

# CARL LEAVITT HUBBS

1894 - 1979

BY RICHARD H. ROSENBLATT

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When Carl Hubbs came to the Scripps Institution of Oceanography in 1944 at the age of 50, it was as one of the world's most distinguished ichthyologists. He was also returning to scenes of his early San Diego home. Although born in Arizona, Hubbs lived from age 2 to 11 in San Diego and spent most of his boyhood years in southern California. California



**Carl Hubbs in his laboratory in the Scripps Building shortly after his arrival in La Jolla.**

in those days was barely populated in today's terms, and he had ample opportunity to interact with nature. His early interest in birds was given an impetus by the opportunity to accompany the ornithologist and University of California Professor Loye Holmes Miller on a field trip. He was graduated from high school in 1912. Although he had been advised to attend the University of California, he was fortunate to attend Los Angeles Junior College where George Bliss Culver was an instructor, Culver had worked with David Starr Jordan, the nation's pre-eminent ichthyologist, then President of Stanford University. Culver had turned Hubbs's attention to fishes and convinced him to continue his education at Stanford, at that time the center of American ichthyology and the home of an important museum with an extensive collection of amphibians, reptiles, and fishes.

There Charles Henry Gilbert—one of the country's most dynamic ichthyologists and a close associate and collaborator of Jordan's—became Hubbs's advisor and mentor. While an undergraduate, Hubbs was assigned the job of curating the extensive Stanford fish collection. He was active in research on the collection, publishing his first paper in 1915. He also managed to spend much time in the field. Some of Hubbs's long-term interests were formed during this period. On one trip to Monterey County he spotted a sea otter, then thought to be extinct in California. He also made a collecting trip to the Great Basin with John Otterbein Snyder, surveying the relict fishes of the basin of ancient Lake Bonneville. He was to return to the fishes of the desert over and over during his career.

Carl Hubbs entered graduate school in 1916. Although he did work with Jordan, beginning a study of fishes that Jordan had obtained in Egypt, his advisor on his master's thesis research was Gilbert. In later years Hubbs sometimes referred to himself as Jordan's last student, but the relationship was more that of master and apprentice. Hubbs's master's research was on the deep sea grenadiers (Macruridae) collected in Japan by the U. S. Fish Commission steamer *Albatross*, another interest that he never abandoned. As a student, he published 11 papers in 1916 and 1917, foreshadowing his later prodigious publication record.

Early in 1917 Hubbs left Stanford to become Assistant Curator of Fishes, Amphibians, and Reptiles at Chicago's Field Museum of Natural History, receiving his M.A. in June. Hubbs spent the war years there, and later recounted that the trustees informed the staff that they could expect no pay raises while there was a war on. It was at this time that he married Laura Clark, whom he had met at Stanford. Laura, a statistician, had received her M.A. in 1916, and was teaching mathematics. She was to become his collaborator and constant companion. In 1920 Hubbs was terminated at the museum for what he referred to as "blatant insubordination." He did not remain unemployed, as he had already accepted a position at the University of Michigan.

At Michigan, Hubbs was appointed as Instructor and Curator of Fishes in the Museum of Zoology. There he undertook to build the collection. When he left Michigan in 1944, the collection was the largest and best of North American freshwater fishes. But he also added marine fishes from the west coast of America, Japan, and Indonesia. He had built one of the great collections of the world, consisting of some two million specimens. Much of this collection was due to the efforts of the Hubbs family and students. Carl, Laura, and the three children, Clark, Earl, and Frances, spent every summer in the field, collecting and camping by various bodies of water. The Michigan collection was not only one of the largest in the country, it was certainly the best curated, thanks in no small part to Laura Hubbs. Carl had devised a data sheet for recording locality and ecological data from each station. Each station was allotted a "Field Number" consisting of the year preceded by the letter H, and the consecutive number of the station as it was entered. This number would accompany one lot of fishes from a station. When a lot of a species was cataloged, the field number and the number and size range of specimens were recorded on a catalog card for that species. The name and number of individuals were recorded on the data sheet. Thus the taxonomic catalog contained a record of all lots of a species, and the data sheet contained a list of species occurring at a given locality. This system was infinitely more flexible than the older cataloging systems then in use in which every lot cataloged was entered on a single line in a ledger and given a unique number. Hubbs's cataloging method required more labor, but

expenditure of energy was never an obstacle separating Hubbs from a goal. Besides, he had his indefatigable wife as cataloger. This method of data storage and specimen cataloging developed at the University of Michigan is used in every North American fish collection that is recent enough to have adopted it.

