Microbiology and Microbiologists at the Scripps Institution of Oceanography

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Preamble: As indicated by the title, this Report deals mainly with the development of marine microbiology and related fields of study at the Scripps Institution. Emphasis is on my own observations, experiences, and recollections, except for events and people prior to June 1931 when I first visited the Institution to explore opportunities for teaching and research. It was expected that four or five other "old timers" would be covering their respective fields of study.

The following report was prepared (mostly in 1980) to be part of a book entitled, "Those Were the Days; These Were the People." This title was suggested by Dr. B. E. Volcani, Professor of Marine Biology at the Institution. The book was supposed to be an account of the development of various marine sciences at the Scripps Institution up until about 1948 by scientists who were here before that time. Questions concerning the authorship of the book and its editorial policy have delayed the fruition of the book. The following has been prepared for the SIO Reference Series, currently under the direction of Elizabeth N. Shor.

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Section 1. Preparing for a Career in Marine Microbiology

As Dr. Roger Revelle has said about oceanography, it could be said that marine microbiology is what marine microbiologists do. They study the ecology, characteristics, biochemical activities, and importance of bacteria and allied microbes or microorganisms in marine environments. The allied microbes consist mainly of yeasts, filamentous fungi, microflagellates, microalgae, and some of the smaller protozoans. With a few exceptions, microbial spcies are microscopic in size. Most single cells must be magnified from 100 to 1000 or more times in order to be seen. Most microbes are unicellular. Cells range in size from about 0.1 micrometer (abbreviated μm) to 10 μm or more. One micrometer is equivalent to about 1/25,000 of an inch.

Marine microbiology is highly interdisciplinary in scope. Marine microbiologists must work in close collaboration with chemists, biochemists, other biologists, geologists, geochemists, physical oceanographers, and engineers. There were very few marine microbiologists before I came to the Scripps Institution in 1931. This branch of science was in its embryonic stage of development. The fragmentary and scattered literature dealing with marine microbes was controversial. Figuratively speaking, only a handful of papers on this subject had been published prior to 1930.

My becoming a marine microbiologists was fortuitous. From earliest pre-school recollections, I had wanted to be a doctor, meaning a medical doctor, the kind who does some good. Not many

other options appeared to be open for a boy who spent the first 18 years of his life on a farm in upper Snake River Valley, Idaho. My parents were very poor pioneers living in a two-room log house that they had built themselves. It was about five miles to the nearest settlement, Rigby, which had a population of less than 200 in 1904. Transportation was restricted to horses on unpaved roads or trails. I was 12 years old before seeing an automobile. I never owned one until coming to California in 1929. During the first 15 years of my life on the farm there were no telephones or indoor plumbing. This was long before the days of television.

In this rather rustic environment up until graduating from high school in 1922, I could contemplate no future other than being either a farmer like my father, a school teacher, a sheep-herder, a cowboy, a store-keeper, a fireman or engineer on a steam engine, or a doctor. The latter two occupations impressed me as being most glamorous. My older brother and sister both became elementary school teachers, earning sixty or seventy dollars a month for working only five days a week. I became a school teacher successfully and successively at the elementary, college, university, and graduate school levels.

In those days (1920-30), a high school graduate could qualify as an elementary school teacher in Idaho by studying at a State Normal School for nine weeks. A 5-year certificate could be obtained by one year's study, and a Life Certificate after two year's study. Much to the displeasure of my father, who wanted me to stay on the farm, I matriculated at Albion State Normal School. Albion is about 165 miles from Rigby, 100 miles from Pocatello.

From that time forward, my parents never provided any financial assistance. After buying a railroad ticket, I had barely enough funds for my tuition ($16) and one month's room and board. However, a janitorial job at the school for four hours a day five days a week paid $30 per month. This, augmented by income from odd jobs on and off the campus, proved to be more than adequate for books and other expenses.

The first year at Albion (1922-23) was so pleasant and rewarding that I stayed there for another year. The school gave me a better job as "hasher," a combination dining-room waiter and busboy. Three times each day seven days a week I served 18 students or Faculty members in the campus dining room. For this I received my board and a room in Miller Hall, the men's dormitory. Spending money was earned by barbering for 25¢ per person. Other campus activities included being business manager of the yearbook, vice-president of the student body, president of the Philomathean Society (an 85-member literary club), chairman of the debating team, and leading roles in two school dramas. Incidentally, in 1947 the name of the school was changed to Southern Idaho College of Education. In 1951 it became the College of Education in what is now Idaho State University in Pocatello.

After receiving a Life Certificate, I was qualified to accept a position in the Rigby elementary school. There I taught the fifth grade and was principal for two years. During those two years, I attended the National Summer School at the Utah State Agricultural College in Logan and took half a dozen correspondence courses from this College during the other months.

Although the Board of Trustees in Rigby offered me a contract for another year as principal and teacher in the elementary school, I had decided long before the end of the second year to return to college. At Utah State Agricultural College (now Utah State University), my major became bacteriology and biochemistry. The requirements for a B.S. degree were completed in four quarters in time to graduate with the class of 1927. All of this time I was working part time as either a Research Assistant subsidized by the U.S. Department of Agriculture or as a Teaching Assistant in the Department of Bacteriology and Biochemistry under the chairmanship of Prof. J. E. Greaves. These appointments continued during my first year as a graduate student. During the second year, I served half time as Instructor in Bacteriology and Biochemistry. The requirements for the M.S. degree in Bacteriology were completed long before the commencements exercises in May 1929. At that time a M.S. degree required a Masters thesis as well as a comprehensive oral examination by a committee of six. My committee consisted of Professors E. G. Carter (Bacteriology), W. W. Henderson (Zoology), C. T. Hirst (Chemistry), F. L. West (Physical Chemistry and Dean of the Graduate Division), and J. E. Greaves (Bacteriology and Biochemistry).

Inasmuch as Utah State Agricultural College was not offering degrees higher than the Masters at that time, further education required obtaining financial support elsewhere. At the suggestion of Prof. Greaves, I applied to two other land-grant colleges that offered training in agricultural bacteriology leading to the Ph.D. degree: the University of Wisconsin (Prof. E. B. Fred) and Rutgers University (Prof. S. A. Waksman). Much to my delight,

each offered me a position as Research Assistant. Before deciding which to accept, I received another pleasant surprise. The Willard Dawson Thompson Scholarship had been awarded to me.

Only then did I learn that this prestigious Scholarship was awarded every other year to the graduate student who had the best academic and activities record at either Brigham Young University in Provo, Utah State Agricultural College in Logan, or the University of Utah in Salt Lake City. Only students born in Utah were eligible for consideration and it was required that the recipient of the Scholarship be accepted as a doctoral candidate at the University of California in Berkeley. Immediately I applied for admission to the Dean of the Graduate Division (Dr. C. B. Lipman, a famous soil bacteriologist and personal friend of Prof. J. E. Greaves) and to Prof. Karl F. Meyer (Chairman of the Department of Bacteriology). My being born in Utah was fortuitous, because about that time (1904) my parents were living in Idaho with two children in a two-room log house. Therefore, my mother returned to her parents' less primitive home on Provo Bench (now Orem) for my birth.

On my 25th birthday anniversary, 22 August 1904, I arrived in San Francisco across the Bay from Oakland and Berkeley. After finding a room in a boarding house on Parnassus Avenue near the University of California Medical School, I took a street car to Sunset Beach four miles west near the end of Golden Gate Park. There for the first time in my life I saw the sea, a part of the Pacific Ocean. It seemed to go on forever beyond the horizon with ever-changing colors and perpetually breaking waves. Like so many tourists, I removed my shoes and socks to wade in the surf

and feel the sand between my toes. This was my first glimpse of the ocean with which I was to become preoccupied for more than half a century. Up until this time the largest bodies of water besides the Snake River that I had seen were the Great Salt Lake, Bear Lake, Utah Lake, and a few small reservoirs. I didn't realize it then that this day marked the beginning of a new life. It was also my first day in California.

Before coming I had learned that Prof. Meyer, with whom I was to work, divided his time between the Berkeley and San Francisco campuses of the University of California. His headquarters were in San Francisco where he was Director of the Hooper Foundation for Medical Research associated with the medical school. It developed that most of my dissertation research was done in Hooper Foundation and the majority of my other predoctoral studies were on the Berkeley campus. This made it necessary for me to commute three or four times per week between the two campuses. The trip required about 90 minutes each way under favorable conditions, changing from the San Francisco street cars to the Bay ferryboat and from the ferry to the big "red cars" on the Oakland/ Berkeley side. I soon learned how to study quite effectively at least part of the time. While commuting for two years, my boat was involved in collisions three times. One of the boats on which I was riding started to sink after colliding with a freighter. This required the passengers to transfer to the freighter and various rescue vessels. Not infrequently dense fog over the Bay made it necessary for boats to navigate by sound. The Bay crossing never ceased to be exciting. During the two years (1929-31) when I was commuting, the Bay Bridge was under construction. I watched the caissons being built and the cables being spun from tower to tower.

It developed that the Thompson Scholarship was a cash award, with no obligations whatever other than maintaining an acceptable scholastic record. A check was received each month. The stipend was more than enough to cover the cost of tuition, transportation, board and room, books, and other expenses. Having no dependants or debts and by being frugal, I saved enough to purchase a second-hand car before moving to La Jolla 29 months later. This was the first time in my life when it was not necessary to work for a living.

Before I came to California, it had been decided by correspondence that I would work under the supervision of Prof. Meyer on cultural requirements and metabolism of the Brucella group. The chief objectives were to develop a synthetic or chemically defined medium for cultivating various species of Brucella and to develop better methods for the identification of species. Brucella is a genus of bacteria of which there are several species. Some of these are infectious for cattle, sheep, goats, pigs, poultry, dogs, cats, and other animals. Certain species cause the "wasting disease" in man. Certain forms of the disease are sometimes called "contagious abortion," brucellosis, or the "Mediterranean Sea fever."

Also on my guidance committee were Dr. Max S. Marshall, Professor of Bacteriology in the Medical School, and Dr. T. D. Beckwith, Professor of Bacteriology in the Department of Bacteriology on the Berkeley campus. A well-equipped office-laboratory was reserved for me in Hooper Foundation. Glassware, including culture tubes, petri dishes, and pipettes, was prepared for me by a technical assistant. A more than adequate allocation was

available for the acquisition of chemicals, nutrients, reagents, glassware, and other laboratory supplies. My laboratory or adjacent ones had various kinds of incubators, microscopes, centrifuges, pH meters, spectrometers, sterilizers, and other apparatus.

Prof. Meyer was abroad during the first few weeks when I was getting oriented in Hooper Foundation. Consequently, it was necessary for me to seek the advice or approval of my plans from either Dr. Marshall in the Medical School or Dr. Beckwith in Berkeley. Both were empathetic, cooperative, and full of good ideas about which courses and seminars I should take, but neither cared to approve any part of my research program in the absence of Dr. Meyer. Very helpful were Janet Gunnison, Beatrice Howitt, and Beatrice Eddy, who were also working on Dr. Meyer's Brucella research team.

Prof. Meyer returned to Hooper Foundation early in November, 1929. Everyone having problems, progress reports, future plans, and budgets was waiting for a conference. Within a week he gave me an appointment through his secretary, Miss Eleanor Rankin, to confer with him in his office at 2:00 p.m. At 1:55 I was in the reception room watching the clock and the movements of scared people. At 3:00 p.m. I was still waiting, wondering why they called it a reception room. Being somewhat annoyed by the waiting, I told Miss Rankin that I was returning to my laboratory on the floor below. She warned, "Dr. Meyer might be angry. He is a very busy man, you know."

A couple of hours later, Miss Rankin summoned me by telephone. In less than two minutes, I was back in his waiting room. With no waiting whatever, I was ushered into His presence. Without

offering a handshake or inviting me to sit, he contemptuously greeted me, "So you're Tsoble." Exhibiting irritation he continued, "I'm a busy man, Tsoble. You had an appointment with me at two and here you are after five. If you are going to work with me, you won't keep me waiting." Only then did he stop talking long enough for me to say anything.

The circumstances didn't seem to call for the conventional "Pleased to meet you." Politely as possible, I replied, "Unless you realize that my time is also worth something, I'm not going to be working with you." Frightened by this bold statement, I paused for a moment to think about whether it would be prudent to add, "My name is pronounced like it is printed, ZoBell to rhyme with no bell." He learned this later, but he never learned to pronounce the Z.

At this point, he interrupted me by standing up, all six feet four of him. He slowly stepped toward me as though wondering whether to throw me out of the door or the window. Instead, he reached for a cigar and offered me one. Surprised, I could only say, "No, thanks, I don't smoke." After lighting his and puffing a few times, he asked rather brusquely, "What's on your mind?"

For a few weeks I had been rehearsing how to tell him what was on my mind. But during the rehearsal, Dr. Meyer was known to me only as a world renowned bacteriologist. So I changed my script by telling his as succinctly as possible that I needed his approval as Chairman of my Guidance Committee to proceed with my research program. He expressed querulous surprise to hear that I had already started on what I hoped would become my doctoral dissertation. He started to ask incisive questions

concerning my experimental methods, observations, and data. After half an hour of such dialogue, he requested me to prepare a typed report. He wanted it before the Christmas holidays. He stated, "Miss Rankin will type it for you."

The progress report was on its way within a week. Then there was more waiting for a response from Dr. Meyer.

The first conference with Dr. Meyer had been rather discouraging to say the least. His brusque manner seemed to confirm whispered remarks by certain staff members and students that he was sometimes insensitive, extremely exacting, inconsiderate, and unkind. There were rumors of certain students' and staff members' having been bullied and humiliated almost beyond the bounds of human endurance by his cutting criticisms. The situation looked rather bleak for several days. Some thought was given to petitioning Dean Lipman for permission to transfer to the Berkeley campus. I also started to watch the want ads for employment opportunities elsewhere.

The Clorox Company in Oakland was seeking the services of an experienced chemist-bacteriologist to work on product control and the development of new products. The Clorox people granted me an interview to become acquainted with some of their personnel and to inspect their laboratory facilities. Everything looked favorable. The starting salary was about the same as that received by an Assistant Professor in the University of California. After they examined my curriculum vitae and some letters of commendation, the position was offered to me, effective 2 January 1930. Only the kindness and counsel of Dr. Max Marshall and the Thompson Scholarship kept me from accepting the offer.

Shortly before Christmas, Dr. Meyer requested another conference via Miss Rankin. It was to be in my office-laboratory. He appeared promptly at the designated time. From that day forward, most of our conferences were in my office-laboratory, where there was no room for waiting. During this conference, he expressed the opinion that my progress report contained two novel observations that he would like to prepare for publication. Within a few months, an article entitled, "The metabolism of the Brucella group in synthetic media" appeared in SCIENCE (72:176-177, 1930), co-authored by C. E. ZoBell and K. F. Meyer.

Some of our conferences were on the back seat of a chauffeured car enroute to and from the Berkeley campus, hospitals, food-packing plants, and other places where Dr. Meyer had business. He explained that this saved time and we could converse without being interrupted. These taxicab conferences proved to be a tremendous learning experience for me. Dr. Meyer was a man of exceptionally broad knowledge and experience, especially in the field of pathology, food bacteriology, medical microbiology, and veterinary science. He had a D.V.M. degree (1919) and a Ph.D. (1924) from the University of Zurich, an honorary M.D. degree and an LL.D. He strived for perfection in everything and expected his students to do likewise. He gradually became my personal tutor, usually kind, considerate, and always objective.

After our first encounter, he nearly always treated me as an equal, almost. Occasionally, he was somewhat surly and sadistic. I never learned to like his cigar smoke or the way he unleashed his caustic tongue on certain students and staff members. For their slightest errors in technical speech or technique, he would sometimes mercilessly upbraid errant ones.

The course in medical bacteriology usually called for a lecture from 2 to 2:50 p.m., followed by laboratory exercises from 3 to 5:30 p.m. When Prof. Meyer was scheduled to lecture, he might appear any time between 2 and 2:30 or later. He offered no apologies for keeping 40 students waiting for half an hour or longer. Then he would give an almost spell-binding lecture, sometimes for two hours or more without consulting notes. He dramatized, paced the floor, and made frequent use of the chalk board. Then abruptly and almost arrogently he would declare, "Time out for smokes." Most of the students came prepared with coffee, candy bars, crackers, or fruit, because they knew from experience that after the recess, Dr. Meyer might talk for another hour or two, sometimes until after seven or eight o'clock. None of us dared or cared to leave.

Working as I was with all known species of Brucella, my Guidance Committee required me to take Dr. Jacob Traum's course in Veterinary Bacteriology as well as special studies (research) in Veterinary Science, supervised by Dr. Traum and Dr. C. S. Mudge. Eventually, these two professor along with the three members of my Guidance Committee, K. F. Meyer, Max S. Marshall, and T. D. Beckwith, served as the Committee in charge of my dissertation research. Working in the Veterinary Science Department resulted in my becoming acquainted with the microflora of various kinds of domestic animals, including poultry and pond fish. This training proved to be useful later when investigating diseases of marine fishes and for serving 40 years on the Research Committee of the Zoological Society of San Diego.

Having satisfied the foreign language requirements (a reading knowledge of scientific French and German) and most of the course requirements prescribed by my Guidance Committee, I was eager to take the Qualifying Examination. Ordinarily this examination must be passed before the Ph.D. candidate proceeds with a doctoral dissertation.

About 14 months after my matriculation at the University of California, my Qualifying Examination Committee was appointed: K. F. Meyer (Chairman), Max S. Marshall (Medical Bacteriology), T. D. Beckwith (General Bacteriology), Jacob Traum (Veterinary Bacteriology, C. L. A. Schmidt (Biochemistry), J. C. Geiger (Communicable Diseases), and C. B. Lipman (Soil Bacteriology). Earlier Dr. Lipman had interested me in the bacterial precipitation of calcium carbonate in tropical seas, so I had often visited his laboratory on the Berkeley campus. He was the first to tell me something about the bacteriology of seawater and bottom sediments.

The Committee examined me early in October, 1930. Although a frightening ordeal, the questions seemed to be fair and quite comprehensive. After nearly three hours of grilling, I was excused from the room. It was exhausting but also exhilerating. I was able to answer most of the questions, but a few questions made me admit, "I don't know" or "I am not sure." When he called me back to learn the outcome, Dr. Meyer informed me that I had failed. He dismissed me with the admonition, "You had better be reading a lot of books."

This was a most shocking upset. Dr. Meyer had asked only one question, "What were the principal contributions of Robert

Koch to the development of bacteriology?" As a college teacher, I had lectured on Koch's contributions. As a tutor of medical students, I had summarized Koch's contributions several times. As a student, I had listened carefully to Dr. Meyer's classical lecture on Koch. It was a subject on which I was prepared to speak a little or a lot. On the occasion of my examination, though, after only two or three statements, Dr. Meyer contemptuously remarked, "That's enough. You may be excused from the room."

It was several days before Dr. Meyer gave me an appointment at my request. He seemed sulky or sullen. His answers to my queries were enigmatic. Where did I fail? What did I do wrong? What can I do to satisfy the requirements? To the latter question he snorted, "Read a lot of books." He seemed angry when I asked, "What books, for example?" He recommended, "Kolle und Wasserman, for example." This is a 16-volume Handbuch der pathogen Mikro-organismen printed in 1913, all in old German script. As another example, he prescribed Zentralblatt für Mikrobiologie, a German periodical consisting of more than a hundred volumes.

Obviously, Dr. Meyer was in no mood to talk about the matter at that time, so I asked him a couple of questions about my ongoing research. These he answered more affably. He continued to come to my office-laboratory once or twice a week, always greeting me with, "What's new?" During such visits, I occasionally asked him when I could hope to have another chance at the Qualifying Examination. It was March 15, 1931 before he invited me to come to his home on Lincoln Way in San Francisco one evening for another try. The examination was preceded by dinner at seven o'clock.

Except for the servants who served the dinner, there seemed to be no one else in his large house. It was a formal dinner for two, served in courses with wine before and during the meal. As I was unaccustomed to alcoholic beverages, the wine made me somewhat light-headed and sleepy. Dr. Meyer was exceptionally conversational. He tried hard to place me at ease by talking about mundane matters. It was after eight o'clock before the last course was served. Then we moved into his study for a few sips of cognac and a game of chess. Before I could protest, he assured me that, "Chess is relaxing. It cultivates one's power of concentration." Within 30 minutes he asserted, "Check mate."

As nine o'clock neared, I reminded my mentor, or tormentor, why I was there. He insisted on one more game. This time he beat me more handily than in the first game. At this point, I insisted as politely as possible that we start the examination. Feinting surprise, he inquired, "What examination?" Before I could recover sufficiently to reply, he laughingly added, "Oh, that? You passed that last October. I didn't want you to get a big head. I'll

tell Dean Lipman on Monday." Then he chuckled merrily as though this was the best joke of the year.

Thereafter, virtually all of my working and thinking time could be devoted to my graduate studies and research without worrying about preparing for advancement to candidacy for the Ph.D. degree. Even the Brucella (bacteria) started to behave better as more and more was learned about their likes, dislikes, and metabolism. In order to accelerate the investigations, Dr. Meyer provided a full-time technical assistant to expedite the investigations.

My Thompson Scholarship expired at the end of June 1931, leaving me without financial support. This had been anticipated by Dr. Meyer, who put me on the Hooper Foundation payroll for full-time employment as a Research Assistant from 1 July to 31 December 1931. During most of this period, between 12 and 15 hours per day were devoted to dissertation research and writing, deviating from this schedule only to participate in seminars or to audit distinguished lecturers. Ten days at the end of June were taken off to participate in the AAAS meetings in Pasadena and to visit the Scripps Institution of Oceanography (SIO) in La Jolla.

Up until this time I had heard a little about the SIO from Dr. C. B. Lipman, Prof. Charles E. Kofoid, Dr. Wm. E. Ritter, and Dr. Hermann Sommers. Dr. Sommers was a Research Associate at Hooper Foundation working on mussel poisoning. He was examining samples of the California mussel, Mytilus californianus, and the dinoflagellate, Gonyaulax catenella, for toxins. Samples were provided by personnel at the SIO to which Dr. Sommers had made a

few trips. He had me make some tests to see whether microbes could be involved in shellfish poisoning. Dr. Sommers told me much about the SIO and its personnel.

Dr. Ritter, then (1930) in semi-retirement, had been the director of the Scripps Institution for Biological Research until 1923. He expressed great pride in what had become the Scripps Institution of Oceanography. Prof. Kofoid, a well-known zoologist, was also one of the founding fathers of the Institution. Both of these biologists were introduced to me by Dr. Lipman, who served as Dean of the Graduate Division from 1923 to 1944. Dean Lipman was one of the world's foremost soil bacteriologists.

