against employment of two members of one family.") He added: "I am more interested in the opportunities for research work than in the salary." This was his lifelong philosophy. He continued:

> We have had relatively little discussion regarding fields of research in which I might be engaged at Scripps. I would no doubt want to put considerable emphasis on systematic and variational studies of west coast marine fishes, particularly those in which speciation would be correlated with oceanographical conditions. I have two or three rather major pieces of work along such lines nearly completed, and I have set these aside with the idea that these jobs would be among the first to be completed if we go to the coast. I would no doubt be interested in exploratory work, for in-

[17] Letter from Hubbs to Sverdrup, September 11, 1943.
[18] Letter from Hubbs to Sverdrup, May 2, 1944.
[19] Letter from Hubbs to Paul Needham, May 15, 1944.
[20] Letter from Hubbs to Sverdrup, May 19, 1944.

stance with the fauna of the deep basins off the southern California coast. I will probably be interested too in detailed analyses of the distribution of fishes along the entire west coast, again as correlated with the oceanographic conditions.[21]

Hubbs had another California project in mind as well, as he wrote to W. I. Follett in Oakland, with whom he had been corresponding for a decade: "I look forward particularly to cooperating with you in making better known the California fish fauna. I no doubt will have new material published from time to time on the systematics and biology of the fishes but will definitely hope that you will maintain your plan to work toward a 'Fishes of California.' It will be a pleasure to make records and other information available for your project."[22]

Notice of Hubbs's appointment as professor at Scripps Institution came on September 1, 1944, with an announcement by University President Robert G. Sproul that Hubbs "is an exceptionally prolific writer. . . . His fertility in producing sound ideas is as amazing as is the energy he brings to his work."[23]

Among the goods that the Hubbses sent to their new location was his personal library of ichthyological and natural history items. He had begun accumulating a library while a student at Stanford, and he increased it actively through exchanges of reprints, membership in many scientific societies, and purchases. He had, for example, bought significant works on fishes from the library of Carl H. Eigenmann (some purchased by Eigenmann from British ichthyologist Albert C. L. G. Günther in 1910). Hubbs also received a number of books as review editor for *American Naturalist* from 1941 to 1947. During Hubbs's long trip to the Orient in 1929, his wife had set up the cataloging of his library, which was then

[21] *Ibid.*

[22] Letter from Hubbs to Follett, June 1, 1944.

[23] University of California *Clip Sheet*, September 5, 1944.

continuously kept up-to-date as items were added. Hubbs estimated in 1944 that his library contained 40,000 books and reprints, as well as a collection of journals.[24] (In comparison, the Library of Scripps Institution of Oceanography in 1941 held 18,000 volumes, of which about 12,000 were bound periodicals, and 30,000 reprints.)

Hubbs arrived at Scripps in mid-October of 1944, near his fiftieth birthday, after collecting fishes in the Great Basin en route. Like other educational institutions, Scripps was in a slow period in 1944; wartime researches and military service decimated the staff and student enrollment. There were essentially seven senior academic staff members in residence, five students, and several research visitors. The institution's ship, *E. W. Scripps*, was on loan to the Navy until 1947. Repairs and renovations to the buildings were almost impossible to arrange.

The Hubbses accepted the circumstances and turned immediately to marine researches. Although she was not on the payroll, Laura Hubbs continued to work alongside her husband, both at the office and in the field. In a seminar six months after his arrival, Hubbs commented that their collecting had been curtailed by gasoline rationing, so that "we have taken only 107 species to date." These included, however, several rare and a few new species of fishes. He annotated extensions of ranges, observed territorial defense in blennies in the aquarium tanks, began an analysis of the fish fauna of the kelp beds through specimens from the kelp harvesters and from lobster traps, and noted ecological effects on speciation. "We have managed," he commented, "to dip into the edge of the marine grab bag."[25]

One of Hubbs's concerns before reaching Scripps had

[24] Letter from Hubbs to Sverdrup, May 19, 1944.