It was also at the University Michigan that Hubbs obtained his Ph.D. In the late 1920s the university had begun a program of institutional improvement by upgrading its faculty. And Hubbs, one of its most active and widely

known professors, did not have a doctorate. Then President Ruthven came to Hubbs's office and asked that he submit a dissertation. It is said that Hubbs responded by pointing to several papers and saying "which one?" The Zoology Department scientists put together a committee and Hubbs submitted the paper "The Structural Consequences of the Development Rate in Fishes Considered in Reference to Certain Problems of Evolution." The paper was duly accepted by the doctoral committee, the degree was awarded in 1927. One can only imagine the nature of the oral examination given to the confident candidate Hubbs. The rumor was that the committee emerged pale, and Hubbs emerged smiling.

His paper, which anticipated the current emphasis placed on changes of rate processes in development in morphological evolution, was only one of a series of influential works done by Hubbs in this period. There was a literal outpouring of papers on the taxonomy and faunistics of fishes, done with a degree of thoroughness and accuracy that gave rise to the adjective "Hubbsian." He had long been interested in the problem of the latitudinal variation in the number of repeated body parts in fishes. It had been observed by Jordan that in the Northern Hemisphere, fishes of higher latitudes had more vertebrae and fin-rays. This had been codified as "Jordan's Law." If somewhat less universal than the law of gravitation, it is a widespread phenomenon and one of considerable interest evolutionarily as well as to fisheries biologists who until recently used such data to distinguish stocks within a species. Hubbs provided much corroboration, and an explanation, based on varying rates and duration of differentiation and growth, that has been the basis of much further work and that still stands.

Hubbs had been struck by a number of specimens that were intermediate between what otherwise seemed to be valid species. Some of these were recognized as distinct species. He recognized that they must be hybrids. By performing laboratory crosses he and his



**Laura, Clark and Carl Hubbs collecting in Nevada in 1934.**

collaborator Laura were able to demonstrate that certain putative species of sunfishes were actually sterile hybrids. They observed that hybridization in nature was more common in disturbed habitats such as those produced by Pleistocene glaciation.

In examining collections they had made in Mexico, Hubbs noted a species of killifish of the genus *Mollienesia* (now referred to the genus *Poecilia*) that seemed to be represented only by females. Together with Laura, Hubbs determined that this all female species was of hybrid origin, but that the development of the eggs had to be stimulated by sperm from males of one of the parental species. Hubbs coined the term "Amazon molly" for the species, and the process came to be called gynogenesis. This phenomenon has subsequently been discovered in other fishes, and there is now a considerable literature in this area of research pioneered by the Hubbses.

In addition to his prodigious output of basic research, Hubbs found the time and energy to become the founding Director of the Institute of Fisheries Research, a cooperative endeavor between the university and the Michigan Department of Conservation. Under his direction the institute innovated techniques of restoration of streams and other aquatic habitats, as well as carrying out a variety of fisheries investigations. One outcome of his activities in the area of fisheries was the publication with Karl Lagler of the handbook *Guide to the Fishes of the Great Lakes and Tributary Waters*. This publication, in addition to identification keys, illustrations, and range maps, had extensive instructions on collecting methods, data recording, and preservation. There was also an exhaustive description of external anatomy and methods of counting and measuring morphological features. This publication became Hubbs's most cited paper, as for many years almost all taxonomic papers published by U. S. ichthyologists included the statement "counts and measurements made according to the methods of Hubbs and Lagler."

Hubbs had visited the Scripps Institution of Oceanography in 1943, and had co-authored two papers with the curator of the Scripps Aquarium, Percy Barnhart, who maintained a small collection of fishes. Following this visit Hubbs was offered a position by then Director Harald Sverdrup. In 1944 Hubbs accepted the offer, citing his interest in renewing his studies of west coast marine fishes. He brought with him his library of a number of journals and some 40,000 reprints and books, mostly on ichthyological subjects, but also containing many items related to his broad interests in evolution and vertebrates in general. Without this library, carrying out research on fishes at Scripps would have been difficult indeed in those days before photocopying, easy interlibrary loans, and electronic communication. His library, grown to more than 70,000 entries is now a much used part of the Scripps Institution Library.