I had been acquainted with Dean Lipman since 1926 through his publications on soil bacteriology and his visits to my major professor (Dr. J. E. Greaves) at Utah State Agricultural College. During my two years at the University of California, I saw him quite often in his laboratory and occasionally to confer with him in his capacity as Dean. Among those working in Lipman's laboratory was a classmate of mine from Utah State, Dudley Greaves, a son of Dr. Greaves. This gave me another reason for visiting Lipman's laboratory to see what was happening whenever schedules permitted. I learned some novel and useful laboratory techniques. At that time, as one of his numerous interests, Dr. Lipman was obsessed with the possibilities of microbial life in outer space. Despite the National Academy caliber of his research in soil bacteriology, some of his colleagues ridiculed his quest for living bacteria in meteorites. Had he lived until the space age with NASA support and modern technology, Lipman might have become the leader of microbial expeditions to the moon, Mars, and the deep sea.

Actually, C. B. Lipman was a pioneer in marine microbiology. He was the first to introduce me to this almost fathomless field of learning. As early as 1920, he published a note entitled, "Studies on sea-water bacteria in the South Seas," Carnegie Inst. Washington, Yearbook No. 19:196-197. He discussed marine bacteria in his paper, "Does nitrification occur in sea-water," Science, 56:501-503, 1922. Another problem of prime importance was considered in his paper on "The concentration of sea-water as affecting its bacterial population," Jour. Bacteriol. 12:311-313, 1926. Lipman authored several papers on the bacterial precipitation of calcium carbonate in tropical seas as exemplified by, "A critical review and experimental study of Drew's bacterial hypothesis on $CaCO_3$ in the sea," Carnegie Inst. Washington, Dept. Mar. Biol., No. 19:179-191, 1924.

During a conference in early May 1931, Dean Lipman told me about the interest of Dr. T. W. Vaughan in the precipitation of calcium carbonate. Dr. Vaughan was looking for a marine microbiologists to work on this and other microbial research problems at Scripps Institution. Dr. Vaughan was director of the Institution (1925-36). He was coming to the Berkeley campus soon to discuss budgets, student affairs, and other matters. Believing that I might be interested in the position at SIO, Dean Lipman had forwarded my curriculum vitae to La Jolla and he arranged for me to meet Dr. Vaughan in Berkeley.

The interview with Dr. Vaughan on May 15 was pleasant and exciting. He explained that the marine microbiologist would be expected to investigate other microbiota beside bacteria. The research should deal largely with marine or oceanic problems.

There would be no one to tell me what to do or how to do it. He stressed the interdisciplinary and international aspects of the marine sciences. It was agreed that the University would grant me a leave of absence. Scripps Institution would pay my travel expenses to visit La Jolla for a few days immediately following the AAAS meetings in Pasadena (15-20 June 1931). My first impressions were that I would like to work under the guidance of this genteel man. During this interview Dr. Vaughan earmed my respect. With better acquaintance under various circumstances, he gained my admiration.

In a letter dated 25 May 1931, Dr. Vaughan wrote in part, "I have the authority from Vice-President Deutsch to make you the following offer: Instructor in Marine Microbiology at the initial salary of $2200 per year, your term of service to begin January 1, 1932.... Mrs. C. B. Feltham has been working here as technical assistant in bacteriology. She has been reappointed for the year beginning July 1, 1931. She will help Dr. Gee transfer the bacteriological equipment from the old laboratory (in Scripps Hall) to the new building (Ritter Hall). Thereafter she will be available to start working under your supervision. It might be desirable for you to give her instructions prior to your arrival at the Institution in January. We are expecting to see you in La Jolla next month."

The bus ride on the coastal route from San Francisco to Pasadena on June 15 was a delightful experience. During the AAAS meetings at the California Institute of Technology, I presented a paper on "The sulfur metabolism of the Brucella group" before the Society for Experimental Biology and Medicine. Later this paper

was published (jointly with Dr. K. F. Meyer) in the Journal of Infectious Diseases (51:91-98, 1932).

I met Denis L. Fox for the first time at the AAAS meetings. Like myself and with similar objectives, he was on his way to La Jolla to explore a position at the Scripps Institution.

Early Saturday, June 20, I proceeded to the La Jolla Hotel on Girard Avenue. After using Saturday afternoon and all day Sunday to explore the village and San Diego, I visited the SIO campus Monday morning, 22 June 1931. The Institution's car, a six- (more or less) passenger model without a top, provided transportation for the two-mile trip. Besides people connected with the Institution, the car also carried mail, freight, pets, groceries, guests, etc. Ordinarily, it was driven by either Carl Johnson, a versatile carpenter, plumber, mechanic, and handy man, or James Ross, the Superintendent of Building and Grounds.

The resignation of Haldane Gee as Assistant Professor of Marine Bacteriology, effective 7 November 1930, had opened the billet for a marine microbiologists. Before coming to the SIO in July 1928, Dr. Gee had worked at Yale University on the bacterial spoilage of haddock. He phased out some of this research on fish spoilage at SIO where Dr. Vaughan encouraged him to investigate the bacterial precipitation of calcium carbonate. His laboratory technician, Mrs. Catharine B. Feltham (1930-1936), was trained as a nurse.

Besides discussing his rather dim views on the prospects for marine bacteriology, during my visit with him on June 23 and 24, Dr. Gee spent several hours briefing me on working conditions, personnel, and problems on the SIO campus. With considerable

detail, he acquainted me with staff members and students, their achievements, shortcomings, eccentricities, and research activities. On balance, Dr. Gee rated SIO Faculty and students as being rather average as compared with personnel with whom he was acquainted at Yale University, Berkeley, or Toronto University.

Personally, I was favorably impressed by meeting SIO personnel alone and in groups. All seemed to be friendly, cordial, outgoing, and empathetic. Most of the staff members and students asked me about the research program that I proposed to pursue at Scripps. Were the microbial infections of marine animals and plants to be investigated or would I be working on the preservation of fish from the sea? Did my concept of microbiology embrace phytoplankton, protozoans, and other microscopic forms besides bacteria?

Before I returned to San Francisco on June 25, Dr. Vaughan asked whether I planned to accept his offer. I had about decided to say, "Yes, thank you; at least for a year or two." But back in San Francisco, Dr. Meyer seemed to question the wisdom of my moving to the La Jolla campus. He wondered out loud whether marine microbiology could contribute much to the betterment of humanity and whether adequate funds and facilities would ever become available. He directed my attention to the isolation of the Institution from large library, cultural, and educational centers. He renewed his offer for a combined research and teaching position at Hooper Foundation for Medical Research and the Department of Bacteriology in San Francisco.

During the next few weeks I concentrated upon completing my research work and a doctoral dissertation. Early in October, my

175-page dissertation was approved by all members of the Committee in charge. The final examination was passed on 25 November 1931 without any reservations, 27 months after matriculation at the University of California. A total of twelve papers on some aspects of "The cultural requirements and metabolism of the Brucella group" were published in peer-reviewed periodicals. K. F. Meyer was a joint author on most of these papers. His writing ability and national reputation did much to expedite publication.

A few days after my final examination, Dr. Meyer told me that I could plan to leave San Francisco any time after December 18. The remainder of the month would be vacation with pay. He anticipated that this would provide ample time for moving to La Jolla. He promised to bring me back to San Francisco within a year or two. Actually, he did offer me a position as Instructor in Bacteriology in 1933. It was two years before he was able to offer an assistant professorship with the approval of President Sproul.

Preparation for moving to La Jolla required little more than packing two suitcases and buying a second-hand car. This was my first car. Now, more than 50 years later, I am driving my sixth, the other five having been purchased new, with payment in full upon delivery. The secret of making cars last so long is living close enough to my place of business to walk to and from work.

On the SIO campus, where I arrived December 21, Cottage No. 30 (now called T-30) had been reserved for my family. We lived in it with reasonable comfort for 20 years before building a

home on a lot adjacent to the SIO campus in 1952. The family consisted of a young wife and eventually two sons. Karl, born in La Jolla on 9 January 1932, is now an attorney in La Jolla. He earned his A.B. degree at Columbia and his LL.B. degree at Stanford University. Dean, born on 17 October 1934, took his A.B. (med.)at the University of California, Berkeley, and his M.D. degree at the University of California Medical School, San Francisco.

Part II. The SIO in 1932 and Before

For convenience in discussing the history of the Scripps Institution of Oceanography (SIO), its development can be treated in four major epochs or periods: (1) The period of peregrinations (1892 to 1912) was characterized by exploration and expanding objectives culminating in the organization of the Marine Biological Association of San Diego. (2) The medieval period began in 1912 when the Association was transferred to the University of California and its name was changed to the Scripps Institution for Biological Research. (3) The next 16 years, called the renaissance period for purposes of this report, began in 1932 when Ritter Hall and a new seawater system were ready for use. It was a period of gradual growth, expanding activities, and improvements in the standards of academic excellence. Director Vaughan was at his best and Director Sverdrup (1936-1948) brought a new dimension to the SIO. (4) The renaissance has continued into the present, called the period of exponential growth. This period has been marked by increases and improvements in pemanent buildings, research facilities, research vessels, funds, facilities, publications, faculty, students, support personnel, libraries, and international recognition.

Except for trying to finish certain features that were started prior to 1948, my report ends with the resignation of Director Sverdrup in 1948. Since then the Institution has become much too large for me to be intimately acquainted with all of the personnel and happenings. The total "head count" on the campus exceeded a thousand in 1975.

I have been on the scene as one of the actors and interested observers since January 1932. In preparing this report, I must rely upon conversations, memory, and printed material for what happened prior to 1932. My becoming an SIO staff member brought the total number of employees to 32. The names of the staff, support personnel, and students are listed below. The dates in parentheses show the years of service:

T. Wayland Vaughan, Ph.D. (1925-1936) Director and Professor of Oceanography, Marine Sediments, Palenotology, and Geology

George F. McEwen, Ph.D. (1908-1952) Professor of Physical Oceanography and Curator of Oceanography

Francis B. Sumner, Ph.D. (1913-1952) Professor of Biology, especially genetics and fish biology

W. E. Allen, M.A. (1918-1926) Assistant Professor of Oceanography, specializing in the study of diatoms and other phytoplankton

Erik G. Moberg, Ph.D. (1926-1946) Asisstant Professor of Oceanography, practicing marine chemistry

Denis L. Fox, Ph.D. (1931-1969) Instructor in the Physiology of Marine Organisms and later Marine Biochemistry

Claude E. ZoBell, Ph.D. (1932-1972) Instructor in Marine Microbiology with emphasis on bacteria and geomicrobiology

A. F. Gorton, Ph.D. (1928-1933) Associate in Oceanography

Percy F. Barnhart, M.S. (1914-1946) Associate in Oceanography and Curator of the Biological Collection, in charge of the museum and aquarium

Stanley W. Chambers (1924-1955) Associate in Physical Oceanography

Burt Richardson, M.A. (1928-1932) Associate in Physics, specializing in meteorology

Burton W. Varney, Ph.D. (1932-1933) Research Associate in Meteorology

Catharine B. Feltham, R.N. (1929-1934) Technical Assistant in Bacteriology, working for Dr. ZoBell

Tillie Genter (1919-1947) Secretary and Librarian, sometimes functioning as an administrative assistant, purchasing agent, purser, and storehouse keeper

Ruth Ragan (1928-1949) Assistant Secretary and later a librarian

Ruth McKitrick (now Holland, 1932-1936) Stenographer working for Dr. Moberg and others

Corinne Copeland (1931-1932) Computer

Elise Driese (1932-1933) Computer

George Armstrong (1931-1933) General Assistant, who collected specimens for scientists, delivered the mail, washed glassware, etc.

Murdock Ross (1929-1936) Engineer and later Captain on the boat, *Scripps*, which burned and sank in 1936

James (Jim) Ross (1912-1937) Captain of the boat *Scripps* and Superintendant of Buildings and Grounds

Carl I. Johnson (1929-1953) Mechanic and handy man, sometimes Supt. Bldgs. & Grounds (1942-1944) and then Foreman (1945-1953)

George F. Fuller and Robert E.Wilson were custodians of buildings (called janitors in 1932).

The following were half-time Research Assistants, each receiving $1200 per year. The dates in parentheses show when each was awarded a Ph.D. by the University of California, Berkeley:

Easter E. Cupp (1934) Plankton diatoms, working with Prof. Allen

Richard H. Fleming (1934) Marine chemistry, working with Dr. Moberg

Eldon M. Thorp (1934) Marine geology, working with Dr. Vaughan

Nelson A. Wells (1934) Fish physiology, working with Dr. Sumner

Earl H. Myers (1934) Foraminifera, working with Dr. Vaughan

Roger R. Revelle (1936) Marine Geology, working with Dr. Vaughan

Maynard A. Harding was also a Research Assistant, who was working for an M.S. degree in oceanography. He assisted Dr. Moberg in marine chemistry from 1930 through 1933.

Academically and administratively, the SIO was closely affiliated with U.C., Berkeley. All courses of instruction, all personnel appointments, all major construction or repairs, all purchases for items exceeding $50, all annual budgets, all leaves of absence, all travel expenses, and many other matters required prior approval from either the Office of the President or the Dean of the Graduate Division. The University of California at Los Angeles (UCLA) was in its infancy in 1932. Five years earlier (1927), it was known as the University of California, Southern Branch (UCSB), having originated from the California State Normal School located on Vermont Avenue in downtown Los Angeles. It moved to its present 411-acre campus in Westwood Village in 1920. Its first Ph.D. degree was granted by UCLA in 1938.

The most conspicuous structure on the SIO campus when I first visited La Jolla in June 1931 was the 1000-foot pier built during 1915-1916 (see Fig. 1, p. 34a). The 177-acre campus beside the sea was about two miles north of the village. The population of La Jolla was about 4000. Except for the small SIO colony, nearly all of the people lived south of the La Jolla Beach and Tennis Club. A picture taken looking south from the top of the "biological grade" (sometimes called the "Scripps Grade"), near the northern boundary of the SIO campus at an elevation of about 200 feet, showed only three buildings besides those of the Tennis Club and Scripps Institution. The picture showed no homes on the north side of Mount Soledad. The picture taken near mid-day showed only three or four vehicles on the highway between the northwest corner of the campus and the village. This was then the principal highway between Los Angeles and San Diego. Land along North La Jolla Shores and a mile or so east of the sea shore was used mainly for pasture for cattle and horses and for growing hay and vegetables. Most of the 177-acre campus was fenced to retain grazing cows and horses.

As shown in Fig. 1, there were three major buildings and about two dozen cottages and service buildings. The first wing of Ritter Hall (RH) was nearing completion in June 1931. The George W. Scripps Hall (SH) was the first permanent building on the campus. It was completed in mid-1910. It was a two-story, 50 x 75-foot, reenforced-concrete building. It still stands and is being restored as a national historical landmark. Director Vaughan's office (1925-1936) was on the second floor in the southeast corner (see Fig. 2, p. 34b). Earlier (1910-1915) it had been the office and residence of the first Director, Dr. William E. Ritter. In 1932, Tillie Genter was Director Vaughan's secretary. Dr. Sumner's domain consisted of the two middle rooms on the north side of the second floor of Scripps Hall and the large aquarium room in the southwest corner on the first floor. Prof. Allen had an office-laboratory in the northwest corner of the second floor. His Research

Assistant, Easter Cupp, worked in the adjoining office-laboratory. Quartered on the ground floor (Fig. 3, p.36) of Scripps Hall in 1932 were Research Assistants Earl H. Myers, Eldon Thorp, Roger Revelle, and Nelson Wells. Dr. Gorton also had an office on the ground floor.

There was a bridge providing a passageway from the second floor of Scripps Hall to the second floor of the Library-Museum Building (Fig. 4, p. 36). The latter, finished in 1916, housed books, museum specimens, offices, laboratories, and a small auditorium. Percy Barnhart had his office and laboratory in the basement of the Library-Museum Building from 1916 until his retirement in 1946.

There was a small (24 x 48-ft) public aquarium located a few steps north of Scripps Hall. The aquarium had 19 concrete tanks with plate-glass fronts for exhibiting marine animals and plants. Mr. Barnhart was the curator. This building was demolished in 1948 after the construction of Vaughan Hall, having many more exhibition tanks and museum displays.

Other buildings on the SIO campus in 1932 included several galvanized iron garages used for cars, work shops, or storage space, and 24 redwood cottages. The latter were built between 1913 and 1916 to accommodate staff members, students, visiting investigators, and guests. The rental fees ranged from $12 to $21 per month, depending on the number of bedrooms. The ZoBells had Cottage No. 30, now (1980) called T-30, and used for B-T (bathythermograph) work. We were flanked on the south by Earl and Ethyl Myers in Cottage No. 29 and on the north by Nelson and Thelma Wells in Cottage No. 31. In 1943, the Martin Johnson family moved into No. 29 and the E. W. Allen family moved into No. 31. The Stanley Chambers family lived in No. 28, which was demolished several years ago. The George McEwan family lived in Cottage No. 25.

Number 32 was a commons building called the "Community House," (Fig. 5, p. 36). It was a combination dormitory, recreational hall, and club house that could accommodate overnight up to 25 people if some slept on the floor. This two-story redwood structure had three bathrooms and dining space for up to 40 people. Various combinations of married couples, families with children, single students, visiting investigators, guests, and field parties were housed from time to time in the Community House. On special occasions, campus parties, either with or without refreshments, were held there, sometimes scientific or business meetings for groups ranging from 12 to 30 or 40. The Community House was demolished in 1963 to provide space for the IGPP Building (Institute for Geophysics and Planetary Physics). Up until that time there was a hundred-foot long wooden bridge to provide a narrow walkway across the rather deep (15 to 45-feet) arroyo. It was highly functional and quite picturesque, being supported by trestles

consisting of telephone poles. The stringers or longitudinal supports consisted of about a dozen telephone poles. The walkway consisted of 2 x 12-inch redwood planks. It was not uncommon to encounter a skunk while crossing the bridge on dark nights.

In 1932, Dr. Vaughan and family were living in the Director's House (No. 16 on Fig. 1). Presently (1980) it is designated T-16 and is being used as headquarters for the Sea Grant College Program. Dr. W. E. Ritter lived in the Director's House from 1915 until his retirement in 1924. Dr. Sverdrup and family lived there from 1936 until his retirement in 1948. It was the residence of Dr. Hubbs from 1948 until 1954. The Hubbs took in so many guest that T-16 became facetiously known as the "Hubbs Hotel." Later two directors (Dr. Carl Eckart from 1948 to 1950 and Dr. Roger Revelle from 1950 ro 1963) had off-campus homes in La Jolla.

The open space immediately north of the pier and west of Cottage 28 was called the "badlands" in 1932 (see Fig. 1). This is the area where the benthic laboratory, support shops, diving lockers, storehouse, and the new (1977) Marine Biology Building are now located. The "badlands" area was graded in 1949 to provide level space for garages and parking. The area was in the mouth of a rather rugged deep arroyo between Cottage No. 24 and Cottages No. 25, 26, and 27. At its upper end the arroyo had been partly filled during the construction of the "Biological Grade," Discovery Way, and the two intersecting temporary dirt roads shown by dashed lines on Fig. 1. A 30-inch galvanized iron culvert under Discovery Way was covered with about 12 feet of earth at its western end and with 3 or 4 feet of earth at its eastern end. The grading created a small catchment basin for water during the rainy season. Sewage effluent from cottage septic tanks kept the bottom of the arroyo moist enough during most of the year to provide for profuse growths of bamboos, moss, grasses, algae, and other vegetation.

The most extensive growth of bamboos was in the "badlands" across Discovery Way from the Director's House. The peripheral dry bare banks, consisting of clay and shattered sandstone, were badly eroded to give the appearance of a miniature Grand Canyon. At the bottom of the arroyo and extending several yards up the bank some of the profuse growth of bamboo was as high as an elephant's eye. It was so dense that there were only a few trails through it. These trails were made mainly by dogs, wild rabbits, coyotes, bobcats, foxes, and children. Children sometimes made "play houses" in the "badlands," usually without the permission of their parents. An occasional tramp found shelter in the "badlands." It was a haven for skunks, ground squirrels, opossums, and a large variety of birds, including the California quail.

In 1932 about 90% of the 177-acre campus was fenced with barbed wire

to make pastures for cattle and sometimes horses. Various kinds of eucalyptus trees were starting to grow in several select areas. The seedling saplings required irrigation to keep them alive during the long dry season. O. B. (Obie) Maler and later Laurence Fiori and other gardeners spent much time trucking water in open barrels from which it was either siphoned or bucketted into little basins around the trees.

Except for the two-lane black-top road traversing the campus, most of the other roadways and paths were not paved. They were generally muddy during the short rainy season and dusty the rest of the year. The annual precipitation ranged from 3 to 30 inches, the mean being around 9 inches. Most of this rain fell during five or six storms, sometimes at a rate of an inch or more per hour. These sudden downpours resulted in considerable flooding and soil erosion.

The first month I was here (January, 1932), a rainstorm inundated La Jolla Shores Drive and other streets near the Beach and Tennis Club, making it impossible to drive a car to the Scripps Memorial Hospital. The Hospital was located on Prospect Street near the west end of Silverado Street. In almost blinding darkness after midnight, it was necessary to take my expectant wife up to La Jolla Junction and then back to the Hospital via Torrey Pines Road and Pearl Street. This typical rainstorm is vividly remembered, because my elder son, Karl, was almost born on the back seat of a roadster, 50 years ago as of January 9, 1982.

Ninety years earlier (1892), the Scripps Institution of Oceanography was in its earliest embryonic or conceptual stages. The Institution grew out of the efforts of Dr. William E. Ritter, Dr. Charles A. Kofoid, Dr. H. B. Torrey, and others in the Department of Zoology, U.C., Berkeley, to establish a station for studying the natural histories of marine organisms. Along with a few of their colleagues and students, they constructed a 14 x16-foot tent-house at Pacific Grove on Monterey Bay for use during the summer of 1892. The following summer, field work was continued at Avalon Bay on Santa Catalina Island. During the summers of 1894 and 1902, the zoologists worked in an old building, used as a combination office-laboratory and dormitory, near San Pedro Bay. From 1896 through 1901, the field work of the U.C. zoologists consisted mainly of collecting and reconnoitering expeditions along the west coast from Alaska to San Diego. In 1903, Dr. Ritter and associates set up a station on the shores of Glorietta Bay within San Diego Bay. Here they started to receive substantial community support to supplement the meager funds provided by the Department of Zoology, Berkeley.

In 1903, the marine station at Glorietta Bay was incorporated as the Marine Biological Association of San Diego, commonly called the MBA. Except for the salaries of personnel having appointments with the University of

California, the MBA was funded by the San Diego Chamber of Commerce and a few civic-minded philanthropists. One of the most generous of these was E. W. Scripps, a newspaper publisher and buisness man. Although the University of California had no official academic or administrative affiliation with the MBA, it was tacity assumed by all parties concerned that the funding and administration of MBA would eventually become the responsibility of U.C., Berkeley.

Dr. Ritter was the director of the MBA, or "station" as he preferred to call it. This is illustrated in his 111-page report entitled, "The Marine Biological Station: Its History, Present Conditions, Achievements, and Aims" (Univ. Calif. Publ. in Zoology, 9:137-248, 1912). Dr. Ritter was the first to explain to me that in marine parlance a "station" is the place where the observations were made or where data and samples were collected.

