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W. T. EDMONDSON
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A Biographical Memoir by
JOHN T. LEHMAN AND DONNA A. LEHMAN

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Biographical Memoir

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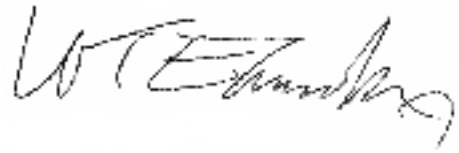

W. T. EDMONDSON

April 24, 1916—January 10, 2000

BY JOHN T. LEHMAN AND DONNA A. LEHMAN

ROBERT FOGEL, FORMER PROFESSOR of mycology at the University of Michigan and an avid reader of all sorts of biographies, once told us that there was a missing element in most of the genre that applied to scientists. "You know what I'm still looking for?" he asked. "I want to see someone explore the sources of scientific creativity and inspiration that made these people what they are, and the practices, short of magic, that made their laboratories such special places." Of course it is natural for scientists to rank such matters high on their scale of interests. We function in a workplace where reproducibility of results is the essential criterion of validity, and where the results must be capable of reproduction in the hands of any other competent scientist. When we see individuals who stand out as intellectual high points on our professional landscape, we want to know the rational pathway and ontogeny of their careers. Maybe there is practical advice or useful tips that we can apply to our own experience. The last thing we need to hear is that the man is a genius, that's all there is to it.

There is more to learn from good scientists than just how to analyze your data and how to formulate meaningful inquiries. There is this matter of the sources of inspiration and creativity that permeate their work. There is also the

question about pathways of individual development, both in intellect and in character. Edmondson makes a fine subject because he made a transition from scientist to public figure but kept his scientific credentials shiny and up to date. When we asked him why he thought he had been elected to the National Academy of Sciences, in 1973, he acknowledged that his work leading to remediation and recovery of Lake Washington from eutrophication had to be the biggest part of it. He did not think that work represented his best creative abilities in science, but it did represent the application of scientific knowledge to an environmental problem, coupled with consistent, reasoned communication and education of the general public that led to a greater public good.

The sources of information for this memoir include a series of tape-recorded interviews with Tommy and Yvette Edmondson during the mid-1990s, together with the archival materials identified in the reference list. Much of the basic account is told in the interview subject's own words or something very close to them, interspersed with our commentary.

CHILDHOOD

Where and how do scientists get their starts in science? In the case of Tommy Edmondson, influences can be found in a childhood that was rich in experience, when surroundings and events formed the raw material for a native sense of curiosity and adventure. An appetite for things interesting led him to the natural world, and the interests later took on concrete professional dimensions through interactions with extraordinary teachers.

W. T. Edmondson's earliest memories traced to the small town of Seymour, in southern Indiana, where his family moved when he was two years old, and where he spent an active childhood. Earlier than that, the family resided in

Milwaukee, where Tommy had been born in, of all places, Radium Hospital, on April 24, 1916. It is hard to imagine a medical facility with such a name ever existed, but there it was. The Edmondson family newly arrived in Seymour then consisted of mother, Marie Kelley; father, Clarence Edward; and brother, Frank, 4 years his senior. Younger brother Richard came along eight years later.

The Edmondsons and Kelleys had their ancestral roots in England and Northern Ireland, respectively, but had become transplants to the New World in the 18th and 19th century. The Edmondsons were Quakers who came to Maryland. Most of their descendents became early settlers of Ohio. The Kelleys immigrated and were settled in northern Ohio by 1835. Clarence and Marie were reared on farms where both had finished high school but had not attended college. Both parents had a very high respect for education, as did all members of the extended family with whom young Tommy came in contact. Marie had been a legal stenographer and typist before her marriage; Clarence was a route agent for the American Railway Express Company.

His first two years in Milwaukee made a lasting imprint on Tommy, reinforced by stories told to him by his mother for years afterward. The family resided on Cass Street, in the Pasadena Apartments, not far from McKinley Beach of Lake Michigan. As soon as he could toddle, Tommy and Marie toured the lake shore each afternoon. Those daily limnological excursions became such a treasured routine that when transplanted to Seymour, the youngster would charge down the street each day at walk time, only to explode in frustration at his inability to locate the lake. But there were other diversions in Seymour, and there was plenty of nature to explore. The Edmondsons lived near the edge of town at that time, and the surroundings were rich with ponds, creeks, and a river. The walks with mother to Lake Michigan became

substituted by visits to a nearby pig farm, to feed domestic scraps to the animals. The olfactory experience permitted Tommy to say later that he fully comprehended reports of lake eutrophication in which the odors of decaying algae were likened to the smell of "a foul and neglected pig sty."