[25] "Ichthyological Discoveries Since Coming to Scripps," seminar at Scripps Institution, March 30, 1945.

been where he would be able to store large series of specimens while he was studying them. He felt that Scripps Institution or Berkeley would not have such a facility and asked Sverdrup if he should arrange for storage at Stanford, the California Academy of Sciences, the University of Michigan, or even the National Museum.[26] Sverdrup replied that a postwar building program should make the needed facility available,[27] essentially assuring the establishment of what has become one of the country's largest collections of fishes. Hubbs devised the system for cataloging the collection and supervised it through many years of exponential growth.

His first opportunity to collect beyond the southern California coast came, oddly enough, from a movie star: Errol Flynn, the son of a marine biologist. In the summer of 1946, Flynn offered to let a scientist from Scripps Institution accompany him on his yacht *Zaca* from San Diego to Acapulco, Mexico. Hubbs leaped at the chance. It was scarcely a scientific expedition, but Hubbs did succeed in making extensive fish collections at several islands off the west coast of Mexico and in Acapulco Bay, areas that were then scantily represented in collections. He commented on what he thought was insular endemism in the fishes of Guadalupe Island, but later collecting established broader ranges for those species. Guadalupe Island, with its populations of marine mammals and its distinctive plants, became a favorite destination for Hubbs over many years.

In the spring of 1947, a multi-institutional program was created to try to determine why the catch of sardines off California had dropped dramatically. State and federal fisheries people joined forces with researchers from Scripps Institution and the California Academy of Sciences to attack the problem, with generous support from the state and com-

[26] Letter from Hubbs to Sverdrup, August 17, 1944.
[27] Letters from Sverdrup to Hubbs, August 21, 1944.

mercial fishermen. Hubbs was active in establishing the format of the California Cooperative Oceanic Fisheries Investigation, and he derived support from it for fisheries researches for many years. The Isaacs-Kidd Midwater Trawl, which opened an almost untouched collecting region to biologists, was one of the program's earliest equipment developments (1950).

Simultaneously, from 1948 to the mid-1950s, Hubbs supervised researches by Conrad Limbaugh, financed by Kelco Company, to determine whether the cutting of kelp interfered with sportfishing. The project became an intensive study of the ecology of the kelp beds of southern California, with an inventory of their plant and animal life and interrelations. It was concluded that kelp harvesting had no detectable detrimental effect on fishing.

As noted earlier, Hubbs continued his studies of the isolated relict fish populations of the western states, chiefly with his son-in-law Robert Rush Miller of the University of Michigan. His concern over the extinction of some species of western freshwater fishes led Hubbs into major conservation efforts on their behalf. One of his earliest concerns was with the Devils Hole pupfish (*Cyprinodon diabolis*). He suggested the common name pupfish for the genus, for the seemingly playful behavior of these small fishes. In the 1940s he and Miller proposed that Devils Hole, the small spring that held the sole population of *C. diabolis*, be made a separate part of Death Valley National Monument. This was finally done in 1952 in a proclamation by President Harry S Truman. Through the years Hubbs monitored the spring regularly and participated in efforts to keep its water level adequate for the threatened pupfish. Others joined the conservation efforts for endangered western fishes, and in 1969 they formed the Desert Fishes Council, which Hubbs participated in each year with keen enthusiasm.

Hubbs's observations of anomalies in the distribution of fishes and other marine organisms along the Pacific Coast led him to try to determine the causes. In 1949 he published a landmark paper, "Changes in the Fish Fauna of Western North America Correlated with Changes in Ocean Temperatures." This much-cited and influential work documents changes in north-south fish distribution correlated with water temperature changes in historic time.

Hubbs enlarged his researches into archeology and an analysis of past climate. Many years of daily coastal temperature records were available from Scripps Institution and other California locations, so in 1948 Hubbs set out to extend the series southward into Baja California, Mexico. The roads there were dusty or sandy ruts, and in the rainy season muddy morasses, but he acquired a four-wheel drive vehicle and, accompanied always by Laura and sometimes by students or hardy guests, he jolted down the peninsula. For fourteen years they took temperature records once a month (with a few exceptions) at a series of sixty-one coastal stations extending 225 miles southward. "At first we waded out into fairly clear water [said Hubbs], and then, after some very cold-water duckings, and ankles painfully struck by rolling cobbles, we used a casting thermometer constructed in our instrument shop."[28]

The temperature runs, as Hubbs called them, quickly showed dramatic differences over short distances, in one case 12°C in two miles on either side of a projecting point (Punta Banda). He delimited alternating cold and warm areas along the Baja California coast; in the cold spots the fishes, invertebrates, and algae included species typical of the cold central California coast not found in the intervening warmer waters.