From 1903 until 1907, makeshift laboratory-offices were used at Glorietta Bay. In 1907, the MBA moved to a small (24 x 60-foot) wooden office-laboratory building constructed on Alligator Head in La Jolla Park near the cove. It was sometimes referred to as the "Little Green Laboratory at the Cove" (Scripps Institution of Oceanography - First Fifty Years by Helen Raitt and Beatrice Moulton, Ward Richie Press, San Francisco, 217 p., 1966). The building could accommodate ten or twelve people, depending upon who they were and what they were doing.

Later in 1907, the present 177-acre campus was added to the MBA by the City of San Diego, thanks largely to the generosity of Miss Ellen B. Scripps and her brother E. W. Scripps. Part of the purchase price was relinquishing title to the five acres of land in La Jolla Park. At that time the population of La Jolla was approximately 1300. Unimproved rural land was selling for form $10 to $20 per acre.

By mutual consent the Regents of the University of California and officers of the Marine Biological Association, the name of the latter was changed to the Scripps Institution for Biological Research of the University of California in 1912. At this time, the University became responsible for the financial and academic administration of the Institution, sometimes abbreviated SIBR. After a long gestation or embryonic period, 1912 is generally accepted as the birth date of the Scripps Institution.

Dr. Ritter was retained as director of the SIBR. Dr. George F. McEwen was the hydrographer. Mr. Ellis L. Michaels, a zoologist, was an administrative assistant. Non-resident or part-time staff members included Dr. C.A. Kofoid, Dr. J. F. Daniels, and Mr. A. L. Burrows, all from the Department of Zoology, U.C. Berkeley. Other part-time staff members were Dr. C. O. Easterly (Professor of Zoology, Occidental College), Dr. Myrtle Johnson (a biology teacher at the Pasadena High School), and Mr. H. C. Burbridge (a chemist from Stanford University).

Mr. Wesley C. Crandall was a close friend and business associate of the Scripps family and an officer of the Institution from 1910 to 1924.

Earlier he had been an Instructor in Biology at San Diego State Normal School, now San Diego State University (SDSU). In 1911, he was Secretary of the Marine Biological Association, served as its naturalist, and was Captain of the *Alexander Agizziz*. The latter was a modified scow (length 85 ft, beam 26 ft) built in 1907 for biolgical and hydrographic surveys. It was powered by two 30-hp gasoline engines. Its operation required a crew of five and it had sleeping accommodations for nine. John Dahl was its master in 1910. Being somewhat less than ideal for its intended purpose, the *Alexander Agizziz* was sold in 1917.

At the time the MBA became the Scripps Institution for Biological Research in 1912, Capt. Crandall was also serving as Business agent. He soon became Business Manager of the SIBR, a position he held until 1924. He supervised the construction of the campus cottages, paying particular attention to the Director's House, built in 1913 for Dr. Ritter. When Dr. Vaughan became the director of the SIO in 1924, he felt that the Instituion could get along without a salaried Business Manager. However, as a business advisor for the Scripps family, Capt. Crandall continued to serve the SIO in an advisory capacity. He seemed to be taking an active interest in the progress, personnel, activities, and financial problems when I joined the staff in 1932. He reported to Dr. Vaughan that approximately one-fourth of the funds for scientific research in fiscal year 1923-24 were allocted to Dr. Sumner's studies on genetics and heredity of mice:

Marine Biology	$ 8,750
Hydrography	6,300
Genetics and heredity	5,240
Total	$20,290

Dr. F. B. Sumner joined the resident staff of the SIBR in 1913. Mr. P. S. Barnhart came in 1914, and Mr. Winfred E. Allen, a biologist, in 1918. Having only a M.A. degree, he was generally addressed as Professor Allen, although he never attained a rank higher than Assistant Professor.

The "Mouse House" was built in Seaweed Canyon in 1913 to satisfy part of the research needs of Dr. Sumner. He was working on the genetics of certain subspecies of *Peromyscus*, a genus of white-footed deer mice. This project appealed to Mr. E. W. Scripps and it was endorsed by Director Ritter. Later, however, Director Vaughan questioned the appropriatness of such a project in an institution of oceanography. After 17 year, the mouse research was gradually and grudeingly phased out, thereby minimizing the friction between Dr. Sumner and Dr. Vaughan.

Dr. Ritter served as Director of the Scripps Institution for Biological Research until September 1923. Several years in advance of his retirement he and the Advisory Board of the Institution agreed that the research and teaching programs of the Institution should be expanded to embrace physical as well as biological sciences. Early in 1924, a committee of the Southern Branch of the Univesity of California recommended that the name of SIBR be changed to Scripps Institution of Oceanography of the University of California. The new and present (1980) name became official on 13 October 1925, when it was approved by the Regents. Several years later (1936), Dr. Ritter felt obliged to inform the scientific community that he had advocated changing the name of the Institution from Scripps Institution of Biological Research to Scripps Institution of Oceanography (see his statement in *Science*, vol. 84, page 83 entitled, "The name 'Scripps Institution of Oceanography.'" Dr. T. Wayland Vaughan endorsed the change in the name and policies of the Institution before he accepted the directorship, effective as of 1 February 1925. For five months (September through January), Dr. Francis B. Sumner was the Acting Director.

Dr. Vaughan was responsible for the recruitment of Dr. Eric G. Moberg (chemistry, 1926), Dr. Denis L. Fox (biochemistry, 1931), Dr. Claude E. ZoBell (microbiology, 1932), Dr. Martin W. Johnson (zoology, 1934), Dr. Richard H. Fleming (oceanography, 1934), and Dr. Roger R. Revelle (oceanography, 1936). He may have over-reacted to the new name of the Institution by having Dr. McEwen's title summarily changed from Professor of Hydrography to Professor of Physical Oceanography. Similarly, Dr. Moberg's title was changed almost automatically from Assistant Professor of Marine Chemistry to Assistant Professor of Chemical Oceanography, and, presto, Percy Barnhart became Assistant in Oceanography instead of a Marine Biologist. Dr. Vaughan was more deliberate in changing the title of Dr. Fox from Assistant Professor of the Physiology of Organisms to Assistant Professor of Marine Biochemistry.

The SIO "fleet" in 1932 consisted of a couple of row boats and a refitted purse seiner renamed the *Scripps* (1925). This 64 x15-foot boat had berths for ten persons. It was powered by an 85-hp gasoline engine. The *Scripps* had enough braided wire line (cable) to take water temperatures or samples from depths as great as 45 meters (14,700 feet). Its cruising range was about 100 miles. Its crew consisted of the Captain, Murdock (Murty) G. Ross, and sometimes cook. Most cruises were completed in 10 or 12 hours, during which a scientist or his assistant doubled as cook, coffee-maker, and dishwasher. Earlier (1925-1930), Dr. Moberg served as master and captain of the boat. During the summer months, the *Scripps* generally made weekly one- day trips to stations five or ten miles offshore. Its two longest

(overnight) trips were to San Clemente Island (60 miles offshore) and Santa Barbara Islands (110 miles from La Jolla). Owing to a shortage of seagoing personnel, only five trips to offshore stations were made in 1930.

The 38-foot long gasoline-powered *Loma* was one of the first boats operated by the Marine Biological Association of San Diego. The *Loma* was an E. W. Scripps yacht, which was converted into a collecting boat in 1904. It rarely ventured more than a mile or two offshore. It served well enough for two seasons before it accidentally ran aground near the Point Loma lighthouse (25 July 1906). Before it could be refloated, breakers washed it onto the nearby rocky ledge where it was abandoned after salvaging everything possible.

Running seawater was piped into Scripps Hall in 1910 when a circulating seawater system was installed. An electric-powered pump was capable of delivering 2100 gallons of water per hour to the laboratories and aquarium. A 5000-gallon storage tank provided gravity-fed water at constant pressure. The tank was still standing near the old aquarium a short distance north of Scripps Hall when I visited the campus in June 1931. At that time a 60,000-gallon seawater tank was under construction about 800 feet inland at a higher elevation near the intesection of La Jolla Shores Drive and Discovery Way (see SW on Fig. 1). Seawater was pumped and piped from the end of the pier in a 4-inch lead pipe. It was delivered by gravity through 2 1/2-inch lead pipes to the laboratories and the aquarium.

Seaweed Canyon, mentioned on page 31, is the canyon paralled to the coastline, located about half a mile east of the intertidal zone. It was so named because large quantities (thousands of tons) of kelp (mostly *Macrocystis pyrifera*) were processed there for obtaining potash and coincidentally iodine. This work was subsidized by the U.S. Department of Agriculture. The potash was used to fertilize soil and in the manufacture of gun powder. Captain W. C. Randall, a staff member of the Scripps Institution of Biological Research, participated in making surveys to determine the abundance and harvesting of kelp along the Pacific coast. Our supply of potash, mainly from Europe, was cut off by Germany durng World War I (1914-1918). For further information see D. K. Tressler's 762-page book entitled, "Marine Products of Commerce," Chemical Catalog Co., New York, 1923.

Interestingly, Dr. W. E. Ritter was one of the first to recognize the significance of marine microbiology for a fuller understanding to the sea around us. In his treatise on "The Marine Biological Station of San Diego," University of California Publications in Zoology, 1912, he reported on page 220 that "The ultramicroscopic organisms of the sea are probably the most important field still untouched by the Station. . . . Under this head would

come . . . . the bacteriology of the sea in the large sense. . . . If organic germs --better minute organisms-- are carried through all space . . . . here, there, everywhere, and all the time, what more promising place to hunt for them . . . than the vast expanses of the sea which for eons have surely been both the germinating and the conserving beds of myriads of organic beings?"

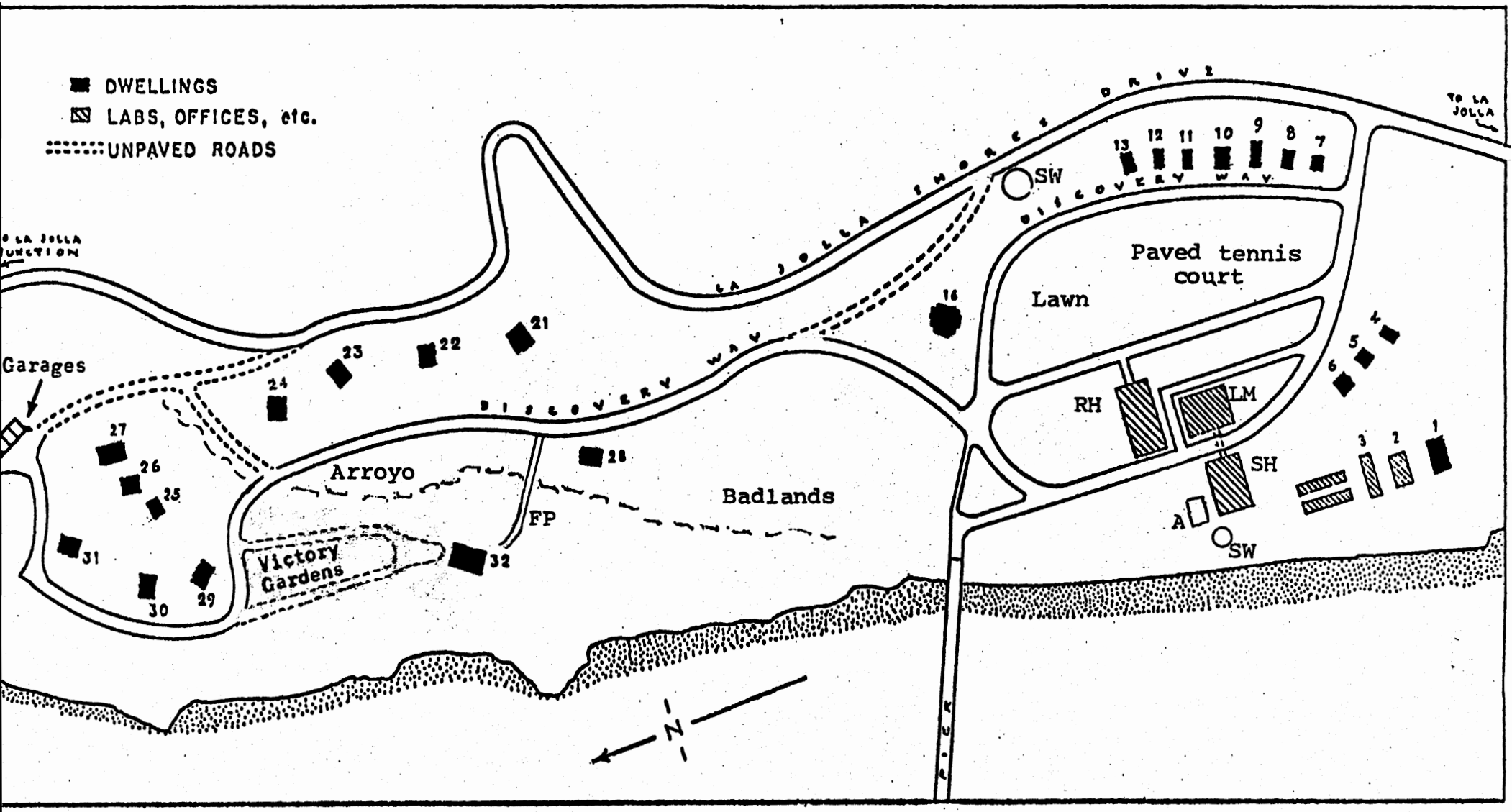


Fig. 1. Principal Streets and Buildings on the SIO Campus in 1932

A = Aquarium, FP = Footpath and bridge, SH = Scripps Hall,
LM = Library-Museum Bldg., RH = Ritter Hall, #16 = Director's House,
#32 = Community House or Commons, SW = Seawater tanks

Note: This chart shows the approximate locations of buildings and roads. The buildings and width of roads are not drawn to scale. The Library-Museum Building (LM) and Scripps Hall (SH) were much closer together. They were connected by a passageway as shown in Fig. 4.

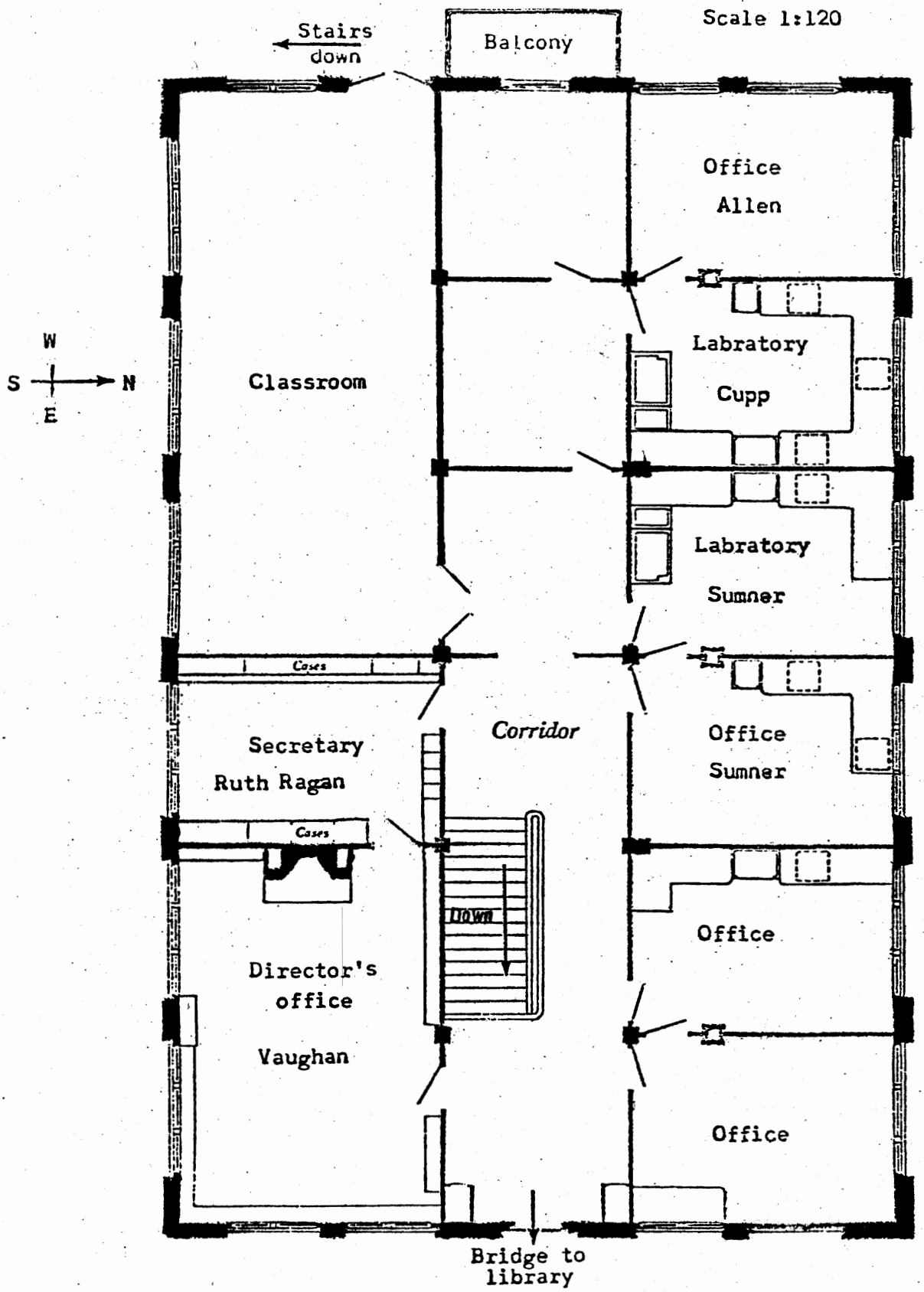


Fig. 2. Second floor of Scripps Hall (50 x 75 ft) as of 1932. The double doors at the west end of the classroom and the stairs to the ground were installed in 1952 when the bridge to the library was demolished.

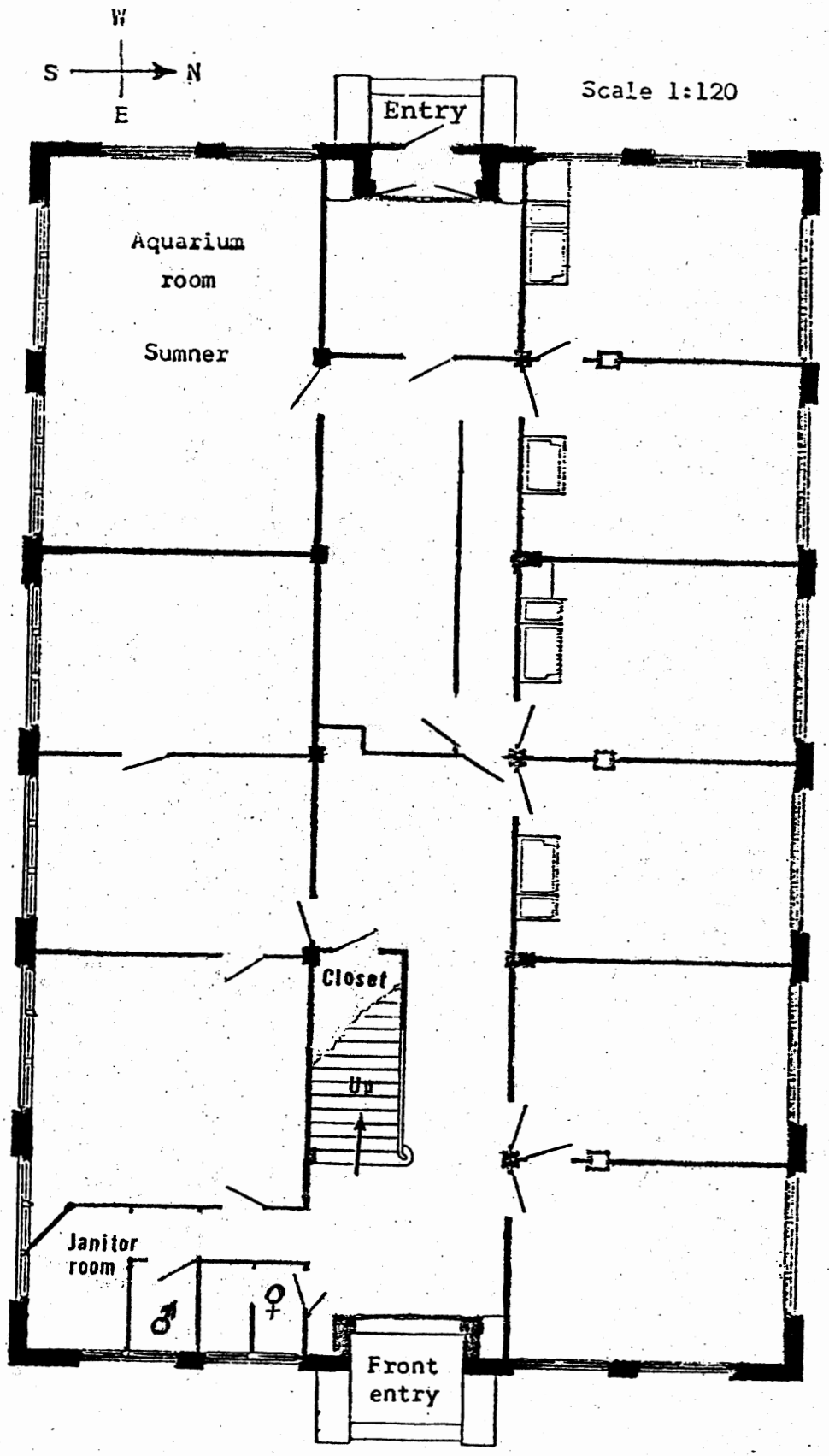


Fig. 3. Ground floor of Scripps Hall as of 1932. Most of the rooms served as office-laboratories. Scripps Hall underwent major remodelling in 1916, 1927, 1931-32, and 1979 in addition to dozens of minor changes since 1910.

Fig. 4. Bridge connecting Scripps Hall (right) with second floor of Library-Museum Building

Fig. 5. Footbridge leading to the Community House

III. Facilities, Funds, and Personnel from 1932 to 1948

Why 1932 to 1948? My sojourn at the Scripps Institution of Oceanography began here on the first of January 1932. Moreover, the completion of Ritter hall in 1931 nearly doubled the effective working space for laboratories, offices, libraries, classrooms, aquaria, museums, etc. This is illustrated by the following data compiled by Elizabeth Shor:

Dates	Name of building or facility	Assignable space (ft^2)	Total to date
1910	George H. Scripps Hall	5,237	5,237
1913-40	Mouse House	300	5,537
1915-51	Old Aquarium	1,152	6,689
1916	Building on pier	475	7,164
1916-77	Library-Museum Building	6,976	14,140
1931	Ritter Hall	13,800	27,940
1946	Marine Physical Laboratory	36,588	64,528
1950	Vaughan Hall	11,320	75,848
1952	Radio station	369	76,217
1952	Visibility Laboratory	9,476	85,693
1956	Ritter hall, 1st new wing	14,582	100,275
1958	Experimental Aquarium	5,694	105,969
1959	Scripps Hall, 1st wing	6,476	112,445
1959	Radio station, geodesic domes	900	113,345
1960	Ritter Hall, 2nd new wing	24,000	137,345
1960	Sumner Auditorium	2,126	139,471
1960	Sverdrup Hall	35,006	174,477
1960	Marine Science Development shop	6,371	180,848
1962	Shore Processes Laboratory	9,336	190,184
1963	Institute Geophysics & Planetary Physics	29,723	219,907
1964	Hydraulics Laboratory	15,894	235,801
1965	Physiological Research Laboratory	9,869	245,670
1966	Nimitz Marine Facilities	39,655	285,325
1970	Deep Sea Drilling Building	18,203	303,528
1975	Norpax Building	12,811	316,339
1976	Eckart Hall (Library)	31,993	348,332
1977	Marine Biology Building	39,398	387,730
1977	Scripps Hall, 2nd wing	1,611	389,341
1979	Remote Sensing Facility trailer	800	390,141
1980/81	Norpax trailers	1,500	391,641

Note: In addition to the large trailers listed above, there are several other smaller mobile units in various places on the campus.