Childhood in Seymour was fun, filled with lots of picnics and family reunions, but there were difficult times as well. In 1922 Marie was hospitalized for an extended time, and Tommy and Frank were sent to live with their maternal grandparents in Springfield, Ohio. The translocation lasted long enough for Tommy to attend a Montessori kindergarten, where the teachers made a point that stayed with him all the years after. The children would be given various patterns to cut out: paper dolls, images of lions, dogs, horses, and so forth. The object for each child would be to cut these patterns out and to paste them on posters. The kindergarteners were instructed solemnly that there are only two techniques for cutting. Either you must trim around the outside or you must cut right through the middle of the line, but whatever you did, you had to be consistent. The advice about consistency was generalizable, and Tommy accepted it as an axiom about the reproducibility of any scientific work.

Eventually Marie recuperated and the brothers returned to Seymour in time for Tommy to start the first grade, as well as to embark on Tom Sawyer-like explorations of the rural stretches beyond the town limits. The ponds and waterways were rich with curious inhabitants that deserved a closer and more studious look, so Tommy built an outdoor study site in his back yard. He buried an old tub in the ground, filled it with water, and populated it with creatures from his collecting trips. He favored crayfish, which would display their open claws defensively at his inspections. He also started to recognize that there were mysterious forms gliding about

just at the limits of visibility, giving hints of a strange world in miniature.

This was also a time of great travel opportunities, which came as a fringe benefit of their father's job with Railway Express. Clarence would take sons Frank and Tommy along with him on Saturday trips and whenever else they were not in school. Along the railroad, communications were by Morse code and the train crews could monitor the message traffic from the caboose as they rolled. By listening in, Tommy learned some valuable facts about the importance of spacing in any kind of communication. With practice you could tell just from the pace and pauses of the clatter who was working the keys at stationhouses up and down the line. Just as you might recognize a voice or an accent, identities were announced by the way the words and letters were spaced and metered. It had to be so, or so it seemed, because there was no other variable possible. That realization fascinated Tommy, and it enriched his appreciation for music and expression with any kind of sound.

Music was a part of daily life. There was a piano as well as a phonograph in the Edmondson home, and although no one took formal lessons, Marie could play the piano well enough by ear to treat family members and visitors to popular songs quite regularly. Clarence, too, had a flare for artistic expression that came out in his workshop and even the kitchen. He liked to make gifts for family friends that bore his personal touch. His angel food cakes were famous, taking prizes at the county fair and being much sought after at church socials. He loved to bake cakes, claiming that a secret proportion of ashes in the batter from his omnipresent cigars gave his creations their appeal.

In 1925 family life changed tragically for the Edmondsons when Clarence passed away, leaving Marie, Frank, nine-year-old Tommy, and one-year-old Dick. The loss had great

financial impact, of course, and Marie tried to compensate by turning a room of the house into a store for dry goods and notions obtained from a family friend who was a wholesaler. She supplemented the business by taking in secretarial tasks, mainly typing. Frank and Tommy found some degree of diversion and interest in Boy Scouting and summers at Camp Bedford, Indiana. Tommy accumulated his merit badges to the level of Eagle Scout, though he missed out on the ceremonial award when his family uprooted and moved to Connecticut. Camp Bedford became an annual ritual and rich source of activities through elementary school and junior high. There, Frank acquired what proved to be a lifelong vocation to astronomy. Cloudless summer nights away from distracting electric lights proved ideal for studying the stars, and no one would call the boys to bed. Frank organized and managed the open-air observatory, and he bestowed on his brother the title of assistant professor of astronomy, a title he would later grant to many others when he became department chair at Indiana University. Under Frank's instruction Tommy learned to recognize the temporal progressions of planets, stars, and constellations.