Once at Scripps, Hubbs set out to build a collection of west coast fishes, similar to the one he had left at Michigan. However, the institution was not able to provide much in the way of logistic support or space, although the director assured him that planned postwar building should make the needed space available. This promise was not to be fulfilled until 1960.

Hubbs made perhaps his most interesting, if not his most scientifically rewarding, collecting trip in 1946. He had met the marine biologist father of the movie star Errol Flynn, then spending a sabbatical at San Diego State College. Errol Flynn, known as much for his off-screen exploits as on, had acquired the yacht *Zaca*. *Zaca* had been used for

scientific purposes by its previous owner Templeton Crocker, and perhaps this played some role in the invitation at the suggestion of Flynn senior to Hubbs by Errol to accompany him on a trip to Acapulco, Mexico. Hubbs was able to visit Guadalupe Island as well as to collect at Acapulco. Although the collections were of necessity modest, the visit to Guadalupe, where he saw elephant seals, then almost extinct, started a lifelong interest in the island and its flora and fauna. On several of Hubbs's subsequent trips to Guadalupe he was accompanied by a botanist, Reid Moran of the San Diego Natural History Museum, who was able to collect and describe the flora of the island, fast being driven to extinction by introduced goats.

Flynn combined business with science by producing a film, the short subject *The Cruise of the Zaca*, intended for theatrical release. Loosely based on the trip, the film ends with a celebration on the beach at Acapulco, complete with dancers in grass skirts. It also begins with an episode in which Hubbs and Flynn use a helicopter to observe gray whales in Baja California. In the film, which was finally released in 1952, Flynn falls from the helicopter while attempting to photograph the whales and it is necessary for Carl to assume the controls and rescue him. It is clear that Carl was enjoying himself



**Carl Hubbs, Harald Sverdrup and Errol Flynn in front of the Scripps Library.**

immensely. A scratchy copy of the film was long available at Scripps and was frequently shown to groups of appreciative graduate students, to the delight of Carl and the distress of Laura. The original is now in the Archives of the Scripps Library.

One of Hubbs's long-term interests was biogeography, and in 1949 he published a seminal and still cited paper "Changes in the fish fauna of western North America correlated with changes in ocean temperature."

In this paper he established, from the examination of early accounts, that the fish fauna of California at the turn of the century had a distinct warm-water component, with fishes appearing in the markets of San Francisco and Monterey that now are found only far to the south. Although ocean temperature data for that period were sparse, he was able to convincingly argue from air temperature data that the climate had been warmer in that period. Observations of records of northward extensions of range among fishes during El Niño years have abundantly borne out the validity of Hubbs's analysis.

This interest also led Hubbs to begin in 1948 the collection of shore temperature data from La Jolla south along the Baja California coast. He established a series of 61 stations, stretching as far south as Cape Colnett. In those innocent days permits were unthought of; all that was necessary was the purchase of a tourist card from the Mexican government. The stations were occupied once a month on what came to be known as the "Temperature Run." Many of the runs were done by Carl and Laura, although in later years they were done by assistants, most notably Alan Stover. The results demonstrated a number of seasonal upwelling areas along the south sides of points such as Punta Banda and Santo Tomas. The upwelling of cold water produced the anomalous-seeming phenomenon that the fauna of the south side of a point would have a more northern composition than that of the northern side.

Observations of aboriginal Native American kitchen middens along the coast led Hubbs to an interest in archeology. For example, plates of the gumbot chiton could be found in the middens, although the species now occurs only in the colder waters north of Point Conception. He and assistants collected material from these middens (now housed in the San Diego Museum of Man) for analysis. The establishment of the La Jolla Radiocarbon Laboratory, to which Hubbs contributed time and energy as well as material, allowed the dating of the samples, and this, coupled with the determination of oxygen isotope ratios of the mollusc material demonstrated that there had been marked temperature fluctuations in coastal temperature since the end of the Wisconsin Period.

In 1947 the California Cooperative Oceanic Fisheries Investigations was established as a multi-institutional program to investigate the collapse of the important fishery for the California sardine. Hubbs was a participant in the establishment of the program, and received support from it for many years. Although the emphasis of the program has turned to the sampling of fish eggs and larvae by use of plankton nets, Hubbs early on participated in planning for the collection of deep sea fishes. Partly from his desire to have a collecting tool more efficient at capturing adult fishes than the 1 or 2 meter plankton net, John Isaacs, who was to head the Marine Life Research Program, and Lewis Kidd designed a midwater trawl that was larger and could be towed faster. The IKMT as it came to be known was the standard tool for collecting midwater fishes for many years, and is still in use. Its development marked the beginning of the Scripps deep sea fish collection, now one of the largest and most important in the world.