The 37,000-ft^2 Southwest Fisheries Center (SFC) does not appear in the foregoing compilation, because it is a National Oceanic and Atmospheric (NOAA) facility that is owned and operated on the SIO campus by the U.S. Department of Commerce. It was completed in 1965. The SFC has about 150 employees. There is close collaboration between the SFC and SIO personnel, many of whom share certain facilities.

Likewise missing from the compilation is about 15,000 ft^2 of assignable space in ten temporary (T) redwood cottages. From the time of their construction (1912-1915) until 1950 to 1956, these cottages were used as residences. Remodelled in various ways, the remaining cottages are now (1983) being used as offices, laboratories, and meeting places.

The foregoing compilation shows that between 1932 and 1948 the area of SIO working space more than doubled by the acquisition of the Marine Physical Laboratory. Thereafter, the area of working space increased much more rapidly as did funding and the number of staff members and students. There were only a few Federal Government contracts prior to 1948, after which SIO personnel began to receive more and more, larger and larger Government grants. Dr. Sverdrup brought a new dimension to oceanography. Despite the aftermath of the great national depression (1929-1936), the effects of World War II, and a frugal budget, his leadership resulted in remarkable progress in oceanographic research and education.

During this period (1932-1948), the scientific staff was substantially enlarged and enriched by the addition of such scientists as:

Dr. Harald U. Sverdrup, oceanography, 1936-1948
Dr. Richard H. Fleming, oceanography, 1934-1946
Dr. Martin W. Johnson, zooplankton, 1934-1962
Dr. Roger R. Revelle, marine sediments and oceanography, 1936-1965
Dr. Marston C. Sargent, plant physiology, 1939-1951
Dr. Francis P. Shepard, submarine geology, 1942-1968
Dr. Carl L. Hubbs, marine fishes and mammals, 1944-1969
Dr. Norris W. Rakestraw, chemical oceanography, 1946-1966
Dr. David Carritt, marine chemistry, 1948-1949
Dr. Theodore J. Walker, marine botany, 1948-1957
Dr. Walter H. Munk, geophysics, 1947-1983
Dr. Robert S. Arthur (Ph.D., 1950), physical oceanography, 1946-1979
Dr. Theodore R. Folsom (Ph.D., 1952), oceanography, 1947-1975
Dr. Warren S. Wooster (Ph.D., 1953), chemical oceanography, 1946-1973

Note that besides Direactor Vaughan, who retired in 1936, five other staff members retired or resigned before 1946.

After receiving his Ph.D. degree in oceanography, Dr. Fleming became a Research Associate in Oceanography in 1934, an Instructor in 1939, and an

Assistant Professor of Oceanography in 1942. He was granted a leave of absence on 1 July 1941 to devote full time to the University of California Division of War Research (UCDWR) with headquarters at nearby Point Loma. He became Assistant Director of the UCDWR program in 1942. He resigned in 1946 to become Director of the newly organized Division of Oceanography of the U.S. Navy Hydrographic Office.

Dr. Roger Revelle volunteered for active duty in the U.S. Navy Reserve in 1941 as a Lieutenant (j.g.). He organized and directed the oceanography section of the Bureau of Ships. He advanced to the rank of Commander by 1946. Five years later he became the fifth Director of the Scripps Institution of Oceanography (1951-1965).

Dr. Marston Sargent, who joined the SIO staff in 1937, also volunteered for active duty in the Navy in 1942. He was placed in charge of biological research work for the Bureau of Ships. Later and for several years, he served as an officer in the Office of Naval Research (ONR).

Between 1936 and 1942, the academic and fiscal administration of the Institution were gradually transferred from the Berkeley campus to the University of California at Los Angeles (UCLA). The "at" was deleted in 1953. Closer geographic proximity helped to expedite communications at all levels. The teaching and research programs were greatly improved. Between 1932 and 1948, a total of 18 Ph.D. degrees were earned at the Institution as compared with only four between 1919 and 1932.

Except for the 13,800-ft^2 Marine Physical Laboratory (MPL) built on Point Loma in 1946, there was no major construction on the campus until Vaughan Hall was built in 1950. Ritter Hall along with Scripps Hall and the Library-Museum Building seemed to provide more than ample working space for everyone. In less than a decade, however, working space became inadequate owing to the influx of scientists and students and expanding research programs. One by one as circumstances permitted, the cottages, which were originally designated for residences, were converted into offices and laboratories. Trailer units were brought to the campus to serve as offices and laboratories. The construction of other buildings brought the assignable floor space up to 100,275 ft^2 by 1956. That is when the first annex or new wing to Ritter Hall was finished. The marine biology group, then eight in number, moved from the first floor of old Ritter Hall (Fig. 6, p. 60) to the northwest corner of the new wing (Fig. 7, p. 61).

The west or back door on the ground floor of old Ritter hall opened on the service street as it does at present. The ground floor (Fig. 8, p. 62) had two large wet laboratories with running seawater, a photographic laboratory, a steam-heating plant (for Ritter Hall, Scripps Hall, and the Library-Museum Building), and four large rooms for visiting investigators and students.

Within a few years, these four room were assigned to botanists: Dr. Marston C. Sargent (1939-1951) followed by Dr. Theodore J. Walker (1948-1957), and then by Dr. Francis T. Haxo (1952-1977), a plant physiologist concerned primarily with photosynthesis. Dr. Cheng C. K. Tseng (1943-1947) worked there as visiting investigator from China. He was interested in red algae that produce agar and other gel-forming polysaccharides. He returned to China and became a high-ranking officer in the Academia Sinica Institute of Oceanology in charge of marine aquaculture.

From 1932 until 1956, my marine microbiology domain consisted of rooms No.1314 to1325 in the front half of the first floor in old Ritter Hall (Fig. 6). During most of this period, the front door, (facing east) of Ritter Hall opened at the same level as the principal cross-campus street. This street was demolished, as was the front entrance to old Ritter Hall, to make room for the new wing in 1956. During the 24-year period form 1932 to 1956, more than a hundred research assistants, associates, laboratory assistants, clerks, secretaries, and visiting investigators worked with me. At any one time the numbers ranged from four to fifteen (see Fig. 9, p. 63). Both before and after the marine microbiology group was moved from the first floor of old Ritter Hall in 1956 to the second floor of the new wing, some of my associates were accomodated by Prof. Fox in his biochemistry laboratories or in the high pressure laboratory on the ground floor.

From 1932 until 1934, the two central rooms on the first floor of old Ritter Hall (Fig. 6) were occupied by Eldon M. Thorp and Earl H. Myers, respectively. Both were working under the supervision of Dr. Vaughan. Mr. Myers, assisted by his wife, Ethel, was studying the life history of certain foraminiforans (marine protozoans). After completing the requirements for a Ph.D. in marine geology in 1934, Dr. Thorp returned to Baylor University to teach geology.

Dr. Martin W. Johnson, from the University of Washington, had Room No. 1328 in Ritter Hall, probably the smallest office on the campus. On the other side of the corridor, Dr. Johnson had a more spaceous laboratory (Room No. 1333) for studying crustaceans and zooplankton. Owing to an acute shortage of funds, he was appointed as a Research Associate at a salary of only $1800 in 1934. Within a couple of years, he was appointed to the rank of Instructor in Marine Biology at a salary rate of $2400. This was the rank and salary of Drs. Fox and ZoBell up until mid-1936. It was the standard salary of Instructors on other campuses of the University of California who worked 11 months of the year.

Dr. Johnson did much to help me to become a better biological oceanographer. Whenever circumstances permitted, I audited his lectures and seminars. From him, I gained much useful information on plankton-sampling

methods, net-mesh sizes, the composition of zooplankton, and their distribution on the sea. He was interested in marine food chains. He pioneered in the investigation of underwater sounds produced by marine animals. For nearly half a century he has been a greatly appreciated neighbor both intramurally and extramurally. He has trained many good students in biological oceanography. Martin moved into bigger and better quarters when the first wing of Ritter Hall was built in 1956. Recently he has been enshrined on the SIO campus by having his residence for more than 20 years, now T-29, remodelled for conferences and campus parties officially named the Martin W. Johnson House.

From 1932 until he moved to the new Marine Biology Building in 1977, Dr. Denis L. Fox and his associates in biochemistry and physiology occupied Rooms No.1339 to 1350 (see Fig. 6). Dr. Fox was a scholar having broad interests in natural science. Within a few years he gained national recognition for his studies on chromogenesis and the feeding habits of mussels and other marine organisms. His name has become synonymous with biochromes, a subject on which he has written two books. He worked cooperatively with advanced students and various Faculty members, especially Dr. F. B. Sumner. Dr. Fox was an egregious ally of marine microbiology and geomicrobiology. He served on Guidance Committees for at least eight of my graduate students and as eithr Co-Chairman or Vice Chairman for the Ph.D. committees of David Updegraff, Fred Sisler, and Doris Courington. Dr. Fox excelled in English grammar, the selection of the most apt word or expressions, and in synthesizing new words from Greek and Latin roots. He was widely known for his keen sense of humor and as a teller of illustrative anecdotes. His manner of telling funny stories was often more amusing than the jokes.

In 1932, the front half of the second floor in Ritter Hall (Fig. 10, p. ~~64~~ 63a) was devoted to chemical oceanorgraphy with Dr. Eric G. Moberg (1926-1946) in charge. At that time, he had two research assistants, Richard H. Fleming and Maynard W. Harding. Besides being a pretty good analytical chemist, Dr. Moberg has an active interest in physical oceanography. For several years he was in charge of boat operations. Although he had no such official title, he seemed to serve as an assistant or associate director during Dr. Vaughan's administration. He was most cooperative and contributed substantially to my education and my research program in marine microbiology

Dr. George F. McEwen (1908-1952) and his associates in physical oceanography had the aft end or seaward half of the second floor in Ritter Hall. These associates in 1932 included Capt. Stanley W. Chambers (1924-1925), Dr. A. F. Gorton (1928-1933), and Dr. B. W. Varney (1932-1933). Mr. Burt Richardson worked with Dr. McEwen as an Associate in Physics during the summer months of 1928 to 1932. Dr. McEwen was primarily an

hydrographer who was also interested in physical and dynamical oceanography. For several years he was interested in the long-range prediction of rainfall in southern California. His predictions were based on the correlation of data on water temperatures and the movements of water masses off the coast of California with subsequent precipitation. I found him to be exceptionally helpful to me and my associates in explaining the relationship between salinity, temperature, the rotation of the earth, wind, and other factors on water movements in the sea. He also helped us with statistical analyses of microbiological data. He knew about as much as any contemporary physist about the transmission of light in the atmosphere and ocean. He collaborated with me in investigating some effects of solar radiations on marine microorganisms, including bacteria and microalgae. He was a co-auther on a paper entitled, "The lethal action of sunlight upon bacteria in seawater," Biological Bulletin 68: 93-106, 1935.

Dr. McEwen also deserves some credit for the following statements copied from the Encyclopaedia Britanica, Micropaedia Vol. 10, p. 890, 1974: "ZoBell was the first to observe the mineralization of organic nitrogen in seawater through the process of photochemical oxidation energized by direct sunlight. Around 1935 he showed that diatoms may chemically reduce nitrogen trioxide to nitrous oxide. About the same time he investigated the assimilation of various nitrogen compounds by phytoplankton." Further information appears in ZoBell's paper on "The assimilation of ammonium nitrogen by *Nitzschia closterium*," Proc. Nat. Acad. Sci. 21:517-522, 1935.

Dr. McEwen was the first staff member to serve the Institution for 40 years (1912-1952). Actually, from 1908 until 1912, he was employed by the forerunner of the Institution, the Marine Biological Association of San Diego.

My office in the southeast corner of the first floor in Ritter Hall (Fig. 6) was large enought (13 x 17 ft) to seat seven or eight people for conferences, committee meetings, seminars, or doctoral examinations. It had nearly a hundred feet of book shelves, a big oak desk, a steel filing cabinet, and six straight-backed chairs. The adjoining room, No.1314a was a smaller office for either a clerk-technician or sometimes a secretary.

The preparation room (No.1322) or kitchen was used to clean and sterilize glassware and to prepare nutrient media. It was equipped with a large horizontal hospital-type steam-operated autoclave and an oven for the dry sterilization of various materials. The oven and autoclave were frequently used by personnel from other laboratories. Room 1322a, with shelves on all four walls was used for the storage of glassware and other materials. Room 1325 was used mainly for chemical analyses. The well insulated constant-temperature room was usually operated at deep-sea temperatures, around 3°C. Room 1317 was for microbiological analyses. No.1317a was a combined office, laboratory, and microscope room.

All of the marine microbiology offices and laboratories were almost lavishly equipped with built-in shelves, cupboards, and cabinets for chemicals, reagents, books, and other supplies. For a few years, though, the shelves and cabinets were almost as bare as Mother Hubbard's cupboard. There were only small quantities of a few of the most commonly used reagents, stains, and nutrient media ingredients such as peptone, agar, and yeast extract. There was a paucity of laboratory glassware (test tubes, beakers, measuring cylindrs, dilution bottles, flasks, etc.) and hardware such as clamps, support standings, tweezers, spatulas, Bunsen burners, pans, sterilizing cans, baskets, racks, and handtools. The only balance (not suitable for analytical work) had a sensitivity of 1.0 gram and a capacity of 2000 grams. There were no tripods, stirring devices, shaking machines, spectrometers, vacuum pumps, centirfuges, pH meters, tensiometers, potentiometers, and the like. Limited quantities and sizes of glass tubing, rubber tubing, and stoppers could sometimes be borrowed from Dr. Moberg's laboratory. He and his associates in chemical oceanography were generous in proviging limited quantities of various chemicals and reagents. However, his shelves and cabinets were also rather sparsely stocked.

My first day on the job here at SIO, I prepared a list of essential office supplies, including 1 ream of plain paper, 1 ream of SIO letterheads, a box of mailing envelopes, 6 dozen manila filing folders, 2 laboratory notebooks, a dozen lead pencils, 2 pen holders, a bottle of blue-black ink, a box of paper clips, and a box of thumb tacks. When the list was presented to Tillie Genter, the Institution's secretary, she counted out about 50 sheets of scratch paper, a dozen paper clips, 2 dozen letterheads, and a dozen envelopes. Matter-of-factly, she explained that owing to delinquencies in the payment of cottage rental fees, the General Fund was exhausted. Later I learned that the General Fund was used for cottage maintenances, minor improvements, and emergencies. During the lean years before government grants (BGG), certain tenants were sometimes asked if they could pay their rent a month or two in advance in order to obtain funds for existing emergencies.

Economically, times were not at their best during the early 1930's, as Charles Dickens would have said. The nation was slowly recovering from the great depression following the stock market crash in 1929. Money was scarce. Unemployment was severe. Southern California was a haven for Hoover camps or Hoovervilles. The State of California was facing bankruptcy, with its expenditures exceeding its receipts. Salaries of all State employees, including employees of the University of California and Scripps Institution, were cut 3.75% in 1933. Even more drastic cuts were made in University funds for supplies and expenses. For a few months

Institution employees were paid with warrants rather than by check. Warrents were small promissory notes issued by the State of California. When the warrants were properly endorsed, most local banks would deposit or pay cash for them at a discount of 10%. After a few months the warrants were redeemed by the State at face value.

The SIO budget allowed around $500 per annum for marine microbiology supplies and equipment. Three representative Institution budgets are summarized below:

	1931-32	1936-37	1940-41
Academic staff salaries	$50,630	$52,616	$59,580
B & G[a] salaries and supplies	20,560	20, 560	17,205
Research expenses & equipment	9,210[b]	9,210[c]	9,785
Total	$80,400	$81,895	$86,670

a: B & G abbreviates Building and Grounds

b: The $9,210 included $2,000 for boat work

c: This $9,210 included $2,000 for boat work and $500 for marine microbiology.

During those first few lean years, my research program was often limited by the availability of facilites and supplies. When several hundred culture tubes were needed to obtain maximal data in certain investigations, only a few dozen were available. When hundreds of pipettes would have expedited a certain research project, after each use it was necessary to clean and sterilize the four dozen that were available. The preparation and sterilization processes generally took half a day, whether one or one hundred pipettes were sterilized. Having only about half as many Petri dishes as a microbiologist could inoculate in an hour, say 36, resulted in a great loss of efficiency when determining the numbers and kinds of bacteria in mud samples that might require a minimum of 12 dozen Petri dishes. These little glass-covered dishes had to be incubated for a week or two before the bacterial colonies developed enought to be counted. Only then could the dishes be cleaned and sterilized for use again.

Considerable time had to be devoted to improvising, innovating, and modifying apparatus needed for experimental work or observations at sea. Most sorely need was a pH meter to determine the hydrogen-ion concentration of culture media, bottom sediments, or seawater. A pH meter is much more precise and convenient than using litmus paper or dyes for pH measurements. A pH meter could be purchased for around $180 in 1932, but $180 was not available for this purpose. Dr. Moberg had one that could be used on

the second floor by making special arrangements in advance. Another alternative was to build a pH meter. From parts and pieces salvaged from junked radio receivers, a couple of vacuum tubes, copper coils, and other readily available hardware, I assembled a pH meter, including the electrodes, for around $15. As a graduate student, I had learned how to make calomel half-cells, hydrogen electrodes, glass electrodes for pH determinations as well as platinum electrodes for measuring redox potentials. Later these electrodes were described in a paper entitled, "Studies on the redox potential of marine sediments," Bull. Amer. Assoc. Petrol. Geol. 30:477-513, 1946. The home-made pH meter is mentioned partly because so many people have the notion that all a microbiologist needs is an autoclave and a microscope.

Also needed was a satisfactory bacteriological water sampler that could be used to collect aseptically water samples from any desired depth in the sea. Most of the samplers used prior to1932 were not effective at depths exceeding 20 or 25 meters. Samples collected with conventional Ekman, Nansen, or Allen water bottles were unsatisfactory for bacteriological analyses for two reasons: (1) Such metal bottles that descended through the water column unsterilized and with both ends open are subject to microbial contamination and (2) copper from such brass bottles tends to kill bacteria or prevent their growth under certain conditions. Bacteriologists before me had tried small glass flasks or test tubes closed with a small-bore glass tube sealed at its outer end. By breaking the glass tube at the desired depth, water was admitted into the flask or test tube. Various breaking mechanisms and arrangements had been tried, none of which was entirely satisfactory. Profiting from the experience of others, I spent considerable time trying to perfect "Apparatus for collecting water samples from different depths for bacteriological analyses." A paper so entitled was published in the Journal of Marine Research (4:173-188, 1941) after the sampler had been used and improved for several years. See also "Some effects of high hydrostatic pressure on apparatus observed on the Danish Galathea Deep-Sea Expedition," Deep-Sea Research 2: 24-32, 1954.

For water depths of less than 200 meters, citrate of magnesia (CM) bottles holding about one pint of water proved to be satisfactory. Chemists and oceanographers used CM bottles by the dozens for water samples to be used for determining dissolved oxygen and chlorinity or salinity. When corrosion caused the metal clamps to fail, the bottles were discarded. We microbiologists salvaged them for modification as bacteriological samplers.

We also found it expedient to salvage flat-sided, pint-size whiskey bottles for use as Roux culture bottles. These served as a substitute for Petri dishes for cultivation bacterial colonies. When properly cleaned and strilized, whiskey bottles proved to be much better than Petri dishes for cultivating bacterial colonies at sea. There was an almost unlimited supply

of whiskey bottles when Petri dishes cost 60 cents each. Not that much whiskey was used by SIO personnel, but there was a continuous supply of bottles along highways. Either I picked them up myself on week-ends or paid children a penny each for unbroken bottles. Later unskilled WPA personnel were exploited for this purpose.

Beginning in 1935, the Works Progress Administration provided emergency employment to millions of people in USA. Twenty-six WPA aides were assigned to the Scripps Institution to work on the grounds, in laboratories, library, and museum. Some of these aides worked under my supervision for a few weeks to a couple of years. Most of them made significant contributions. Nearly all of them, however, required considerable supervision owing to their lack of training in microbiology and biochemistry. They were paid from $40 to $75 per month, the amount depending more upon need than competence.

A 35-year old mechanic became our dish washer. He was dependable and industrious enough. He soon became proficient in cleaning and sterilizing pipettes, culture tubes, and all kinds of bottles. Assisted by George Armstrong, an SIO General Assistant, he rewound and restored an electric motor salvaged from a discarded compressor. The motor was then used to drive a "Motor-driven test-tube brush." A paper having this title was published in the Chemist-Analyst 25:18-23, 1936.

Christi Painter, a clerk who read Russian, translated for us a 297-page monograph entitled, "Studies on bacteria in the Arctic Ocean," by B. L. Isachenko. After I had edited her translation, it was typed in triplicate and bound by other WPA aides working in the library. One copy was accessioned by the SIO Library, one copy was sent to the U.S. Library of Congress, and one copy was kept for the Marine Microbiology collection. Miss Painter also translated several shorter Russian publications dealing with various aspects of marine biology.

E. G. Amstein translated for me a 160-page German monograph by W. Bavendamm on colorless and red sulfur bacteria in fresh and salt water (1924). He also translated Bavendamm's 60-page German treatise on the microbiological precipitation of calcium carbonate in tropical seas (1932). After being edited, these translations were typed in triplicate and bound by other WPA workers. Dr. Vaughan was particularly pleased to see the treatise on the subject of microbiological precipitation of calcium carbonate, a subject in which he had an active interest.

An unemployment carpenter, Larry K. Wardley, built us a few dozen plywood boxes and wooden blocks to accommocate various kinds of culture tubes and other glassware in the shore laboratory and on research vessels. Some of these blocks, trays, and boxes were designed to immobilize pipettes, dilution bottles, culture dishes, and other glassware and hardware on a

rolling ship at sea. Having been treated with preservatives and water-proofing agents, some these boxes and blocks are still in use in the Marine Microbiology Building in 1980.

The foregoing examples should suffice to illustrate some of the contributions of WPA aides. Regardless of training, each one received about $65 per month from the Federal Government for a 40-hour week, plus a small allowance for dependents.