[28] "Biological Oceanography, Geochronology, and Archeology Along the Pacific Coast of Middle America and California," talk at University of Nevada, Las Vegas, April 17, 1975.

In another effort at establishing temperature data, Hubbs arranged in 1949 for approximately thirty volunteer yachtsmen to take lines of measurements of surface temperatures from their craft simultaneously on a single day, while he supervised from above in a Coast Guard airplane.

The trips in Baja California also disclosed considerable evidence of earlier human habitation there and drew Hubbs into collecting shell debris from aboriginal middens for its bearing on past climate. In 1951 he noted that "by supplying critical material from the ascertained cool and warm areas and by running controlled temperature experiments, we have been able to assist [Harold C.] Urey in checking his method of estimating past ocean temperatures through analyses of the oxygen-isotope ratios in mollusk shells."[29] These analyses led Hubbs to conclude that, in the southern California region, ocean temperatures since the end of the Wisconsinan Period (11,000 years ago) were generally warmer than at present, except from 2,500 to 600 years ago, when the ocean was colder. Throughout the period from 11,000 years ago rainfall was higher than at present—until about 400 years ago.[30]

In 1957 the La Jolla Radiocarbon Laboratory was established at Scripps Institution under Hans E. Suess, which made possible the determination of a large number of dates of archeologic and geologic significance. Throughout the 1960s Hubbs coordinated the submission of samples to that laboratory, and he compiled its first five reports. Samples he submitted were chiefly from shell middens dating from the modern to 7,500 years before present, from tufa and shell

[29] "Research in the Biological Sciences," talk at conference on The Place of Scripps Institution in the University, the State, and the Nation, at Scripps Institution, March 26, 1951.

[30] Carl L. Hubbs and Gunnar I. Roden, "Oceanography and Marine Life along the Pacific Coast of Middle America," vol. 1, *Handbook of Middle American Indians* (Austin: University of Texas Press, 1964), pp. 169–70.

remnants along former shorelines of ancient Lake LeConte (Imperial Valley, California) and from offshore islands.

In 1973 Hubbs donated his large collection of archeological samples from Baja California and southern California to the Museum of Man in San Diego, where they have been cataloged and indexed for continuing use.

Hubbs's interest in marine mammals began during his first winter at Scripps Institution in 1944:

> At that time, no one, either among biologists or the general public, gave any serious thought to the gray whale, and the general assumption was that the species, if not extinct, had at least very largely abandoned its runs along the California coast to and from its traditional breeding grounds in the lagoons of Baja California in Mexico. . . . My first inkling that the parade of the gray whale along the coast of southern California had not totally ceased came in 1945 and 1946, when Henry Kritzler, a visiting postdoctoral fellow in Scripps Institution of Oceanography, reported to me his sighting of a few individuals about the kelp beds of Pt. Loma—incidentally observed as he was collecting fulmars. . . . This exciting news led me to establish a gray-whale monitoring project atop the roof of Ritter Hall of Scripps Institution, close to the shore. Here we installed in a small rooftop enclosure . . . an 18.5-power binocular instrument that I had secured from a soldier who had taken it on Iwo Jima. Willing associates and drafted graduate students took turns with me on 15-minute watches per hour throughout daylight, to count the whales going by, plot their positions and speed, and to note down their behavior.[31]

In 1947 Hubbs obtained permission from the commanding general of the Coast Guard in Washington to accompany mercy flights off Mexico. The first of those flights took him low over Scammon and San Ignacio lagoons in Baja California, where he had his first view of the calving locale. "This gave me an uncontrollable desire to go down to observe the whale life in one of the lagoons," he said. So he turned to

[31] "Initial Studies 1945–66 and Conservation Efforts 1956–73," talk to University of California, Berkeley Extension Special Program on "Life of the California Gray Whale," November 8, 1973.

Errol Flynn again, on the premise that very exciting movie shorts could be made at the lagoons. Flynn heartily agreed, and in February, 1948, arranged for a flight by helicopters and a small plane. Some of the footage on gray whales was incorporated into the movie short, "Cruise of the Zaca," released by Warner Brothers in 1952.