Once at Scripps, Hubbs included marine mammals in his scope of interest. He had been informed that gray whales, then thought to be nearly extinct, had been seen near Point Loma on their annual migration to their Baja California mating and calving grounds. With typical Hubbsian enterprise, he had an enclosure built on the roof of Ritter Hall and installed Japanese artillery spotting binoculars that had been brought back by a soldier as war booty. Colleagues and graduate students were persuaded to stand 15 minute watches during daylight hours. The watchers were to count the whales and note course and speed, and make behavioral notes. Fortunately the whale migration takes place in winter when the days are short. Hubbs also instituted aerial counts of the whales in their calving grounds in Scammons and San Ignacio lagoons. Most of the flights were made in planes owned and piloted by Scripps oceanographer Gifford Ewing. The data gathered by Hubbs and the

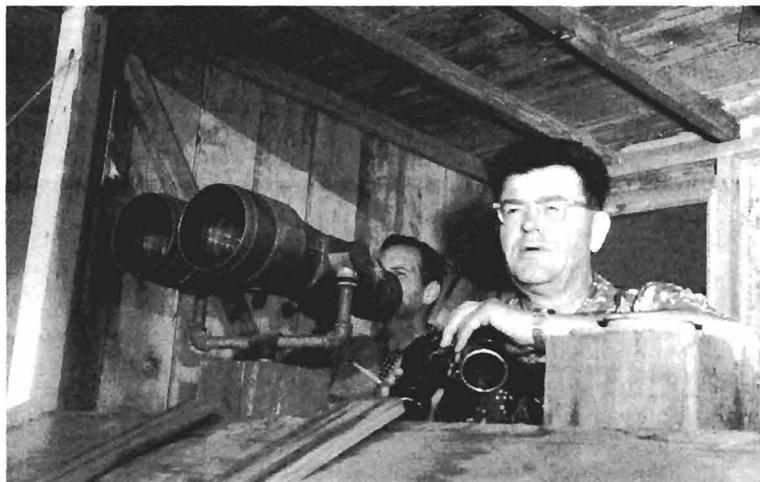
U.S. Fish and Wildlife Service established that the population of gray whales was increasing. Hubbs was the driving force in convincing the Mexican government to establish a sanctuary for the gray whales on their calving grounds, which was finally done in 1972.

On his 1946 visit to Guadalupe Island on *Zaca* Hubbs had observed northern elephant seals, which had been hunted nearly to extinction, and later he found a small population of the Guadalupe fur seal, which had been thought to be extinct since 1928. He documented the increase in population of the former, which has by now regained its original numbers and established rookeries that have become a tourist attraction along the Central California coast. As he had with the gray whale, Hubbs sought protection for these animals and was instrumental in persuading the Mexican government to make Guadalupe Island a preserve.

In those days before the Marine Mammal Protection Act made marine mammals untouchable wards of the Federal government, every cetacean that washed ashore in the San Diego region was examined by Hubbs and assistants. Measurements and dissections were made and, if possible, skeletal material was obtained by what participants referred to as the "whale wrecking crew." One result of those activities was the naming of a whale species as *Mesoplodon hubbsi*. Another is the complete skeleton of a Cuvier's beaked whale that hangs in the San Diego Natural History Museum.

Although Sverdrup had indicated to Hubbs that space for housing a fish collection would be made available by post-war construction, it was to be many years before that commitment would be fulfilled. The Scripps biological collections were housed in the basement of the then Aquarium-Museum (Vaughan Hall). The Marine Vertebrates Collection, as it was formally known—it did contain some marine mammal material and, mysteriously, a preserved flamingo—had a totally inadequate preparation room and a series of overwhelmed student curators. The only provision for large specimens was rust-prone galvanized drums. Material from the CalCOFI program came in, and Hubbs continued to collect, but Carl, and especially Laura, were unable to give it the time that they had spent on the collection at Michigan.