By teaching various college courses for the Extension Division of the University of California after 7:30 p.m., I augmented my regular income somewhat. Between 1935 and 1945, I had a total of 282 students enrolled in 14 classes. Some of these were held in the Scripps Hall classroom and a few of the students were SIO staff members or students. Most of the classes were either lecture-laboratory or lecture-demonstration courses given twice a week during the semester. The Extension Division allowed 10% of the tuition fees for laboratory expenses. This contributed substantially to the marine microbiology laboratory supply inventory.

Other BGG support was forthcoming from an agreement with a San Diego manufacturing and distributing company. The Sterile Porducts Company retained me as a consultant and provided funds for laboratory supplies and a student assistant to test the germ-killing power of various clinical products that were being developed. In lieu of overhead, the company provided more than ample funds for chemicals, reagents, pipettes, culture tubes, thermometers, etc.

Good working relationships were established with a sister research institution in La Jolla, the Research Division of the Scripps Metabolic Clinic. Its library collection was superior to ours in virtually all fields of study except physical oceanography, hydrography, meteorology, and zoology. The Clinic's research laboratories seemed to have virtually all kinds of biochemical and microbiological apparatus, chemicals, reagents, and other supplies. Dr. Eaton MacKay, a senior research biochemist, was especially helpful. Not only was he a fountain of information in his chosen field of study, he was also cooperative and generous. He invited me to use certain specialized apparatus such as spectrometers, centrifuges, analytical balances, galvanometers, and tensiometers, for example. When I noticed that his labortory discarded etched pipettes, culture tubes, and Petri dishes, they were salvaged for use in my laboratory. In turn, I helped Dr. MacKay and some of his associates with certain microbiological problems, including infections and immunization of experimental animals.

Beginning in July 1936, the Kelco Company having headquarters in San Diego started to support my studies on beach pollution with special reference to seaweeds and microorganisms. Funds were provided for a part-time technologist and laboratory supplies. This helped to increase our

inventory of chemicals and reagents. Among those who worked with me on the beach pollution problem were Keith M. Budge, Carl H. Oppenheimer, Harold L. Scotton, Dr. J. Fred Wohnus, and Claude W. Palmer. Published results include "Kelp cutting and its consequences," California Conservationist 6:2-4, 1941; "Factors affecting drift seaweeds on some San Diego beaches," Univ. Calif. Inst. Mar. Res., IMR Ref. 59-3, 1959, 122 pages, and "Drift seaweeds on San Diego county beaches," Nova Hedwegia 32:269-314, 1971.

Thanks to improvements in the State and national economy and financial support from other sources, after 1936 there started to be more money for supplies, salaries, and operating expenses. It then became possible to obtain a whole ream of paper or a box of thumbtacks from Tillie Genter. Funds became available for reasonable quantities of office and laboratory supplies (at least until April or May). However, inventory items costing more than $50 had to be requested and justified several months in advance. Adequate funds for travel expenses to scientific meetings were rarely available prior to 1948. Sometimes University funds provided transportation at economy rates with no per diem except for administrative officers. Such business took me to Berkeley nearly every year until 1938, when the administration of the Southern Section of the Graduate Division was shifted to UCLA.

Early in the spring of 1935, Dr. Denis Fox, Dr. Martin Johnson, and I applied for travel expenses to participate in an A.A.A.S. meeting at the University of Washington in Seattle. Director Vaughan informed us that there was only $75 in the SIO travel fund. He gave us the option of either drawing straws for the $75 or dividing it equally among the three of us. We accepted the latter alternative and drove to Seattle together in my car.

Beginning in January 1936, my research program on the biofouling of submerged surfaces was subsidized by contracts with the Bureau of Ships, Department of Navy. This provided funds for a technical assistant, needed supplies, and approved travel expenses. Mr. D. Q. Anderson was one of my technical assistants. The research resulted in several quarterly Progress Reports and four publications as follows:

"Periphytic habits of some marine bacteria," Proc. Soc. Exper. Biol. Med. 35:270-273, 1936.

"The sequence of events in the fouling of submerged surfaces," Official Digest of Federal Paint & Varnish Production Clubs 178:379-385, 1938.

"Primary film formation by bacteria and fouling," Collecting net 14:105-106, 1939.

"The biological approach to the preparation of antiflouling paints," Proc. Scient. Nat. Paint & Laquer Assoc., Circular 588:149-163, 1939.

In 1937 the biofouling research program was substantially expanded to include hyproplanes, mines, submarines, sub-surface current meters, seawater conduits, and other submerged surfaces besides the bottoms of

boats. Submerged periscopes and the lenses of underwater cameras are particularly vulnerable to fouling by microorganisms. Attention was focussed on the development and perfection of methods of removing fouling accumulations and prevention or retarding of attachment or growth of fouling organisms ranging in size from bacteria to barnacles.

The Advisory Committee for this research consisted of two representatives of the Bureau of Ships, SIO Director H. U. Sverdrup, W. E. Allen, and C. E. ZoBell. Other workers on the team were D. L. Fox, J. C. Hindman, R. T. Tschudy, and W. Forest Wheedon. Mr. Wheedon was brought in from the U.S. Navy shipyard at Mare Island in San Francisco Bay. He was primarily a zoologist who had studied mussels and other shellfishes. Dr. Fox had considerable expertise in marine biochemistry with special reference to sessile shellfish. J. Clark Hindman, who eventually (1943) earned his Ph.D. in chemistry here at the Scripps Institution, was well prepared and eager to help with the chemical aspects of biofouling and its prevention. Dr. Robert T. Tschudy, a plant physiologist, was hired to work with Prof. Allen on sessile diatoms and other algae. I was responsible for investigating the part played by bacteria and allied microorganisms in primary film formation on submerged surfaces.

All of us had access to the Navy yards in San Diego Bay, Long Beach, and Mare Island in San Pablo Bay, San Francisco. We were also cognizant of the observations and recommendation of other Bu-Ships research teams, including the one at Woods Hole. The work done under the aegis of Bu-Ships was classified for security purposes. Later (1952), an excellent treatise on "Marine fouling and its prevention" was prepared for Bu-Ships by Woods Hole Oceanographic Institution. It was published by the United States Naval Institute, Annapolis, Maryland. This 388-page treatise has chapters on the effects of fouling, the biology of fouling, and its prevention.

For a couple of years (1940-1942), Drs. Fox and ZoBell made observations for the Bureau of Aeronautics on factors that influence the corrosion and fouling of materials used in the construction of hydroplanes. They tested nearly 400 kinds of surface materials: metals, alloys, plastics, wood, resins, varnishes, paints, etc. Fox and ZoBell also worked together on marine corrosion and fouling problems under the aegis of the National Association of Corrosion Engineers. At a meeting (November 1954) of the Association in Long Beach, ZoBell presented a paper on "Microbial corrosion of marine structural materials." About two years later (April 1956), there was a four-day meeting of the Association at the SIO. Admiral (ret.) Charles D. Wheelock, Director of the Institute of Marine Resources, was General Chairman. ZoBell was Chairman of the Program Committee and presented a keynote address. Other SIO speakers included Dr. Martin W. Johnson, Dr. D. L. Fox, and his students, Eugene F. Corcoran, and James S. Kittridge.

My first substantial grant-in-aid was $6,000 in 1942 from the American Petroleum Institute (API). It provided for the salary of a clerk-technician, stipends for two half-time research assistants, and funds for all required supplies, apparatus, and travel expenses. The grant was increased each year for ten years until the total amount reached almost $100,000. This was the first time that my research programs were not handicapped by a paucity of glassware and hardware. Adequate working space was or became available, sometimes enought to accommodate several marine microbiologists.

A total of 34 publications aggregating nearly 600 pages resulted from API Research Project 43A. All of these papers were reprinted in the Annual Report: Fundamental Resarch on Occurrence and Recovery of Petroleum (1943-1954), an official publication of the API. They were also reprinted in the SIO Contributions. The Project provided funds for the employment and training of 30 people. Seven of the API research assistants who completed Ph.D. dissertations were William D. Rosenfeld (1945), Josephine B. Senn (1946), David M. Updegraff (1948), William E. Hutton (1949), Frederick D. Sisler (1949), Carl H. Oppenheimer (1951), and Richard Y. Morita (1955). Other graduate students and technologists who made noteworth contributions to the Project were Barbara F. Brown, Nance Fountain, Gregory J. Jankowski, Margaret D. Knight, G. David Novelli, Jean E. Switzer, and Helen H. Whelply. Rose Marie Cassady was the clerk-technician. Dr. Herbert F. Haas from Kansas State University and Dr. Carroll W. Grant from Brooklyn College worked a year each on the Project while on sabbatical leaves.

My first Government Grant was received in 1951. It was $17,500 from the Office of Naval Research (ONR) to work on the effects of deep-sea pressures on microbial reaction rates. Later larger grants were received from the National Science Foundation (NSF) and the National Institutes of Health (NIH). The latter helped to support research work on the microbial degradation of carcinogenic hydrocarbons. Between 1951 and my retirement in 1972, Government Grants supported my marine microbiology research, which resulted in 80 Progress Reports aggregating nearly a thousand typed pages and 58 articles in peer-reviewed periodicals.

Also acknowledged is a grant of $11,450 received from the Rockefeller Foundation in 1953 to support research on the importance of microbial activities on biological, biochemical, and geochemical conditions in the sea. Over a six-year period, the Rockefeller Foundation contributed another $71,100. An appreciable part of this was to train personnel.

After recovery from World War II and its economic impact, much more financial support was forthcoming from the State. Salaries were increased almost as fast as the cost of living. More State money was available for equipment, apparatus, buildings, repairs, supplies, and travel. Details are not given, because this is supposed to be primarily an account of people and

conditions during the infancy and adolescence of the Institution.

Shortly after the Pearl Harbor catastrophe in 1941, the western coast of U.S.A. was placed on an alert basis in fear of submarine or other covert attacks or infliltration of the enemy. The defense department installed look-out stations and gun emplacements in strategic positions along the coast, including the edge of the cliff on the SIO campus. Volunteer civilian wardens were organized to look and listen for suspicious movements or sounds during hours of darkness. For several weeks most of the able-bodied men on the campus volunteered for duty in four-hour shifts two or three times each week. We operated in pairs patrolling the western edge of the campus. Institution personnel worked in close cooperation with town people. There was a "blackout" zone five or more miles from the sea in which all street lights, house lights, and headlights were either prohibited or properly shaded.

Other civilian defense measures included Red Cross training. By taking an intensive course three hours per session, certain people who had some premedical background qualified as Red Cross instructors. Among those who received such ccertification on the SIO campus were Drs. D. L. Fox, C. W. Grant, and C. E. ZoBell.

We were often called on by various groups to demonstrate methods for administering artificial respiration, application of tourniguets, bandaging, splinting, transporting injured personnel, etc. Fortunately for all, we had little occasion to administer first aid during or after the War period. Then and for several years thereafter, I was called on to treat and advise victims of singray injuries more frequently than any other ailment. Incidentally, as and Eagle Scout I earned merit badges for efficiency in First Aid, Lifesaving, Public Health, and SWimming.

Owing to the acute shortage of medical doctors and trained nurses during the War, I was authorized by Public Health officials to administer triple-typhoid, tetanus, and smallpox immunizations. My marine micro-biology laboratory doubled as a clinic one afternoon per month. There was only one "fatality." Paul McEwen, the husky teen-age son of Prof. McEwen fainted and fell off the stool before the inoculating needle had touched his skin. Between 1942 and 1945, I immunized more than a hundred persons in Ritter Hall with no complications.

Several years earlier (November 1934) my "clinical laboratory" had found that Director Vaughan was infected with *Mycobacterium tuberculosis*. His chronic caugh followed by his expectorating in a handkerchief induced me to ask him for a sample of sputum. The microscopic examination of properly stained smears on a glass slide revealed the presence of numerous red-stained, rod-shaped bacteria having the appearance of tubercle bacilli. Dr. Vaughan was persuaded to consult his physician, who confirmed my guess

that it was pulmonary tuberculosis. For six months he was bedridden or confined to his home for complete rest. Thanks to modern medicine and his great desire to get well, Dr. Vaughan made a miraculous recovery. He was coopeative in every way. He never complained. One of his first sacrifices was to stop smoking immediately and completely. Up until this time he had been an inveterate smoker of cigars interspersed with cigarettes.

Throughout his illness and convalescence, I saw Dr. Vaughan two or three times per week. During these bed-side visits he used to ask about certain developments at the Institution.

Dr. Vaughan has been on leave from the Institution from August 1932 until the latter part of March 1933. During this period, Dr. Moberg served as Acting Director, effectively assisted by Tillie Genter. Dr. Vaughan had been commissioned by the National Academy of Sciences to prepare a report on the international aspects of oceanography. Obtaining informatiaon for this report required a trip around the world, during which he conferred with nearly all of the known oceanographers. After returning to La Jolla he was confronted with many problems and he had a long report to prepare before the deadline. He had almost two more highly productive years before his resignation became effective in August 1936. He had the respect, admiration, and affection of nearly everyone. This may also be said of Dr. Harald U. Sverdrup who became Director of the SIO in September 1936.

Noteworth was the farewell party given to Dr. and Mrs. Vaughan, as reported by Dr. D. L. Fox in the Faculty Bulletin dated September 9, 1936: "Members of the Scripps Institution of Oceanography gave a farewell party at the La Jolla Yacht Club in honor of Dr. & Mrs. T. Wayland Vaughan and their daughter, Caroline, on August 21. Dr. C. E. ZoBell, chairman of the committee on arrangements, introduced the master of ceremonies, Dr. Roger Revelle, who called on Dr. W. E. Ritter for remarks. Dr. Ritter, the first Director of the Institution, had come from Berkeley for the occasion. Dr. F. B. Sumner read an original humerous poem relating to some of the oceanographic activities of the Institution. In words of appreciation and tribute, Dr. Revelle presented to Dr. Vaughan a memorial album of pictures and autographs of friends and staff members."

On Sunday afternoon, August 30, 1936, members of the Scripps Institution staff together with numerous other friends from La Jolla and San Diego assembled at the Del Mar railroad station to see Dr. and Mrs T. W. Vaughan and daughter, Caroline, off for the east. There was singing and cheers, handshaking and tears on the station platform. Incoming Director and Mrs. Harald U. Sverdrup were among those present. Everyone shouted or whispered his or her version of bon voyage as the Vaughans boarded the train. Dr. Vaughan went directly to Scotland for a meeting of the International Union of Geodesy and Geophysics in Edinburg. He returned to Washington, D. C., in

mid-October to continue his scientific studies at the U.S. National Museum.

Prior to his accepting the directorship of the Institution, Dr. Sverdrup had asked about having a liaison officer in marine biology, a field that was foreign to him. With Dr. Sverdrup's approval and ostensibly the approval of my colleagues, Director Vaughan nominated me for consideration for the position to the Regents via the President's office. The duties of the marine biology liaison officer were outlined as follows: 1) to act as the Director's advisor in matters concerning biological work at the Institution, 2) to consider proposals made by two or more members of the biology group before such proposals are presented to the Director, 3) to prepare special reports as requested by the Director, 4) to prepare rough drafts describing courses of instruction in collaboration with other Faculty members. The title of the new position was not mentioned in the nomination nor did I learn what it was until a letter dated July 16, 1936, was received from Vice-President Deutsch stating that "on the recommendation of Director T. Wayland Vaughan there was added to your title the words 'in charge of Biological Program' and in consideration of the administrative duties thus involved, your total salary was set at $3,000 per annum. This appointment and this salary both began July 1, 1936."

My new title was announced in the Faculty Bulletin and printed in the University's Catalogue of Courses for academic year 1936-37. It was a privilege and for the most part a pleasure to work with Dr. Sverdrup after he became Director of the Institution in September 1936.

All members of the staff seemed to be cooperative and happy until it came to my attention that Prof. F. B. Sumner had reacted negatively to my new title. After learning of Dr. Sumner's displeasure, Dr. Sverdrup called a meeting of all concerned SIO staff members. It seemed to be the consensus of opinion that a more acceptable title would be "Chairman of the biological group."

On December 18, 1936, Dr. Sverdrup wrote as follows to President Sproul: "Referring to our conversation yesterday, I wish to inform you that on the list of staff members of the Scripps Institution which will appear in the Announcement of the Summer Session and elsewhere, I have changed Dr. ZoBell's title from 'Assistant Professor of Marine Microbiology , in charge of the Biological Program' to 'Assistant Professor of Marine Microbiology, Chairman of the biological group.' This change has been undertaken upon the recommendation of Dr. ZoBell himself and the other members of the staff who are interested in this matter." The same day, by memorandum Dr. Sverdrup notified members of the biological group of my change in title following a telephone conference with President Sproul.

Dr. Sverdrup reiterated his desire to have my administrative title changed in his budget recommendations for 1936-37, dated December 13, 1936. He

stated that my duties would be as before and that I should therefore retain the compensation of $300 that I had received in 1936 for my special duties.

This attempt to molliy Dr. Sumner proved to be embarrassing to both Dr. Sverdrup and me. By letter, following the January 8 meeting of the Regents, Mr. John M. Underhill, the Regents' Secretary, notified us that my title was again simply Assistant Professor of Marine Microbiology.

Almost immediately (Januray 14, 1937), Dr. Sverdrup protested that this action was not in agreement with his recommended changes, stating that "The change which has now been undertaken, according to Mr. Underhill's letter, places Dr. ZoBell in and embarrassing situation. If it is officially annuonced that his additional title, ' in charge of the Biological Program.' has been dropped and has not been replaced by another title which gives a more adequate expression of his special duties, it appears that in the middle of the academic year he has, for some reason, been disciplined. The situation is also embarrassing to me, since I am very satisfied with the assistance Dr. ZoBell has given to me and would much regret it is anyone were led to believe that Dr. ZoBell has been demoted."

In light of this letter, President Sproul recommended to the Regents at their next meeting that their action of January 8th be recinded. This the Regents did, thereby restoring my title to "in charge of Biological Program."

Still rankled by my title, Dr. Summner undertook to have it altered by writing directly to President Sproul in October 1937. Believing that the changes suggested by Dr. Sumner had the approval of Dr. Sverdrup, President Sproul acted upon them. Fortunately, Dr. Sverdrup interceded before the matter had been presented to the Regents, asking that no changes in my title be made until the end of the academic year.

Despite various complications resulting from curious University customs, misunderstandings, and officious meddling, for two years (1936-38) my official title was "Assistant Professor of Marine Microbiology, In charge of Biological Program." On January 18, 1938, Dr. Sverdrup recommended to President Sproul that my administrative title be changed to "Assistant to the Director." I served as such during fiscal year 1938-39 and every year thereafter through 1947-48, when I took a year's sabbatical leave abroad on a Rockefeller Foundation Fellowship. The sometimes embarrassing problem of titles and duties is recounted here to illustrate some of the difficulties of administering the Institution by romote control from Berkeley.

One of the most pleasant assignments as assistant to the Director was accompanying Dr. Sverdrup on a week's trip to other campuses of the University of California and Stanford (October 15-22, 1937). We traveled together by rail to and from Berkeley with stops in Davis, San Francisco, Stanford, and Pacific Grove, the latter being the site of Hopkins Marine Station operated by Stanford University. Although the trip was purely

objective, much to my surprise Dr. Sverdrup was also keenly interested in natural history, geological formations, topographical features of the landscape, anthropology, and places of historical, cultural, economic, scenic, or educational interest. He was usually reluctant to talk about himself, his family, or his research. While we were traveling or dining together, he asked many questions about American slang expressions, customs, conventions, word pronounciations, elementary and secondary school education, and like subjects.

I have the most vivid recollections of our first night together in a Pullman sleeping car. Naturally, I expected to occupy the upper berth in our compartment. However, shortly after the porter had made up our bed for the night, Dr. Sverdrup agilely swung himself into the upper berth. He was always remarkably acrobatic. When I remonstrated, he explained that he preferred the upper berth, adding, "If it is also your preference, we will take turns." He was most democratic, rarely "pulling rank," and he usually had a fine sense of humor. Although generally dignified and reserved in a classroom or conference, he was a jolly good traveling companion. In this trip he asked me to keep a record of all expenses, paying hotel bills, tipping, and other transactions involving money.

On the Berkeley campus, we had conferences with Dr. C. B. Lipman, Dean of the Graduate Division, President Sproul, Vice President Deutsche, and some of their associates, and with a few professors who were interested in the research or teaching programs of the Institution.

In San Francisco, we visited officers of the California Academy of Sciences, Steinhart Aquarium in Golden Gate Park, and had a conference with Dr. Karl F. Meyer in Hooper Foundation for Medical Research. In Palo Alto, there was a luncheon reception for Dr. Sverdrup attended by a dozen officers and staff members. Then we were driven to Pacific Grove to see the facilities and meet some of the Hopkins Marine Station personnel.

In retrospect, it was a most pleasant and exaciting experience for me to be a companion of Dr. Sverdrup for a week. Similarly, being associated with him in a broad spectrum of situations was personally pleasant and professionally profitable. Only on two or three occasions were there misunderstandings that resulted in his becoming visibly vexed with me.

Once during a dialog concerning the future goals and plans of the Institution, I suggested that provisions should be made for the growth of the Institution. I never learned whether he interpreted this as a criticism of his policies or ideas or if there had been a breakdown in semantics, because he reacted almost violently. He shouted, "Growth? Is growth a function of this Institution?" Then somewhat more calmly he continued, "The function of this Institution is scientific research and teaching! Growth is not a function." After these pronouncements, he motioned with his hands and head for me to

leave his office. It made me feel like a whipped schoolboy. Usually during face to face conferences and in staff or committee meetings, when Dr. Sverdrup disagreed with a proposal, he would politely say, "Yes," and then after a long pause continue, "but no." Mimicking his "Yes, - - - but no" covertly became common on the campus.

On another occasion, Dr. Sverdrup called me to his office to discuss the problem of campus signs. Strangers and other visitors often wandered around the campus to find certain persons or facilities. In the course of the conversation, I pointed out that a high percentage of the campus visitors came to my office first, owing to its location (see Fig. 1, p. 34 and Fig. 7) off the lobby in front of Ritter Hall adjacent to the principal cross-campus street and parking area. This resulted in my being frequently interrupted to tell visitors how to get to the aquarium, museum, the Directors office, or the rest room, for example. Facetiously, I said "Sometimes it seems that I do more directing around here than you do." Missing the point of my poor joke by 180°, Dr. Sverdrup's face reddened with rage as he yelled, "Your are not the director! You could never be the director. I am the director! You are the assistant to the director, to, to, to!" He was shouting loud enough to bring Miss Genter from the adjoining room. She tactfully motioned me to leave the office.

The following day, Director Sverdrup summoned me to his office to continue our conference. He never returned to the subject of who's directing what. Nor did he apologize for his violent outburst, but in other ways and on many occasions thereafter, he made it clear that he had misunderstood me.