After a few years Hubbs relinquished the shore count of gray whales to Raymond M. Gilmore of the U.S. Fish & Wildlife Service. But in 1952 Hubbs took the opportunity to tally the gray whales in the calving lagoons by airplane, piloted by Scripps Institution physical oceanographer Gifford C. Ewing, "a superb pilot who flew his own planes and knew Baja California as few others ever have."[32] The annual aerial counts continued from 1952 through 1964, variously by the Hubbses and by Gilmore.

On his first visit to Guadalupe Island in 1946, Hubbs observed northern elephant seals (*Mirounga angustirostris*), and over the years he tallied the rise of the population there to at least 15,000 animals. With George A. Bartholomew he recorded the reestablishment of this once rare mammal on other islands off the west coast of Baja California and California.

The Guadalupe fur seal (*Arctocephalus townsendi*) was presumed extinct from about 1928 until Bartholomew found an old male on San Nicolas Island off southern California in 1949. He and Hubbs searched for more on Guadalupe Island without success in 1950, but in 1954 Hubbs finally did locate a group of fourteen on that island in the mouth of a remote cave. For some years he tallied the rise in population of that rare animal also.

Hubbs published twenty-eight papers on marine mammals and participated often in conferences pertaining to

[32] *Ibid.*

their habits, with emphasis on their conservation. As early as 1956 he and Gifford C. Ewing urged Mexican officials to establish a sanctuary for gray whales in lagoons of Baja California. The plan was finally implemented, with Hubbs's participation, in 1972. He also helped persuade Mexican officials to protect the elephant seal and fur seal on Guadalupe Island. Norris noted: "Few Americans have proved as adept as he in garnering the trust of foreign government officials and scientists necessary to achieve such international results."[33] Hubbs was an optimistic and diplomatic conservationist. He observed and commented sagely on national and international efforts to preserve whales, porpoises, sea otters, and other marine mammals. And for many years he prodded and measured every cetacean that was found ashore in the vicinity of San Diego, as he, like others, tried to resolve why these animals become stranded.

Beyond the time that Carl Hubbs devoted to his scientific researches, he accepted and carried out a great many outside commitments. At Scripps Institution he was in charge of the Division of Marine Vertebrates for many years until reorganization drew several units into a larger Division of Marine Biology. He devoted considerable time to the selection of new academics in biology when the institution acquired a major contribution from the Rockefeller Foundation in the 1950s. Always he was a conscientious committee member.

He served for several years on the International Commission on Zoological Nomenclature, patiently working out fine points of usage and priority. He reviewed books frequently, and he was often called upon to review scientific proposals. In later years he found himself obliged to write obituaries frequently. He wrote with facility, in longhand, and without

[33] Kenneth S. Norris, "To Carl Leavitt Hubbs, A Modern Pioneer Naturalist on the Occasion of his Eighieth Year," *Copeia*, 3(1974):581–94.

extensive rewriting, except for his longer technical papers; these he often revised through several editions (and multiple carbons). Most of his letters, sometimes very long ones, were dictated, without losing the thread of his discourse.

Immediately upon his arrival in California in 1944, Hubbs by invitation became a member and fellow of the San Diego Society of Natural History, that city's oldest scientific organization. In the following year he became a member of the board of directors, on which he served for thirty-four years. His primary concerns for the society were its scientific publications and its research program, both of which he subsidized as well as advised. Members of the museum staff often accompanied him on temperature runs and trips to Baja California islands.

By 1948 he also was serving on the Research Committee of the Zoological Society of San Diego, which operates the San Diego Zoo and Wild Animal Park. From 1952 to 1979 he was on the society's board of trustees, and he served on several committees, always urging research and conservation of endangered species.

In 1963 Hubbs was drawn into a new San Diego organization aimed at marine exhibits, which opened as Sea World in 1964. As a member of the executive board he emphasized the great value of and need for research in marine mammals. Quite to his surprise, this culminated in the establishment of the Hubbs–Sea World Research Institute, dedicated in 1977 to both Carl and Laura Hubbs.