The postwar building boom finally came to Scripps Institution in the late 1950s. Sverdrup Hall had been constructed and another major building was planned. It took all the stature and persuasive power of Carl Hubbs and Martin Johnson to convince Roger Revelle, who was not particularly sympathetic to the accumulation of objects, that the collections were



**Sam Hinton, curator of the T. Wayland Vaughan Aquarium Museum and Carl Hubbs in the whale-watching shack atop Ritter Hall, 1950.**

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worth devoting space and resources to. In the end space was allotted for the invertebrate and vertebrate collections on the ground floor of the new addition to Ritter Hall. The vertebrate collection also had a preparation and chemical storage room and two adjacent offices. An important advance was that the institution agreed to provide three curatorial positions on the Professional Research Staff, one each for marine vertebrates, invertebrates, and geology. Each curator was also to have an assistant to help curate the collection. Thanks to the foresight and efforts of Hubbs and Johnson, the Scripps Institution biological collections (now housed in the new Vaughan Hall) are secure for the foreseeable future. The collections are now under the care of curators with tenured faculty appointments, and each has one or more staff assistants. The vertebrate collection now comprises more than two million specimens and 5,000 species and is one of the most important in the world.

In addition to his extraordinary research accomplishments, Hubbs's inexhaustible energy allowed him to pursue an impressive number of other activities. He was editor of the journal of the American Society of Ichthyologists and Herpetologists, *Copeia*, from 1930 to 1937 and was secretary of the society in 1929 and 1930. He served as president in 1934 and in 1946 and was reelected in 1947. He was first chairman of the society's Committee on Nomenclature. (This activity led to his appointment to the International Committee on Zoological Nomenclature, though he soon found that the committee's hairsplitting and legalism was not to his taste.) No one else has played so dominant a role in the ASIH, and it is unlikely that anyone will ever again serve more than one term as president. Hubbs was a faithful and active participant in the annual meetings of the society; anyone misstating a fact or reaching an unwarranted conclusion could count on a question from Hubbs.

Although engaged in marine problems, Hubbs never abandoned his interests in freshwater fishes, particularly those of Mexico and the desert. Aware of the threats to the often small populations of the relict fishes of the desert, Hubbs had been active in conservation efforts. He and his student (and son-in-law) Robert Rush Miller were instrumental in having Devils Hole, a small spring that contains the entire population of the killifish *Cyprinodon diabolus*, made part of the Death Valley National Monument in 1952, long before the endangered species act. Hubbs had coined the felicitous name pupfish for the genus, and one cannot but believe that this name, evocative of man's best friend, did much to aid efforts to save the pupfishes. Would "desert killifish," for example, have had the same cachet? Hubbs was a leader in the establishment of the Desert Fishes Council in 1969, still an active group.

Hubbs continued to collect in the Great Basin. Almost every year would see Carl and Laura taking off for the desert in a four wheel drive vehicle, driven by Hubbs as if there was no tomorrow (or at least no springs to worry about). They would meet Miller and others and explore the fishes of various bodies of water. As a result of these investigations, and following up on his earlier work on the fishes of the Great Basin, he, with Laura Hubbs and former student Robert Rush Miller, completed the long awaited monograph *Hydrographic History and Relict Fishes of the Great Basin*. This work was a major contribution, combining biogeography, taxonomy, and geology in elucidating the hydrography of the Great Basin since the end of the Wisconsin glacial period.

At the time of his 80th birthday in 1974, he was attending a meeting of the Desert Fish Council near the Salton Sea, so a planned surprised birthday celebration had to be postponed for a week.

Out of town participants, including his former student Katsuo Kuronuma (representing the Emperor of Japan) had to change their flights.

Soon after his arrival in San Diego in 1944 Hubbs was invited by the herpetologist Laurence Klauber to join the San Diego Society of Natural History, parent of the San Diego Natural History Museum. He was to serve on the

Board of Directors for 29 years. During that time he became friendly with fellow board member and banker Joseph Sefton. He influenced Sefton to outfit his yacht, *Orca* for research. Sefton made the vessel available under the auspices of the Sefton Foundation for research cruises and teaching. Hubbs made trips with Sefton to Guadalupe Island and various California localities.

In 1948 Hubbs was appointed to the research committee of the Zoological Society of San Diego, which operates the San Diego Zoo, and shortly thereafter to the board of trustees where he served until 1979. This was a period of unparalleled expansion of the zoo, with the establishment of the Wild Animal Park and a greatly increased research and captive breeding program.