Another misunderstanding had to do with rodents. When walking to work one morning, I noticed a dead ground squirrel on the road near the Director's House. There was no evidence of trauma, so I carried the squirrel to the laboratory for further examination. It was laden with fleas and its spleen and liver were abnormally enlarged. The microscopic examination of these organs showed large numbers of small, ellipsoidal to elongated rods that showed bipolar staining. The bacteria looked very much like *Pasteurella pestis*, a close relative of my old friends, the *Brucella*. *Pasteurella pestis* is the causative organism of plague in man and in rats, mice, ground squirrels, gophers, and other rodents. After disinfecting the carcass and its fleas with formaldehyde, I sent the material to Public Health people. They confirmed my suspicions that the squirrel was infected with plague.

Immediately, the State Department of Public health sent an epidemiologist with a crew of two men and a mobile laboratory to the SIO campus to examine other rodents. Nearly 4% of those caught were infected with the bubonic plague bacillus. This started a rodent eradication program here and elsewhere in San Diego County. Actually, I had been thinking about plague because there had been news of outbreaks of bubonic plague elsewhere in

California and Arizona. The Public Health people found large numbers of both roof rats and ship rats around or in some of the old campus buildings, the Director's house and garage in particular. One species named *Rattus norwegica* is sometimes called a "Norwegian." While changing clothes in her bedroom, Mrs. Sverdrup overheard a rat catcher remark, 'Did you ever see such a big fat Norwegian!" A little later, I was summoned to the Director's office to find Dr. Sverdrup quite disturbed. It took only a few words of explanation to restore tranquility.

Printed in 1942 on a brochure headed ALL OUT WAR ON RATS was the following: "This brochure was prepared by Dr. C. E. ZoBell under the aegis of the Visiting Nurse Association (VNA). For several years he has been a Member of the Board of Directors of the VNA. Recently, Dr. ZoBell, a microbiologist at the Scripps Institution of Oceanography, found evidence of campus ground squirrels' being infected with *Pasteurella pestis*. His observations were confirmed by California State epidemiologists, who also found this pathogen in house rats. This resulted in a community campaign against house rats and ground squirrels. Fleas may transmit the pathogen from rodents to people."

At age 60, Dr. Sverdrup resigned as Director of the Scripps Institution (effective in February 1948) to become Director of the newly formed Norwegian Polar Institute. He was awarded an LL.D. by the University of California. There was an outpouring of accolades from Faculty members, Federal Government officers, scholars, and local (La Jolla and San Diego) civic leaders. The La Jolla Kiwanis Club sponsored a farewell dinner and dance at the La Jolla Beach and Tennis Club on February 26, 1948. Dr. Clarence Dykstra, UCLA provost, was the dinner speaker. Several prominent people expressed their admiration and affection for Dr. Sverdrup. The arrangements committee consisted of Gifford Ewing, Lloyd Diffenderfer, and William S. Kellogg. About 200 students, Faculty members, professional associates, and friends were present.

Several other smaller parties were given in town and on the SIO campus for Dr. Harald U. and Mrs. (Gudrun) Sverdrup and their teenage daughter Anna. Scripps Institution students, Faculty, and other personnel honored the Sverdrups with a semi-formal reception and dance on the campus on February 27. Mrs. Stanley W. (Lillian) Chambers served as general chairman. An au revoir receiving line formed in the Director's house (Cottage No. 16) at 8:30 p.m., after which the celebration continued on the second floor of the Library Building. Tables, desks, and chairs were placed along the walls to leave more space for dancing. Arrangements were made for the dancing to continue across the bridge (see Fig. 2, p. 35), down the corridor in Scripps Hall, and into the classroom.

As another token of respect and appreciation, SIO staff members and

friends provided funds for the preparation of a bronze bust of Dr. Sverdrup. It is kept at the Institution where it provides a reminder of the grand role he played in the development of the science of oceanography and in upgrading the teaching and research programs here and elsewhere.

A special memorial number of the Journal of Marine Research (No. 3, Volume 7, pp. 125-685, 1948) was dedicated to Dr. Sverdrup. He was an Associate Editor of the Journal. The memorial volume has 43 invited papers authored by 56 associates. I am pleased and proud to have been a contributor along with one of my superior students, Sydney C. Rittenberg. It was most gratifying to have received an autographed copy of the memorial volume carrying a cordial message from Dr. Sverdrup.

When Dr. Sverdrup assumed the directorship in September 1936, the Institution had a total of 38 employees. The net number was 45 when he resigned in February 1948. During the following fiscal year (1948-49), the total number of SIO employees jumped to 82. This remarkable increase resulted mainly from placing the Marine Physical Laboratory (MPL) and several other UCDWR (see p. 39) personnel under the jurisdiction of the Institution. Listed below are the scientists and engineers who became SIO staff members during fiscal year 1948-49, either by transfer, promotion, or appointment:

Dr. Carl Eckart, Professor of Geophysics, retired 1971, died 1973
Dr. Leonard N. Liebermann, Assoc. Professor of Geophysics
Dr. Fred B. Phleger, Visiting Assoc. Prof. Marine Geology, retired 1977
Dr. Russell W. Raitt, Senior Research Assoc. in Geophysics, retired 1975
Mr. John D. Isaacs , Associate Oceanographer, died 1980
Dr. Robert S. Dietz, Lecturer in Submarine Geology, resigned 1955
Dr. Dana S. Russell, Lecturer in Submarine Geology, resigned 1951
Mr. James M. Snodgrass, Associate Marine Biologist, resigned 1974
Dr. Edward D. Goldberg, Assistant Marine Chemist
Mr. Joseph L. Reid, Assistant Oceanographer
Dr. Philip Rudnick, Assistant Marine Physicist, retired 1969, died 1982
Mr. Victor C. Anderson, Ph.D., 1953, Research Associate in Physics
Dr. Frederick D. Sisler, Assoc. Mar. Microbiologist, resigned 1951, died 1980
Mr. Daniel E. Andrews, Research Associate in Physics, resigned 1951
Dr. Beatrice M. Sweeney, Research Associate in Biology, resigned 1961
Mr. John D. Cochrane, Associate in Oceanography, resigned 1954
Mr. Gifford C. Ewing, Ph.D., 1951, Associate in Oceanography, resigned 1964
Mr. Jeffrey D. Frautschy, Associate in Marine Geology, retired 1982
Mr. Paul L. Horrer, Associate in Oceanography, resigned 1955
Mr. Douglas L. Inman, Ph.D., 1953, Associate in Marine Geology
Mr. Palmer Osborn, Associate in Oceanography, resigned 1952

Mr. James Rusk, Associate in Oceanography, resigned 1951
Mr. William G. Van Dorn, Ph.D., 1954, Assistant in Oceanography
Mr. Louis W. Kidd, Assistant in Oceanography, resigned 1961

Notes: The stated titles are those of fiscal year 1948-49. Most of the people named above were rather rapidly promoted in rank and assumed increased responsibilities.

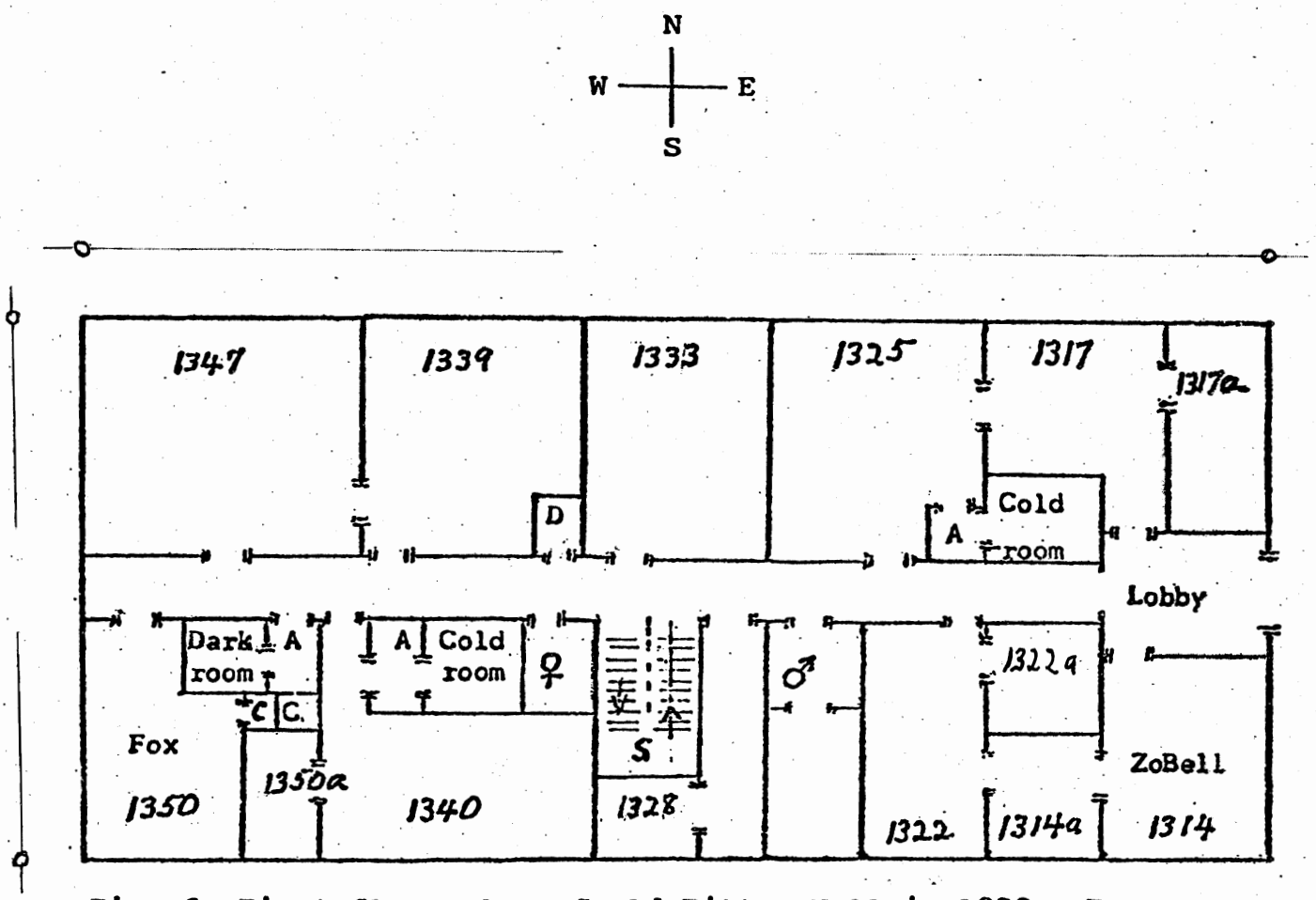


Fig. 6. First-floor plan of old Ritter Hall in 1932. Rooms 1314-1325 were occupied by Dr. ZoBell and his associates in marine microbiology; 1339-1350 by Dr. Fox and his associates in marine biochemistry.

A = Anterooms to darkroom and coldroom; C = Closet and Chimney; D = Dumbwaiter; S = Stairs up and down

Scale: 1" = 15 ft

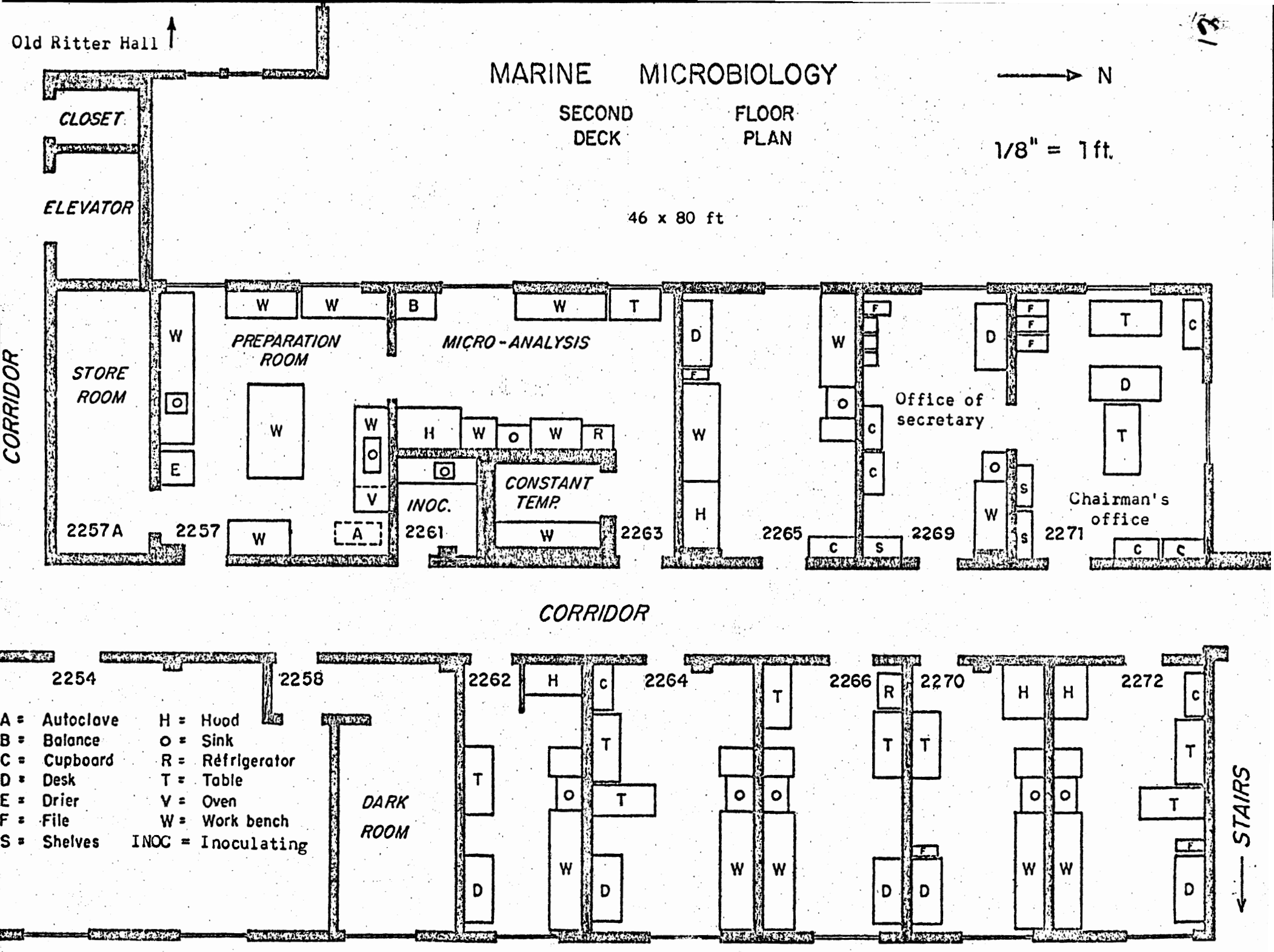
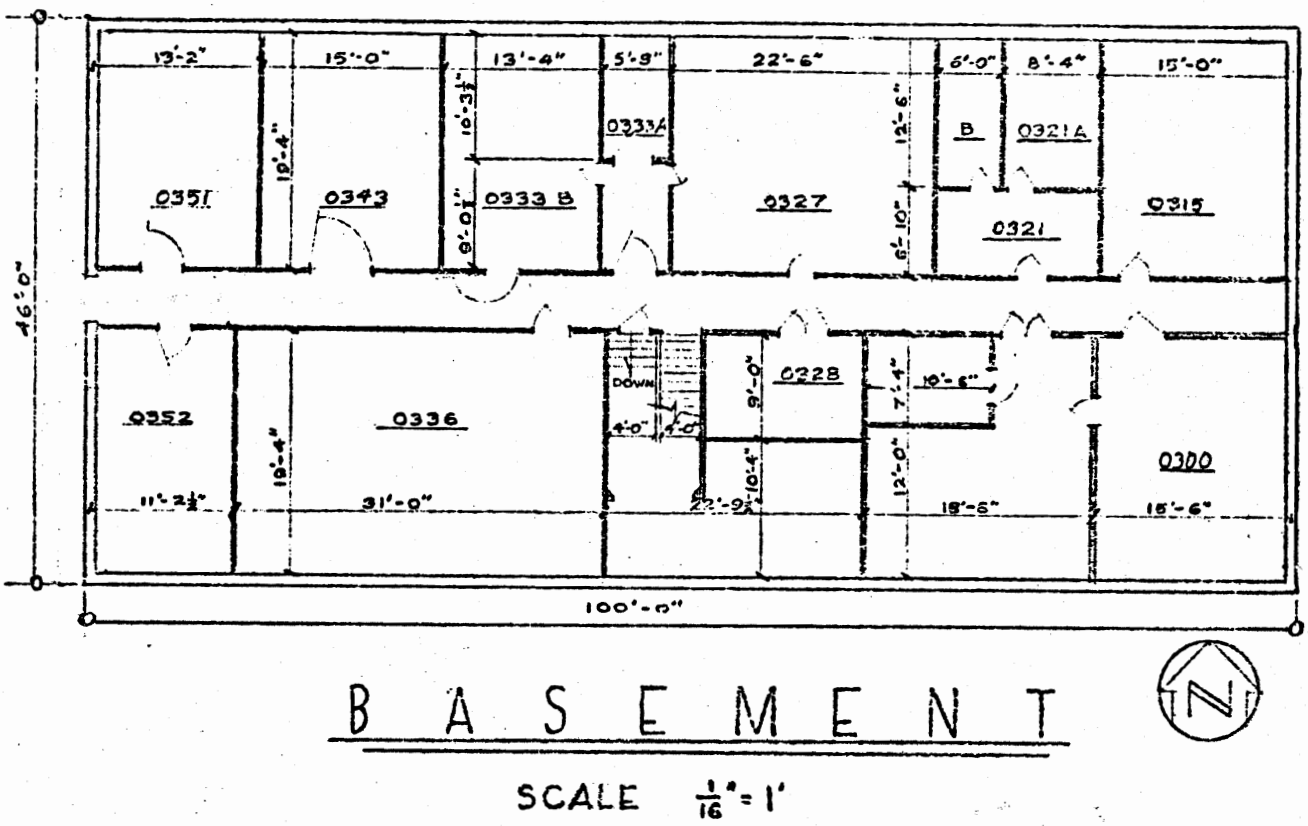


Fig. 7. Marine microbiology laboratories and offices on the second floor of the new wing of Ritter Hall from 1959 to 1977



BASEMENT

SCALE $\frac{1}{16}$" = 1'

Figure 8. PLAN OF THE BASEMENT FLOOR IN OLD RITTER HALL IN 1938: The front or east end was below natural ground level. The aft or west entrance was built at ground or street level. Rooms No. 0300 to 0328 were used mainly by marine botanists. Rooms No. 0333A and B were for photography. Room No. 0336 contained the Institution's steam-heating plant. Rooms No. 0351 and 0352 were equipped with experimental aquaria having running seawater.

Figure 8. Marine microbiology research team of Prof. C. E. ZoBell in front of old Ritter Hall (1954)

1) Dr. E. J. Ferguson Wood, a visiting investigator from Australia, 2) Richard Y. Morita, 3) Harold J. Scotten, 4) Alonzo Webster, 5) Keith M. Budge, 6) Professor ZoBell, 7) David E. Contois, 8) Perrin Winchell, 9) Doris P. Courington, 10) Prof. C. A. Wilhelm Schwartz, a visiting investigator from Germany, 11) Reed Stevens, 12) Carl H. Oppenheimer, and 13) Donald W. Lear

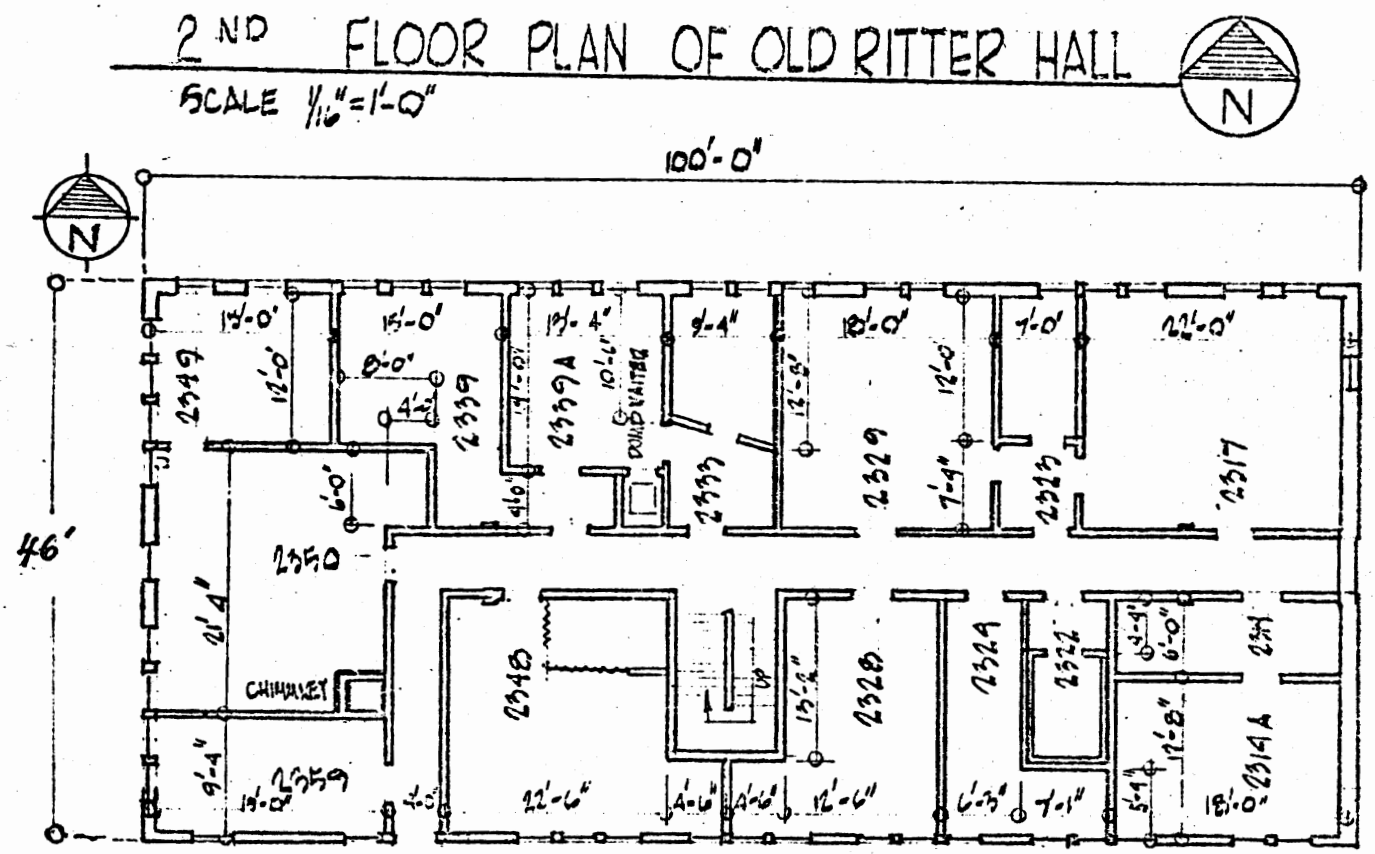


Figure 10. SECOND FLOOR PLAN OF OLD RITTER HALL IN 1938: Rooms No. 2314 to 2329 were used for chemical oceanography with Dr. Eric G. Moberg in charge. Rooms No. 2333 to 2359 were used for meteorology and physical chemistry with Dr. George F. McEwen in charge. Scale: 1/16 inch = 1.0 foot.