One of his earliest educational triumphs came in eighth-grade math class. It was approaching the end of the school term, of the last year that Tommy would spend in Seymour it turned out, and Mr. Ackerman, the math teacher, was outlining the types of math problems students would encounter in high school. Ackerman got into a discussion of geometry, and he drew some squares, 1 inch on a side and then 2 inches on the side, and showed the class that if you doubled the size you quadrupled the area. He repeated the lesson with all sorts of figures and different numbers until everybody got the idea that you just squared the number. And then Ackerman drew a cube 2 inches on each side. He asked somebody what it was and a fellow cried out, "Four!" Ackerman played the

moment: "Everybody who believes that, hold up your hand." Everyone held up their hand except Tommy. Tommy called out, "Eight!" and the classroom exploded. "Everyone just laughed like hell." But the teacher exclaimed, "He's right!" above the ruckus, and he explained why. It had been a dirty trick on almost the whole class, and avoiding it became one of those cherished memories from childhood that sticks with you forever, of having done something right and special. It was a thrill of personal illumination that Tommy would find repeatedly, often while seated at a microscope or pondering what he had seen through it.

At age 12 Tommy received the gift of a toy microscope, and with it he inspected the waters of his backyard aquarium. There he found his first *Paramecium*, but the instrument could not reveal much more. Over at Seymour Junior High School, however, he had access to a better microscope, and there he again inspected the water. He saw his first rotifer, but he didn't know anything about them. There was *Scaridium longicaudum* swimming through the field of view, its form engraved on his mind forever. Tommy was strongly prepared for these mysterious creatures because in the shelves of the public library he had found books that mentioned how beautiful and interesting they were, but otherwise gave no real information. Fortunately, a lucky string of circumstances would place the means to know them better within his grasp.

Seymour, Indiana, was home to an alumnus of Yale College who offered a scholarship there through the Seymour High School. There was almost no competition. Frank Edmondson declared his interest in the grand opportunity, and so he got the scholarship at the end of his senior year of high school, just as Tommy was completing seventh grade. But there were complications. Frank had not taken a course of study in Latin, and you had to have Latin in those days to be admitted to almost any good university. The word from

Yale came down. "You go to your local university, Indiana University, for a year and if you can do a good job there then you can use your fellowship here." So Frank went over to Bloomington and enrolled for his year of college preparation, by Yale accounting. In the meantime Tommy was getting interested in those little things that could now be seen in the water.

Frank roomed in a boarding house in Bloomington with other college boys, one of whom was a bright premedical student named Ross Ora. Frank explained at one point that he had a kid brother who was interested in those little things in the water, and he asked Ross if there were any good books on that subject. It happened that this premed knew about Ward and Whipple's *Fresh-water Biology*, published in 1918, which was the premier English language source of taxonomic keys, illustrations, and natural history observations. The book cost five or six dollars, which was a lot of money. But somehow Grandmother Kelley in Springfield found out about this prized book, and she gave Tommy the money to buy it for his 14th birthday. She also made for him a sturdy cloth carrying bag to tote and protect the new treasure. It was the ideal gift for Tommy, who had been yearning to find out about rotifers. The book was chock-full not only of rotifers, but also of goodies like Cladocerans and myriad other pond creatures who could now be called by name. With the help of Ward and Whipple, Tommy Edmondson found his way around the pond world.

HIGH SCHOOL

If I took you through high school, college and graduate school I would tell you that always the center of the universe was the room with the microscopes and right next to it was the library (1989).

The successful completion of Frank's probationary year at Indiana University coincided with the finish of junior high school for Tommy. The country was in the Great Depression, and things were drying up in Seymour. There weren't many ways for a single mother with three children to make a living, and Marie decided that Frank's destination of New Haven, Connecticut, would offer better prospects than the Midwest. Besides, the family would stay together. Marie found a WPA-supported job as a typist, which paid the bills. The youngest brother, Dick, started school in New Haven. Frank entered Yale and Tommy started at Hillhouse High School, bordering the Yale science campus.

Hillhouse High and the experiences growing from it became a major turning point in Tommy's life. You might say he was ripe for the opportunities that came his way, often by chance meetings or events. Microscopes came first. Tommy's appetite had been whetted in Seymour at the sight of rotifers and such, and he had not been able to sate his craving for more. After settling in New Haven and starting school, he wanted to find some place with a microscope he could use to look at pond water. Hillhouse was a big urban high school, departmentalized, and there were several biology labs. So he went down the corridor, looking into rooms, and spotted one with a woman standing in it who was obviously a teacher. There he entered and announced that he would like to be able to use a microscope to look at pond water. The woman replied, "Why is that?" The query triggered a long conversation. The teacher turned out to be Ruth Ross, and the meeting would be the first in a chain of remarkable events.