In the early 1960s the San Diego City Council decided to entertain proposals for a marine park in Mission Bay Park. Hubbs was invited to join one of the competing groups, in which his former student Kenneth Norris was a principal. One of the strengths of this group was its proposal to make research a part of its program, and Hubbs testified before the city council. It cannot be proved, but his stature as a scientist and conservationist may be what tipped the balance toward the group that established Sea World on Mission Bay. Hubbs was on the executive board of the corporation, and the research arm was established as a modest venture called the Mission Bay Research Foundation, housed in a small office in La Jolla. It was later moved to Sea World itself and renamed the Sea World Research Institute, where it was headed by Hubbs's protégé William Evans. In 1977 it was rededicated as the Carl and Laura Hubbs Sea World Research Institute. Today it has survived



**Joseph Sefton, President of San Diego Trust and Savings Bank and Carl Hubbs examine a moray eel on a collecting trip on R/V *Orca* in the California Channel Islands.**

two changes in ownership of Sea World and is a large and successful institution engaged in far-flung research and conservation activities.

Hubbs did little formal teaching, for despite his excellence and dedication as a researcher, his lecturing style was labored, and he had scant patience with the preparation of lectures on topics of which he had little firsthand knowledge. He was, however, a prolific teacher of graduate students, who learned mainly by example, either during long hours in the field, or looking over the professor's shoulder in the laboratory. Literally generations of graduate students learned to write when Hubbs painstakingly, and sometimes painfully, rewrote their dissertations and theses. He would spend just as much time with manuscripts he reviewed, and Hubbs's editing elevated the quality of writing in much of American ichthyology. He supervised 28 doctoral students at the University of Michigan, including, in 1925, that of his sister-in-law Frances Clark, who later became Director of the research laboratory of the California Department of Fish and Game. At Scripps he supervised 17 students, the last finishing in 1973. The diversity of dissertation topics of Hubbs's students is astonishing, ranging from the expected taxonomy, life history, and behavior of fishes, to chromosome number in chitons, the life cycle of a crayfish, and a study of the ancient Anasazi.

One unorthodox opportunity of education for students and staff was the maintenance of the circulating file. Hubbs maintained a voluminous correspondence. He received letters and manuscripts from colleagues and correspondents around the world. He was faithful in answering letters and providing requested reviews, sometimes to the detriment of ongoing activities. Often his voice could be heard dictating into a recorder letters for his secretary to transcribe the next day. Laura Hubbs was responsible for proofing the letters to make sure that the transcription was accurate. Before filing, almost all incoming and outgoing material, including journals and reprints, was placed in binders in the reading room of Hubbs's library where it was available to all. It was difficult to keep up with Hubbs's correspondence, but anyone who faithfully read the circulating file would be educated in a variety of areas to which graduate students and junior staff were not usually privy.

Hubbs's powerful personality was perhaps as much responsible for his influence on others as his learning. Although not physically prepossessing like his role model David Starr Jordan, he radiated power. He briefly visited Japan in 1929, but left a lasting impression. The great Japanese ichthyologist Matsubara referred to himself as a student of Hubbs, and Japanese ichthyologists regarded him with a feeling akin to awe long after his visit. His energy and tenacity were legendary, as was his attention to detail. Withal, he had a very human side. A youngster bringing in a fish found on the beach would get the great man's attention and would leave feeling that he had done a signal service to science. Carl and Laura were never too busy to offer hospitality to visitors, who usually found themselves staying with the Hubbses. Lunches on the patio looking out on the magnificent Hubbs garden (maintained by Carl and Laura) were a legendary part of a visitor's experience.

Carl Hubbs died on June 30, 1979 at the age of 84 of complications of prostate cancer. He left behind him a legacy of 712 scientific papers and 125 linear feet of personal papers and research records, a world-class research collection, and perhaps most importantly, a tradition of intellectual effort passed on to his students and their students in an ever increasing network.

■ ■ ■ **Author's Note**

In preparing this account I have utilized facts and chronology from the Biographical Memoir prepared for the National Academy of Sciences by Elizabeth N. Shor, Richard H. Rosenblatt, and John D. Isaacs.



Laura C. and Carl Hubbs on a 'temperature run' in Baja California in 1954. Carl holds the casting thermometer, and Laura, as usual, stands ready to make notes.