IV. Students and Teaching

Although employed primarily as a researcher, I enjoyed teaching at all levels. Dr. Vaughan started me at the top. Anomalously, my first official teaching assignment was as a member of the doctoral committee of Earl Myers, who was working on the morphology and life cycles of local foraminifera in 1932. He had a good background in general biology with a major in zoology, but he had learned little about bacteriology, aquatic fungi, micro-algae, or the food of forams. It became my responsibility to tell an older marine biologist what he should know about such subjects mainly by tutoring sessions and suggested readings. In turn, he told me about protozoans, always with emphasis on the microspheric and meglospheric states of the Order Formainiferida, including their feeding habits and how forams precipitate calcium carbonate.

I was almost as excited as Earl when we appeared in Berkeley for his final examination on 7 May 1934. Not only was I eager for him to do well in the presence of Dr. Vaughan, Dr. F. B. Sumner, Dr. C. A. Kofoid, Dr. Harold Kirby, Dean C. B. Lipman, and the invited public, I wanted to ask some proper questions myself, this being the first Ph.D. examination on which I had participated as a committee member. It was an extraordinary perfromance in a startling way. After making the usual introductory remarks, Chairman Vaughan asked Earl to outline briefly his dissertation research. Wide-eyed with excitment and sweating profusely, Earl's mouth opened and his chin dropped but there was no sound except from the uneasy scraping of his feet. Speaking a little louder through his mustache, Dr. Vaughan rephrased his request. Earl toppled from his chair with his eyes and mouth still open. After being revived with ammonia and water, he was helped into a nearby lounge where he vomited on the floor. Most of the committee members looked rather sick themselves, but Dr. Vaughan called the meeting to order in the absence of the student. Dr. Kofoid was first to put into words what all of us were thinking, "Mr. Myers is in no condition to be examined. He is in a state of shock. His health, if not his life, is held in our hands. Inasmuch as all of us have found his dissertation to be satisfactory, if not superior, I suggest that we inform him that he has completed the requirements for the doctor's degree." When one of the committee members started to make a motion, Chairman Vaughan ruled, "We don't need a motion. All we need are your signatures on these documents." Dr. Lipman agreed and admitted that this was not the first time a candidate had become afflicted with "oral examination shock."

From 1925 until 1938, the SIO offered three categories of courses under the aegis of the U.C. Berkeley Graduate Division: (1) Oceanography 200, 3 credits per semester, with all Faculty members participating by giving lectures, making reading assignments, and supervising laboratory or field

work. All students were required to take this course for two semesters as well as (2) Oceanography 201, consisting of research conferences, for which no credit was given, and (3) Ocenography 202, a series of research courses desingnated a, b, c, d, etc., a separate course in different branches of oceanology offered by each Faculty member throughout the year. The course offerings for fiscal year 1936-27 is illustrated below

Graduate Courses

200A-200B. Lectures and Seminar in Oceanography. (3-3) Yr.
Mr. Sverdrup, Mr. Allen, Mr. Fleming, Mr. Fox, Mr. Johnson, Mr. McEwen, Mr. Moberg, Mr. Sumner, Mr. ZoBell.
Lectures, reports, directed reading, laboratory work.

201A-201B. Research Conferences. No credit.

202A-202B. Research in Oceanography. Yr.
Special preliminary requirements, courses, and credits to be arranged. The required major is indicated after each course.

(a) Geological Oceanography.
Major in geology or paleontology, or a combination major which includes geology or paleontology

(b) Dynamaical Oceanography. Mr. Sverdrup, Mr. McEwen
Major in physics.

(c). Numerical and Graphical Treatment of Oceanographic Data.
Major in subject to which the data apply.
Mr. Sverdrup, Mr. McEwen

(d). Quantitative and Systematic Studies of Phytoplankton
Mr. Allen
Major in botany or zoology, or a combination major in botany and zoology.

(e). Chemical Oceanography. Mr. Moberg, Mr. Fleming
Major in chemistry or biochemistry.

(f). Ecology and Physiology of Fishes. Mr. Sumner
Major in zoology or animal physiology.

(g). Marine Microbiology. Mr. ZoBell
Major in bacteriology or plant physiology.

(h). Physiology of Marine Invertebrates. Mr. Fox
Major in physiology or biochemistry.

(i). Zooplankton. Mr. Johnson
Major in zoology.

(j). Ecology and Life Histories of Marine Organisms.
Mr. ZoBell and The Staff
Majors in bacteriology, botany, zoology, paleontology, biochemistry, or plant and animal physiology, or a combination major in two of the subjects listed.

Upper division courses were listed for the first time in 1939-40 when Oceanography 100, Introduction to Oceanography, with all Faculty members participating, was listed in place of Oceanography 200. Applying lower numbers to the couses was not downgrading; on the contrary, it made the numbers more forthright. Oceanography 110, an Introduction to Physical Oceanography, was offered by Dr. Revelle on the UCLA campus. "Special Studies in Marine Science," by all SIO Faculty members was designated 199A-199B, meaning the first and second semesters, respectively. Its credit value varied from 1 to 4, depending upon the how much time the student devoted to his special study. After 1939-40, only graduate courses were in the 200 series, beginning with Oceanography 250A-250B. It, like 8 other courses in the 280 series, was offered both semesters for 1 to 4 credits per term.

Number	Name of course	Instructor(s)
282	Marine Meteorology	Sverdrup & McEwen
283	Marine Geology	Revelle
284	Chemical Oceanography	Moberg
285	Marine Microbiology	ZoBell
286	Phytoplankton	Allen
287	Marine Invertebrates	Johnson
288	Marine Biochemistry	Fox
289	Biology of Fishes	Sumner

In 1945-46, Dr. Carl L. Hubbs replaced Dr. F. B. Sumner as Instructor of Oceanography 289: Biolgoy of Fishes. The following year, this course was called Ichthyology. Dr. Norris Rakestraw replaced Dr. Eric Moberg as Instructor of Chemical Oceanography 284, which became Chemistry of Sea Water 113.

For the first time in 1946-47 and until the present, thesis research was designated either Oceanography 299 or Marine Science 299. Upper division courses in various kinds of oceanology were designated as Oceanography 110 to 125, my course Marine Microbiology bearing number 121. Dr. Russell Raitt started to give a course called Principles of Underwater Sound number 116. Dr. F. P. Shepard's Submarine Geology was numbered 111.

During the period from 1932 to 1945 the student enrollment at SIO ranged from 2 to 12 students. Approximately half of them became candidates for the Ph.D. degree, meaning that they had passed the Qualifying Examinations. Many otherwise good students failed to pass the foreign language reading examinations. Some failed because there was no instruction in foreign languages on the SIO campus and the students didn't know how to learn another language by independent study. Several postponed passing the language examinations or failed, because there were always rumors

afloat that "next year" students would not be required to read any foreign language. They could earn units in one or more "solid enrichment" courses instead of learning to read a foreign language.

My upper division lecture course in Marine Microbiology was offered at least once a year almost every year from 1933-34 until my retirement in June 1972. Four years I was off campus on sabbatical leave or long deep-sea expeditions. When fewer than 5 students enrolled, the course was offered to the individuals as conferences and assigned reading with instruction being largely by oral question and answer method. The student as well as the teacher asked questions.

Dating from 1936-37, I always had at least one student conducting research under my supervision: fall and spring semesters plus the summer terms. At times there were as many as 5 or 6 graduate students conducting research under my supervision, more often only 2 or 3. See pages ~~70~~ and ~~71~~ 69a+b for a description of Marine Microbiology 121.

University funds were nearly always available for one Research Assistant for each Faculty member. In the marine microbiology laboratory, additional half-time Research Assistants were subsidized by either Kelco Company, the American Petroleum Institute, Bureau of Ships, Office of Naval Research, the Rockefeller Foundation, National Science Foundation, National Institutes of Health, Institute of Marine Resources, and other agencies. Until the mid-1960's Research Assistants were expected to devote at least 20 hours per week to assisting with ongoing research projects under the supervision of the Principal Investigator. Beginning in 1965, the policy gradually changed so that some, if not all, Research Assistants received the regualar stipend for devoting all of their time to their studies whether this were foreign language for no credit, upper division courses, graduate courses, or thesis research.

Shortly after Prof. T. D. Beckwith became established as Chairman of the UCLA Department of Bacteriology, he invited me to give a series of lectures to his students. With the mutual approval of all parties concerned, including Director Vaughan and Dean Knudsen of the UCLA Graduate Division, I gave ten lectures on the UCLA campus each year from 1933 to 1936. In the spring semester of 1937, I assumed the full responsibility of giving all of the lectures and supervising the laboratory work for a 3-unit course in Soil Microbiology 104 at UCLA. This required commuting between La Jolla and Westwood twice a week, an experience that was repeated in 1940 and again in 1941. Teaching this course was interrupted in 1938 and 1939 because I was on sabbatical leave at the University of Wisconsin (in limnology) and Woods Hole Oceanographic Institute.

The University of California Extension Division, with headquarters in Berkeley, requested me to give some bacteriology courses to satisfy

community needs. At that time (1932 to 1940) there was no college or univesity south of Los Angeles that provided such instruction. It was hardly appropriate for the SIO curriculum, although I had the required background to give the courses for which the community had petitioned. Because I enjoyed teaching and felt that it would be a community service, this extracurricular activity was undertaken with the approval of the Director(s) of the Scripps Institution, the Dean(s) of the Graduate Division, and the President(s) of the University of California. As may be noted in the following tabulation, the meeting place for some of the courses was the Scripps Institution. The San Diego Zoo Research Laboratory was also a good place for these Extension courses. All classes were held from either 7:00 or 7:30 until 10:00 p.m. The starting date of each course is shown in the tabulation. There were 15 to 22 sessions for each course plus a final examination for those who were working for college credits.

Courses taught by Dr. C. E. ZoBell

Extension Division Course		Units	Students	Date	Place
601ABC	Clinical Bacteriology	3	20	23/6/35	SIO
XL6	General "	2	14	5/12/35	SIO
XL6	" "	2	14	2/2/36	Zoo Hospital
801ABC	Dental "	3	16	5/5/36	SIO
601ABC	Clinical "	3	30	15/9/36	Zoo Hospital
XL6	General "	2	13	1/3/37	" "
806ABC	Serology	3	35	14/9/37	" "
XL6	General Bacterilogy	2	17	2/10/37	SIO
XL121	Marine Microbiology	3	13	24/9/40	SIO
601ABC	Clinical Bacterilogy	3	21	14/10/41	Zoo Hospital
601AB	Refresher course for Lab. Technicians	2	26	17/3/42	Snyder Contua-tion High School
XL101	Public Health and Preventive Medicine	2	43	19/9/44	" " "
XL6	General Bacteriology	2	26	17/2/50	SIO

The University Extension Division provided a Procter, an assistant who helped with the preparation of demonstration materials, lantern slide projection, and laboratory instruction. Adequate funds were provided for expendable supplies or the rental of permanent equipment such as microscopes. My compensation as Instructor ranged from $12 to $25 per student. I usually authorized three or four worthy students to audit my course without paying any fees. My Extension Division students included 18 dentists, 12 nurses, 6 medical doctors, and 3 DMV's. Two students who took my XL6,

601AbC, and XL101 courses were later admitted to medical schools and went on to obtain M.D. degrees. The majority became or continued to be laboratory technicians or technologists. Three of these became proprietors of their own laboratories employing three to six assistants.

Prof. D. L. Fox taught at least one course in Biochemistry for the University Extension Division , maybe more. Quite likely other SIO personnel have conducted courses for the Extension Division, but I do not know who or when.

Besides the foregoing college courses offered by SIO and the University Extension Division were informational lectures given by some of the staff members at high schools and various service clubs in the community. Nearly every year after 1935, I was invited to speak at one or more teacher's institutes (county, state, or national) held in San Diego. The teachers, like members of such service clubs as Kiwanis, Lions, Rotary, Twenty-Thirty, and Soroptimists always seemed eager to learn something about "The science of the sea," "Research program of the Scripps Institution of Oceanography," "Food from the sea," "The marine environment," "The sea and its relation to man," or "The microbial population of the sea." It was an educational experience for me to learn something worth talking about.

For several years arrangements were made directly with the teacher or principal of the school for me to give lectures to various high school groups, which might be for a specific class or something for the entire student body. In order to keep this from taking too much of my time, I restricted such extracurricular taching to an average of no more than one lecture per week during the school year. In recent years, this volunteer program has been adroitly managed by the "Meet the Scientist" program sponsored by the Greater San Diego Industry-Education Council. Several SIO staff members have participated in the program, but the percentage has not been high.

Probably 20 to 25% of the SIO Faculty members have contributed for two or more years to the Greater San Diego Science Fair by guiding the entrants or serving as judges. I served in either or both capacities for thirty years.

Marine Biology 121. Marine Microbiology

A 3-unit course consisting of lectures, demonstrations, conferences, outside reading, special reports, and preparation of a term paper. Term paper topic to be arranged with instructor. Topic to be concerned with some aspect of the characteristics, ecology, methods of studying, physiological activities, or importance in the sea of bacteria, actinomycetes, mold fungi, yeasts, minute algae, microflagellates, and viruses, but exclusive of the protozoa and larger phytoplankton. Prerequisites include Oceanography 110, 112 & 113 plus training in general bacteriology and biochemistry or their substantial equivalents.

SYNOPTIC OUTLINE OR PROSPECTUS

1. Introduction: Scope of course. Marine microorganisms & their importance.
2. Taxonomic Relation of Microbes to Higher Organisms: Broad classification.
3. Morphology of Bacteria: Cell walls, nucleus, flagella, capsules, endospores, etc.
4. Energy Requirements of Bacteria: Kinds of organotrophs and lithotrophs.
5. Nutrient Requirements: Sources of energy, carbon, nitrogen, phosphorus, other minerals, trace elements, growth factors, water, gases. Nutrient media.
6. Oxygen Relations: Aerobes, anaerobes, microaerophiles. Eh or redox potential. Methods of anaerobiosis. Microbial transformations of oxygen & its compounds.
7. Effects of Temperature & Radiations: Temperature tolerance & range of growth. Activity rates. Visible, ultraviolet, ionizing & other radiations.
8. Hydrostatic & Osmotic Pressure: Influence on reproduction, growth, death, enzyme reaction rates, temp. tolerance & occurrence of microbes in the sea.
9. Other Environmental Factors: Surface tension, solid surface, surface-active substances, agitation, sedimentation, antibiotics, predators, symbionts, etc.
10. Water Sampling Methods: Outline of problem. Aspetic & non-toxic conditions. Description of various devices. Storage of samples. Refrigeration & freezing.
11. Collecting Bottom Sediments: Dredges, grabs, corers, suction devices. Subsampling techniques. Storage & examination of bottom sediment samples.
12. Methods of Sterilization: Incineration, dry heat, boiling, steam pressure, disinfectants, ultrafiltration, radiations. Aseptic techniques.
13. Methods of Cultivating Microbes: Solid vs liquid media. Differential media. Receptacles for growing microbes. Conditions of incubation.
14. Methods of Enumerating Microbes: Direct microscopic vs cultural methods. Plate counts vs extinction dilution method. Millipore filter techniques.
15. Bacteria in Sea Water: Abundance at different depths, latitudes, seasons, etc.
16. Bacterial Biomass: Standing crop & estimates of annual yield in the ocean.
17. Microbes in Bottom Sediments: Numbers & kinds. Vertical distribution in cores. Some anomalous occurrences. Evidence of activity. Fossil remains.
18. Geomicrobiology: Microbes as geological & geochemical agents. Effects on pH, Eh, gases, oils, $CaCO_3$, state of sulfur & other elements in sediments.
19. Mineralization of Organic Matter: Aerobic vs anaerobic decompositions. End-products, including microbial cell substance. Marine humus. Carbon cycle.
20. Special Microbial Products: Enzymes, pigments, vitamins, antibiotics, etc.

21. Nitrogen Cycle in the Sea: Nitrogen fixation, ammonification, nitrification, nitrate reduction, denitrification. Nitrogen nutrition of organisms.

22. Phosphorus Cycle: Microbial liberation & uptake of phosphate. Problems.

23. Sulfur Cycle in the Sea: Microbial oxidation of different forms of sulfur. Sulfate reduction. Liberation of sulfur from its organic compounds.

24. Photosynthetic Bacteria: Characteristics, physiology & occurrence in the sea.

25. Outline Classification of Schizomycetes: Relationships & marine representatives.

26. Characteristics of Bacteria Indigenous to Marine Environment: Predominant morphological & physiological types. Compared with freshwater & soil bacteria.

27. Higher Bacteria in the Sea: Actinomycetales, Myxobacteriales, Spirochaetales, etc.

28. Bacterial Nutrition of Animals: Evidence that animals ingest & digest bacteria. Nutrient properties & abundance. Role of bacterial enzymes & vitamins.

29. Marine Yeasts: Characteristics & occurrence in the sea. Methods of study. Importance in food chains. Relation of yeasts to bacteria & mold fungi.

30. Mold Fungi in the Sea: Mycelia associated with aquatic vegetation & certain animals; spores widely distributed. Agents of disease & decomposition.

31. Aerobiology: Abundance & kinds of living things found in air. Sampling & analytical methods. Aerial transport & survival of microbes.

32. Pathogenic Microorganisms: Microbial infections of marine plants & animals.

33. Microbial Spoilage of Food: Discoloration & decomposition of fish during storage.

34. Bacteria of Sanitary Significance: Pollution of sea water, beaches, shellfish beds. Detection, survival & significance of coliform bacteria in the sea.

35. Microbial Deterioration of Man-made Structures: Wood, fish nets, cordage, concrete, iron. Biofouling & bacteria. Submarine cables & coatings.

36. Viruses: General properties. Viral infections in marine organisms. Bacteriophages.

37. Bioluminescence in Microbes: Mechanism of light emission & marine species.

38. Applied Microbial Genetics: Selection, adaptation & evolution in marine microorganisms. Some biochemical & ecological considerations.

39. Recapitulation of Importance of Microorganisms in the Sea: Fundamental contributions to biology. Influence on chemical & physicochemical conditions in sea water & sediments. Beneficial & harmful effects on higher plants and animals. Food spoilage, corrosion, biofouling. Conservation of elements.

40. Some Unsolved Problems Confronting the Marine Microbiologist: Improved sampling & analytical methods for field work. Quantitative data on bacterial biomass, yeasts, microflagellates & chemolithotrophs. Microbial concentration of trace elements and fractionation of isotopes. Flotation mechanisms of marine microbes. Microbial nitrogen fixation. Microflora as indicators of water masses and movements. Physiological, ecological & mutagenetic effects of high hydrostatic pressure. Uniqueness of marine bacteria, yeasts, mold fungi & other microbes. Part played by microbes in mass mortalities. Viral infections of marine organisms. Microbial neuston or microorganisms associated with surface film of water.

V. Visiting Investigators

The teaching and research programs of the Scripps Institution have been substantially enriched by visiting investigators. Indeed, in its infancy, the Institution sometimes had more visiting investigators than resident researchers. (See the account of the first fifty years by Helen Raitt and Beatrice Moulton, Ward Ritchie Press, 1967). During my 48 years (1932-80) on the campus, resident researchers at any one time have always out-numbered visiting investigators by ratios ranging from 2:1 to 5:1. But because most of the latter came for only a few weeks or months, cumulatively in certain years they may have exceeded the number of resident researchers.

Outlined below are the names and principal contributions of visiting investigators who have worked from January 1932 to June30,1972. Besides their contributions to our research program, all of the visitors discussed problems of mutual interest with other students and staff members. Most of them participated in seminars and some gave lectures. It was my policy to accept (with prior approval of administrative officers) as many qualified visiting investigators as could be accommodated. Ordinarily, this was only one or two at a time. After the first few penurious years, adequate funds were usually available to provide expendable supplies for visitors, but nothing for salaries, stipends, travel expenses, or new apparatus except for special grants for this purpose. We never exacated a bench fee from a visiting investigator. A few came for a year or longer. The majority came for either one or two semesters.

Esther Allen (the daughter of W. E. Allen, the diatom specialist) and Thelma Wells (wife of SIO student Nelson Wells) were inherited. They already had "visiting investigator" status in marine microbiology when I became a staff member in January 1932. This arrangement was continued , because both of these young ladies were capable and quite industrious. Miss Allen was encouraged to investigate primary film formation on submerged surfaces. Within a couple of years her careful observations resulted in two publications and the development of methods for determining the abundance of sessile microbial populations in situ. Thelma Wells examined some of the ecological factors that influence the abundance and biochemical activity of filamentous fungi in seawater, bottom sediments, and kelp.

Dr. Helen M. Mathews from the University of British Columbia, Vancouver, Canada, was with us during the summers of 1934 and 1935. She came to learn something about methods of studying marine microorganisms. She became actively interested in my ongoing studies on the aerial transport

of microorganisms with special reference to the exchange of microflora between land and the sea. She contributed enough to justify co-authorship on a paper entitled, "A quantitative study of bacterial flora of sea and land breezed," Proc. Nat. Acad. Sci., 22:567-572, 1936. These studies contributed substantially to my report on "Microorganisms in marine air," Aerobiology symposium, AAAS, Washington, D. C., Publ. No. 17:55-68, 1942.

During the summer and fall of 1935, Dr. Blodwen Lloyd, a faculty member from the Royal Technical College, Glasgow, Scotland, was with us as a visiting investigator. She had been studying bacterial denitrification in shallow Scottish seas and was eager to broaden her horizons. She spent about half of her time working in the marine microbiology laboratory and devoted the remainder of her time to learning what was happening elsewhere on the campus. Besides a detailed report to the Rockefeller Foundation (her sponsor) and the Royal Technical College, she prepared for publication a short article, "Bacteria in stored seawater," J. Roy. Tech. College, Glasgow, 4:173-177, 1936. In this article she acknowledged my contributions, Director Vaughan's kindness, and the many courtesies of other staff members.

Winifred A. Landon was a visiting investigator who registered as a student. She was more concerned with the amount of bacterial biomass in marine environments than with the number of bacteria found in seawater, bottom sediments, and elsewhere in the sea. Miss Landon's research resulted in a joint paper on the "Bacterial nutrition of California mussel." Small mussels (less than one inch in length) were maintained in the dark in filtered seawater. Fasting ones died or lost weight while those that received a diet of only washed bacteria gained an average of about 12% in weight. After her year's leave of abseance (1935-36), she returned to her teaching position.

Mr. E. F. Gabrielson, a sanitary engineer from the San Diego Water Department, had leaves of absences for several weeks in 1936 and early 1937 to work in the marine microbiology laboratory. He was concerned with the pragmatic aspects of microorganisms of sanitary significance in recreational waters, especially *Eschrechia coli* and *Streptococcus faecalis*. Mr. Gabrielson eventually became Chief of his division and has often expressed his gratitude for the cooperation of the Scripps Institution of Oceanography.