In a warmly perceptive account, on the occasion of Carl L. Hubbs's eightieth birthday, his former student Kenneth S. Norris presented many facets of the personality of this "modern pioneer naturalist."[34] Norris credited Hubbs with tremendous energy, enthusiasm, and breadth, with thorough-

[34] *Ibid.*

ness in his researches, complete dedication to science, an insatiable appetite for collecting, endless helpfulness to students and colleagues, and forthrightness. Hubbs was a self-assured man, confident in his abilities, yet always surprised at having his scientific accomplishments honored. On such an occasion in 1975 he commented, "I really don't know why I'm receiving this [award as Headliner of the Year]. All I've ever done in life was exactly what I wanted to do."[35]

What he wanted to do was to find out about nature: to observe, annotate, define organisms in their environment. The enormity of the task energized him, so that one admirer could say, "His visits to scientific institutions have left behind him many an exhausted colleague."[36]

Students and colleagues were awed by Hubbs's painstaking attention to detail and his command of ichthyology. The man himself was not awesome or pretentious. About five feet ten inches tall, and of stocky build, distinguished by straight, black, crew-cut hair that never grayed, he had a keen gaze with a slight twinkle in his eye. Even when engrossed in writing a manuscript or counting and measuring specimens, he accepted interruptions with good grace and turned to the new subject without pause. Amateur naturalists, commercial fishermen, and free-lance writers were received as cordially as colleagues.

His work was also his hobby. For many years he routinely was at his office on Saturdays, and often on Sundays. When a major paper was in process, he and Laura returned to the office in the evenings. Otherwise, he carried home each day a briefcase of unfinished items, and devoted his evenings to them. He also enjoyed many social commitments, especially through his participation in civic and scientific organizations. At his home—in Ann Arbor, on the Scripps campus, and

[35] *San Diego Union*, January 27, 1975.

[36] Citation on Fellows Award of California Academy of Sciences, 1966.

from 1954 on the bluff a mile north of Scripps Institution—the welcome mat was always out for visiting colleagues.

The recognition for his accomplishments in science went chiefly to Carl, but a great deal of credit should be given also to the wife who worked alongside him, maintained his files, kept track of infinite details, traveled with him, absorbed his outbursts of impatience, and welcomed their guests. Together they raised three children: Frances, wife of Robert Rush Miller; Clark, professor of biology at the Univeristy of Texas at Austin; and Earl; high school teacher of biology in Orange County, California. The legacy continues in the grandchildren, several of whom are scientists.

Hubbs was a prolific teacher of graduate students. Twenty-eight students received doctorates under his direction at Michigan, and an additional eighteen after his move to Scripps. The dissertation titles reflect Hubbs's broad interests, so that, in addition to studies on fishes, some were on crayfish, porpoises, and Amerindians. Hubbs did little formal teaching, and his students learned most by accompanying him in the field and standing at his shoulder as he worked at the microscope. Perhaps the most lasting lesson was learned as Hubbs examined every sentence and datum in his students' theses (and colleagues' manuscripts), both for logic and grammar. He retained a keen interest in his students' careers, and he took great satisfaction in their students, whom he enjoyed referring to as his ichthyological grandchildren.

Carl Leavitt Hubbs died on June 30, 1979, after a steadily disabling cancer of the kidneys. It had slowed him physically—but hardly mentally. Three weeks before his death he looked over with pride the first printed copy of "List of the Fishes of California," by Carl L. Hubbs, W. I. Follett, and Lillian J. Dempster, the project that he had promised to help Follett with in 1944. This one was done, and he was pleased—

although he really wanted it to be a much more annotated publication. It was difficult for him to let a project go; there were always unfinished loose ends that would make it better. But he did publish, very extensively, even when he knew that the last word on the subject could not yet be written. His collected works totaled 712 titles.

To Scripps Institution of Oceanography Hubbs willed his library and his personal papers. The library of 80,000 reprints and books and 125 linear feet of personal papers together constitute Hubbs Collection, housed in the Archives of the Scripps Institution of Oceanography, where they continue to be available to researchers.

NOTE: John D. Isaacs participated in the preparation of this account before his death in 1980. All manuscript material and correspondence cited here are from: *Carl Leavitt Hubbs, 1894–1979: Papers, 1915–1979*, 81-8. In the Archives of the Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093.

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