Dr. J. Harold Long, a biology professor from Christian College, Columbia, Missouri, was with us for four months beginning in June 1938. He was preparing to upgrade the graduate program in limnology at Christian College. He worked with me on methods of preparing bacteria-free cultures of unicellular algae, including diatoms. Jointly we published a paper on the "Isolation of bacteria-free cultures of phytoplankton, J. Mar. Res., 1:328-334,

1938. Prof. Long returned to Christian College where he had a distinguished career until his premature death in 1975.

Jean E. Conn, a graduate student from Cornell University, was authorized by Director Sverdrup to come here as a visiting investigator during the last six months of 1938. Besides giving a seminar in the bacteriology of fresh water and becoming aquainted with the marine biology program, she worked under my supervision on the temperature tolerance of bacteria. We became co-authors on a paper based upon work done at the SIO: "Studies on the thermal sensitivity of marine bacteria," J. Bacteriol., 40:223-238, 1940. Conventional nutrient agar used for colony counts solidifies at around 40°C (104°F), a temperature that is lethal within 10 minues for about three-fourths of the bacteria in the sea.

While on sabbatical leave during 1936-37 from the Northwestern University School of Medicine, Prof. A. I. Kendall, an internationally known medical bacteriologist, spent about half of his time in the marine microbiology laboratory as an official visiting investigator. His interests were more in microbes of public health or sanitary significance than in the ocean.

Jackson S. Kiser was another graduate student who did some of his research at the Scripps Institution as a visiting investigator in 1940 and 1941. He had a research fellowship at the San Diego Zoo to investigate the population and activities of bacteria in fish used to feed sea lions. Jack qualified for his Ph.D. degree in microbiology under the aegis of the University of California, Souther Section, Graduate Division, much like SIO students did at that time. He was sponsored by the San Diego Zoological Society's Research Council, of which I was a member. I became a member of Jack's doctoral dissertation committee as did Prof. D. L. Fox. Jack did some outstanding research, the results of which were published in four papers, including "Effects of temperature approximating 0°C upon the growth and biochemical activities of bacteria isolated from mackerel," Food Res., 9:257-267, 1944. After getting his degree, Dr. Kaiser took a position in the research division of Lederle Laboratories. Eventually he became director of the Animal Industry Research and Development Divison.

W. Forest Whedon came here initially in 1940 as a visiting investigator subsidized by the U.S. Bureau of Ships to work on the biofoulng problem. He was assigned to my laboratory, because we had an existing research program on primary file formation on submerged surfaces and its prevention. Whedon was interested primarily in prevention from an engineering point of view. Within a year or two he became too big in the head as well as in personnel to be compatible with marine microbiology, so Director Sverdrup found other quarters for him and his associates. Following Pearl Harbor (December 1941), Director Sverdrup asked Dr. Fox and me to work in an advisory

capacity on Whedon's project aimed at keeping the pontoons of flying boats, mainly Catalinas, free of sessile organisms. As I recall Whedon and his mercenaries were stationed on a Navy base in San Diego.

Two professors of microbiology on sabbatical leave were with us for a half year or longer beginning in July 1941: Rev. Dr. Robert J. Sheehan from the Univesity of Portland and Dr. Carroll W. Grant from Brooklyn College, New York. Dr. Grant became interested in our on going investigtions on the microbial degradation of petroleum hydrocarbons. He remained with us until June 1942. He proved to be one of our most prolific contributors to our teaching and research programs, becoming a co-author of five publications: "Bacterial activity indilute nutrient solutions," Science, 96:189-190, 1942; "The bacterial oxidation of rubber," Science, 96:379-380, 1942; "Oxidation of hydrocarbon by marine bacteria," Proc. Soc. Exper. Biol. Med., 51:266-267, 1942; "Marine microorganisms which oxidize petroleum hydrocarbons," Bull. Amer. Assoc. Petrol. Geol., 27:1175-1193, 1943, and "Bacterial utilization of low concentrations of organic matter," J. Bacteriol., 45:555-564, 1943. Rev. Sheehan was not here long enough to complete a research project, but he did so after returning to Portland, where he introduced a course in Marine Biology. His interest in marine biology continued after he was transferred to the Univesity of Notre Dame.

Dr. C. S. Mudge, who served on my doctoral examination committee in 1931, came to the Scripps Institution on a semi-sabbatical leave from the Univesity of California, Davis. He was with us from July to December 1943, during which time he worked on bacterial respiration in dilute nutrient solutions such as seawater. I had published a few papers on this subject, including "The effect of oxygen tension on the rate of oxidation of organic matter in seawater by bacteria," J. Mar. Res., 3:211-223, 1940. Dr. Mudge quickly mastered my methods and made some improvements. He gave an evening lecture (open to the general public) on the microbiology of milk.

Dr. Jay V. Beck from the University of Idaho joined the marine microbiology group for the first half of 1945 to acquire some expertise in the field of petroelum microbiology. He was subsidized by the Penn Grade Crude Oil Association, which retained him to head a microbiology research laboratory in Bradford, Pennesylvania. They were concerned with the microbial modification of hydrocarbons and microbial liberation of oil from ancient marine sediments. Beck became the first of a few hundred petroleum microbiologists and geomicrobiologists now employed by the petroleum industry. As pointed out by Beerstecher in his 375-page text book on "Petroelum Microbiology" (1954) as well as by Davis in his 604-page book (1967) on the same subject, this new field of learning started at the Scripps Institution of Ocanography. During the last 40 years, it has attracted hundreds of visitors and numerous research grants.

Dr. Benjamin E. Volcani came to us as a Research Fellow from the David Sieft Research Institute, which was the nucleous of the Institute of Science, Rehovoth, Israel in the summer of 1946. A few years earlier (1940), his doctoral dissertation had been based on his "Studies of the microflora of the Dead Sea," published in Hebrew as a separate of 120 pages with a 30-page English summary. Besides gaining an acquaintance with marine biologists and their research problems, Ben employed the submerged slide technique to investigate the microflora of nearshore and Mission Bay deposits.

As a Rockefeller Foundation Fellow, Mrs. Olag Sømme was with us for several months in 1948-49. She was a microbiologist from the Biologisk Laboratorium, Universitet Oslo. Her chief interests were nitrate-reducing bacteria and cellulose-digesting bacteria found in seawater, sediments, phytoplankton, and seaweeds.

One of our most industrious visiting investigators was Dr. Vlaho Cviic'. He came to us for several weeks in 1950 from the Institute of Oceanography and Fisheries, Split, Jugoslavia. His Institute increased his salary generously and provided ample funds for travel, subsistence, accommodations, and expendable laboratory supplies. He made preliminary observations on sessile bacteria, the microbiology of red water, and bacteria as food for lobster larvae. After returning to Split, he published papers on these subjects, with all due credit to SIO personnel. Nearly all of his papers were published in either French or English. Up until the time of his premature death in 1964, Dr. Cviic' was listed among the ten leading marine microbiologists in world. After returning to Jugoslavia, he initiated a moderately large research and teaching program in marine microbiology oriented towards practical applications.

The first geomicrobiologist to come to Scripps as a visiting investigator and observer was an international authority on the microbial transformation of minerals, including petroleum. Prof. Dr. Wilhelm Schwartz was here in 1954 from the Institut für Mikrobiologie, Mahlum über Derneburg, Germany. He was founder and continues to be Editor-in-Chief of "Zeitschrift *für Allgemeine Midrobiologie*, a journal that caters to papers dealing with the effects of microbial activities on environmental conditions and the transformation of minerals.

In Australia, Fergus Wood, as he was called, worked mainly on the microflora of freshly caught marine fish along with microbial ecology and taxonomy of dinoflagellates. During the year at Scripps (1954-55), he became oriented more toward the sea and its metabolism by talking with virtually everyone on the Faculty, especially the biologists. He returned to Cronulla, New South Wales, for only a short period before receivng a professorship at the Institute of Marine Sciences, Miami, Florida. While

there he wrote two books, "Microbiology of oceans and estuaries," 319 p. and "Marine microbial ecology," 243 p.

Holger Jannasch was a post-doctoral investigator from the Institut für Microbiologie, Universität Göttingen, Germany, for a year in 1956-57. He is now one of the world's leaders in marine microbiology. For seaveral years he has been in charge of the marine microbiology research program at Woods Hole, Massachusetts.

Dr. Nobu Taga form the Ocean Research Institute, University of Tokyo, Japan, was a post-doctoral fellow in marine microbiology during 1958-59. He has developed broad interests in the importance of microbial activities in the sea. He has become a leader in this field of study in Japan. He has recently written a textbook of marine microbiology

Dr. Wilfried Gunkel from the Biologische Anstalt Helgoland, West Germany, was with us as a post-doctoral fellow in 1959-60. His main objective was to master methods in marine microbiology, especially methods for estimating microbioal biomass and the microbial degradation of petroleum hydrocarbons. He has become an authority on the oil pollution problem in western Europe. Based on cooperative investigations at Scripps Institution, he published a paper jointly with Dr. G. E. Jones and ZoBell on the "Influence of volume of nutrient agar medium on the development of colonies of marine bacteria," Helgoländer wiss. Meeruntersuch., 8:85-89, 1961. Dr. Gunkel became Chairman of the Biologische Anstalt in Helgoland.

Supported by a grant from the Gulbenkian Foundation, Prof. N. van Uden from the University of Lisbon was a visiting investigator in my laboratory during the spring of 1960. As co-authors, we published a paper entitled "*Candida marine* nov. sp., *Torulopsis torresii* nov. sp., and *T. maris*nov. sp., three yeasts from Torres Strait," Antonie van Leeuwenhoek, J. Microbiol. 28: 275-283, 1962. Dr. van Uden has become one of Europe's leading marine microbiologists.

During the winter of 1960-61, Macario A. Palo was with us from the Biological Research Center, National Institute of Science and Technology, Manila, Philippine Islands. He was chiefly concerned with the parts played by bacteria in the biological productivity of the sea. In 1964, he became director of the NIST.

Dr. Yvonne Freitas was a post-doctoral Fellow in marine microbiology from UNESCO's Institute for International Education in 1962-63. She was from St. Xavier's College, Bombay, India, to which she returned to inspire many students. While at Scripps, she worked on the thermal properties of marine bacteria, employing a polythermostat or temperature-gradient block for this purpose. The polythermostat, developed by Thomas, Scotten, and Bradshaw (Limnol. Oceanogr. 8:357-360, 1963) at SIO provided for 18

different temperatures ranging from near 0° to 25°C for either two triplicate cultures in tubes or three duplicates.

Correspondence with Kaare Gundersen started in 1950 when he was working for a Masters degree at the University of Copenhagen. He expressed a desire to do his doctoral research at the Scripps Institution. His scholastic records and references were all favorable, but the necessary funds for travel and support were not available either here or in Denmark. A few years later when funds and working space became available, Dr. Gundersen had received his Ph.D. from Göteborg University (Sweden) where he had a Lecturship in microbiology. Then in 1963 he received a Sverdrup Fellowship for a year's post-doctoral work at the Scripps Institution. He worked mainly on nitrite and nitrate reduction under various environmental conditions. While here, he received an offer for a professorship at the University of Hawaii to strengthen its program in marine microbiology. Then in 1967, Göteborg Univesity recalled him as Professor and Chairman of what is believed to the the world's first Department of Marine Microbiology.

Dr. Wm. A. Corpe, Barnard College, Columbia University, was with us on a semi-sabbatical leave in 1968. He investigated some of the mechanisms whereby microorganisms attach to solid surfaces. His observations were published in a paper entitled "Detachment of marine periphytic bacteria from surfaces of glass slides," Developments in Indust. Microbiol., 15:281-287, 1974. Incidentally, Dr. Corpe has a chapter in a 439-page book on "Adsorption of Microorganisms to Surfaces (1979). The first sentence in the book states that, "Research on the association between microorganisms and solids surfaces following the pioneer work of ZoBell (1935, 1943) continued in as spasmodic fashion until the present decade."

Another ardent convert to marine barobiology (study of the effects of deep-sea pressure on biological systems) came to us for a year in 1970-71 from California State University, Long Beach, on sabbatical leave. Dr. Juhee Kim collaborated with me in studies that culminated in three papers: "Effects of deep-sea pressures on microbial enzyme systems," Symp. Soc. Exp. Biol., 26:125-146, 1972; "Agarase, amylase, cellulase, and chitinase activity at deep-sea pressure," J. Oceanogr. Soc. Japan, 28:131-137, 1972, and "Occurrence and activity of cell-free enzymes in oceanic environments," in Effects of Ocean Environment on Microbial Activities, R. R. Colwell and R. Y. Morita (ed.) Univ. Park Press, Maryland, p. 378-385, 1974. Dr. Kim's work here was supported by a grant from the Research Corporation.

VI. SIO Library

A summary of such an important teaching and research facility as the SIO book, serial, and document collection requires a special section in this story. As of 30 June 1980, the SIO library shelved 130,700 bound volumes. About two-thirds of these were journals or periodicals, the other 33% being monographs, textbooks, encyclopeidas, and other kinds of books. Additionally, there were approximately 53,00 reprints, reports, pamphlets and dissertations, 36,300 maps and charts, 450 periodicals and serials, and 8200 photomicroscopic documents (fiches, etc.). Since 1977, this collection has been housed in the new library building, which has shelving for 150,000 volumes. Probably, provisions could be made to accommodate up to 200,000 volumes. In both quality and quantity, there is no other collection of marine science literature that can compare with Scripps except possibly the combined collection of the Woods Hole Oceanographic Institution and the Marine Biology Laboratory.

Nearly 1,400,000 books and about a thousand different periodicals are available within a radius of half a mile on the UCSD campus in the Central University Library and its four branches: the Biomedical Library, the Science & Engineering Library, the Cluster Undergraduate Library, and the Scripps Institution of Oceanography Library. If a certain desired publication is not in any library on the UCSD campus (something that can be determined by telephone), computerized methods can be employed to ascertain whether it is in any other University of California library, such as Los Angeles, Berkeley, Davis, Irvine, Riverside, San Francisco, Santa Barbara, or Santa Curz. Another option is to ask the computer whether the desired publication is available in other universities or government libraries.

In 1912 when the Marine Biological Association of San Diego officially became the Scripps Institution for Biological Research of the Univesity of California, its library collection consisted of something less than 500 volumes supplemented by a much larger number of phamphlets and reprints, 15 journal subscriptions, and the considerable library of Director Ritter. The entire collection was shelved in one room of the George H. Scripps Building, where it was cared for mainly by volunteers, staff members or students. The first of these were graduate students Myrtle Johnson and Nina Waddell in 1912-13. Dr. S. Stillman Berry came to Scripps in 1913 as the Institution's first Librarian. He was an invertebrate zoologist from Stanford University, conducting research on the taxonomy of mollusks. He reaceived a nominal fee to manage the library collection. He left Scripps in 1918 to conduct independent research in Redlands, Calif. He died April 9, 1984 at the age of 97.

By the time the Library-Museum Building was completed in 1916, the collection had increased to approximately 5300 bound volumes plus 7000 reprints. The chief input was the gift of most of Dr. Ritter's personal library. Between 1912 and 1916, Mr. E. W. Scripps and his sister, Ellen B. Scripps, matched the amounts contributed by the University of California for the purchase of books. Lesser amounts were donated by several philanthropic citizens. Certain staff members contributed journals, reprints, pamphlets, and books.

The library collection had grown to nearly 9000 bound volumes plus about 12,000 reprints by 1925. This is when the name of the institution was changed to the Scripps Institution of Oceanography. Dr. T. Wayland Vaughan was the director. His secretary, Tillie Genter, was placed in charge of the library collection. Ruth Ragan, who joined the staff as assistant secretary in 1929, gradually relieved Miss Genter of her library responsibilities. By 1935, Miss Ragan was preparing and signing library reports. She was consientious, industrious, dependable, and loyal. Although primarily a secretary, she was in charge of the library during Dr. Sverdrup's administration. She cooperated with the Library Committee and initiated several improvements herself. However, in her zeal she worked harder at trying to protect books and periodicals from people than in increasing the usefulness of the library. She attained the rank of Librarian II in 1946 and retired in 1949.

Mr. W. Roy Holleman became the first professional librarian in the SIO Library in 1950. He was followed by Joseph Gantner in 1963 and then by William J. Goff in 1966. The latter's administration has been one of expansion and the application of more modern methods of making printed information readily available.

When I first visited the SIO Library in June 1931, the collection consisted of 12,850 bound volumes (about half of which were journals), 180 serial subscriptions, and 870 maps and charts. A good many of the serials were received from marine stations, government agencies, and other research organization in exchange for the Bulletin of the Scripps Institution for Biological Research (or Oceanography after 1924), and later the "Contributions." The Bulletin has been published continuously at irregular intervals since 1916. From then until 1926, 16 numbers were printed and distributed. The so-called Technical Series of the SIO Bulletin started in 1927 with Volume I. Volume 22 was completed in 1976.

The "Contributions of the Scripps Institution of Oceanography" is a selected collection of reprints authored by staff members, students, or visiting investigators. Presumably, Volume I consisted of 26 papers published between 1893 and 1904, the latter being the date when the Marine

Biological Association of San Diego was incorporated. Unlike Volumes 2 to 35, the original series that are now bound, catalogued, and shelved with Special Collections in the SIO Library. Volume I is not available. I have tried to determine the number and titles of papers published by marine station personnel up to 1904 from the bibliography and text of W. E. Ritter's detailed report on "The Marine Biological Station of San Diego -- Its History, Present Conditions, Achievements and Aims," (Univ. Calif. Publ. Zool. 9:137-248, 1912). Volume 2 contains reprints of qualifying papers for 1904 and 1905; Volume 3 contains such for 1906 and 1907. The papers for 1908 and 1909 are bound in Volumes 4 and 5 respectively. In 1910 two volumes (No. 6 and 7) were required for the contributions, but Volume 10 easily accommodated all of the contributions for 1912, 1913, and 1914. This was a transitional period following the transformation of the Marine Biological Association of San Diego into the Scripps Institution of Biological Research of the University of California. Also World War I was having adverse effects on the economy in America as well as in Europe. Interestingly, Volume 23 had contributions from three years: 1924, 1925, and 1926. This was also a period of economic depression as well as a transitional period involving changes in administration and the name of the Institution.

The term "Contributions of the Scripps Institution of Oceanography" was applied retroactively to the collection of reprints in 1937. Volumes No. 34 and 35 were completed in 1937. At that time, WPA assistance was used for typing new headings, preparing tables of contents, and binding the Contributions for Volumes 2 to 35. A "New Series of Contributions" was commenced in 1938. Volume I of the New Series contained 40 papers, including 7 authored by C.E. ZoBell, 5 by H. U. Sverdrup, 4 by W. E. Allen, and 3 each by W. R. Coe and F. B. Sumner. Only two copies of Volume I were prepared for library use, but in subsequent years 200 or more copies were prepared mainly for exchange purposes. Several copies of Volumes 2, 3, and 4 for 1939, 1940, and 1941 respectively, were saved for nations at war on for those to whom shipments were curtailed by the War. The number has been gradually increased until 900 copies of the Contributions were prepared in 1980. Volume 50 prepared in 1980 consisted of three parts having a total of 3745 pages. Of these pages, 59 consisted of author indices and titles of papers, 93 pages were reprints dealing with the atmosphere, biology, 1049 pages, chemistry, 483 pages, engineering, 48 pages, geology, 1106 pages, physics, 505 pages, space, 25 pages, and miscellaneous, 377 pages.

When Dr. Sverdrup assumed the directorship of the Institution in 1936, the library had 14,600 bound volumes, 18,000 reprints, 1100 maps and charts, and 330 serial subscriptions. At the time of his retirement in 1948, the number of bound volumes had been increased to 23,400. There were about

20,000 reprints, 6000 maps and charts, and nearly 500 serial subscriptions.

The reprint collection, for which I have been giving data hereinabove, should not be confused with the Contributions of the Scripps Institution. Whereas the latter consisted of reprints based on research by SIO personnel, the so-called "reprint collection" consisted of reprints from many parts of the world. Most of the papers were printed in the English language and the subject matter has been predominately various aspects of marine biology with far fewer reprints dealing with chemistry and the physical sciences. For the first few decades, the incoming reprints were filed and catalogued in chronological order. The system simplified filing, but it left much to be desired for research or information retrieval purposes. There were sporadic attempts dating from 1904 to have the acting librarian perpare an author index, but it was usually months or sometimes a year or more in arrears owing to the multiplicity of the duties of library personnel. The author index was updated by WPA personnel in the mid-1930's and a subject index of reprints was started.

In the days of penny post cards, staff members and students were encouraged to request reprints directly from authors for personal use as well as for the SIO collection. During the administration of both Dr. Vaughan and Dr. Sverdrup, either Tillie Genter or later the library and storehouse supplied stamped and printed post cards for requesting reptints. Except briefly in 1917, when the postage on post cards was doubled for a few months, stamped post cards for domestic delivery cost only 1¢ until 1952. The rates for Air Mail or overseas delivery were appreciably higher. Then from 1952 until 1955, the cost of so-called "penny post cards" increased from 1¢ to 2¢ each and the basic rate for a 1-ounce First Class letter increased from 2¢ to 3¢. Postage rates continued to incrase until at present (1980) postage for a post card is 10¢ for domestic delivery and 15¢ for overseas delivery by Air Mail wherever available. An "Aerogramme" cost 21¢. In the meantime, the cost of reprints increased from 1¢ per printed page from 1904 to 1924 up to from 15 to 50¢ per page in 1980.

Managing the reprint collection by the "open shelf" system required more attention of trained library personnel as the number of students, staff members, and visitors increased from year to year. There was almost intolerable misuse and abuse of the collection resulting in the losses or misplacement of reprints. With the addition of more and more crucial books and journals after 1950, there was less and less reliance on an active open reprint collection. In 1965, the library stopped accepting reprints. At that time, the reprint collection containing 21,029 reprints was transferred to Special Collections.

Shortly after taking charge as director of the Institution in 1936, Dr. Sverdrup requested Ruth Ragan to supervise the rearrangement of bound books in the library assisted by WPA helpers. Irrespective of library call numbers, all literature dealing with meteorology and physical oceanography was transferred to shelves apart from the predominantly biologic literature. This resulted in considerable confusion and whispered comments by all concerned. Dr. Sverdrup explained that the new and somewht unorthodox arrangement of books made it much easier for him to find what he wanted. When asked in confidence what he though of of the new arrangement, Fred Faulkner characterized it as being "more profane than profound." Fred, a WPA employee who happened to be completely deaf, was well trained in library science. As assistant to the Director, I was called into Dr. Sverdrup's office several times for confidential talks concerning the shelving of books. Eventually without any confrontations or loss of face, an open staff discussion of the catalouging and shelving of books led to the adoption of Library of Congress cards. Up until this time the Dewey Decimal System had been used.