Ms. Ross did, indeed, arrange for Tommy to come in after school and use the microscopes. It was the beginning of much more; in fact, it was the starting point for a remarkable career path. Everyone who retrospects can point to one or more

events where his life could go one way or another depending on what happens at the moment. Tommy put his stock on this chance meeting with Ruth Ross over a microscope. Meeting another teacher probably would have produced different consequences and opportunities. Ms. Ross permitted free use of the lab and its microscopes, so that for months Tommy spent at least an hour every day after school looking at his collections from ponds around New Haven. With Ward and Whipple at his side he found his way not only through rotifers but also through filamentous algae, protozoa, and many small invertebrates. He particularly enjoyed looking at the creatures attached to aquatic plants, and sessile rotifers were the best for aesthetics. Tommy was practicing the skills of discovery of a naturalist. He certainly was not formulating any hypotheses.

Ruth Ross was taking courses at Yale. Many of the high school faculty took courses in their field at Yale from time to time. Ross was then taking a course in histology from Professor Wesley Roswell Coe. After she noticed that Tommy had been into the laboratory quite diligently, she asked Professor Coe if it would be alright to bring her young student over to listen to the lectures. Coe acceded. To Tommy's delight he was able to sit in on the rest of Coe's histology course. Histology proved to be a beautiful subject, structural and organized, with textbooks richly illustrated in lovely colored pictures. Coe took a personal interest in the young pupil and introduced him to Professor Lorande Loss Woodruff, the protozoologist. Woodruff introduced Tommy to his marvelous collection of classical monographs of microscopic life forms, including works by Ehrenberg, Hudson and Gosse, and others. But as Woodruff assessed the interests of the youngster he recognized that it was the man down the hall that Tommy really should see.

That man down the hall was the youngest instructor in the Department of Biology, G. Evelyn Hutchinson, newly recruited from Cambridge University by way of a stint in South Africa. Woodruff made the necessary introduction, and the two began to chat. No sooner had Tommy mentioned the word rotifer than Hutchinson produced a thermos bottle filled from a recent collecting trip, and poured some water into a finger bowl at the dissecting microscope. There was the colonial rotifer *Conochilus hippocrepis* by the thousands. Tommy later recorded his account of this defining moment in his essay "Rotifer Study as a Way of Life" (1989).

Ms. Ross had become his guide to a world of science and learning, but by his recollection, this educator with evident deep interest and respect for her pupil contributed to his enduring love of music, as well:

> Something else she did during high school years was to take me to New York to meet F. J. Myers, the rotifer man, at the American Museum of Natural History. She also took me to opera in New York. She was a pretty musical person. She had taken cello lessons from one of the cellists in the Boston symphony when she was going to college in Boston and she could do a decent job playing the piano. By that time I had gotten very much interested in organ music and Bach and we played through an awful lot of Bach music with me plunking out the pedal part down at the bass end of the keyboard and she would do the hand part. I learned enough to read the bass clef and hit notes one after another. I couldn't play chords. And we went to lots of concerts.

COLLEGE

He was never told that he had to go to college but it was presented as just the most wonderful thing that anybody could ever do. Graduate school and becoming an educator was even better. But a lot of that was just by indirection. He learned a lot by example later on. —Yvette Edmondson

Transition from Hillhouse to Yale College was seamless. Hillhouse High School had eight Sterling Memorial New Haven Scholarships for their graduates to attend Yale, and Tommy received one of them. That covered tuition for all four years. He lived at home with his mother and younger brother, and he belonged to the Sheffield Scientific School, not yet part of the residential colleges.

Tommy's college yearbook "History of the Class of 1938" followed his brief family history with an account of his academic accomplishments and future plans:

He has taken the biological science course in Sheff and belongs to Sigma Xi. Edmondson has had seven papers published on various zoological subjects in such publications as *Science*, the *Transactions of the American Microscopical Society, Archiv für Hydrobiologie,* and the *Memoirs of the Connecticut Academy of Arts and Science*. While at Yale he has lived at home. He intends to do graduate work in zoology at the University of Wisconsin and at Yale.

In truth, his home away from home had become the Osborn Memorial Laboratories on Prospect Street, where he spent his evenings at the microscope. But his new mentor, Evelyn Hutchinson, had begun to encourage him to press his quantitative skills to the limit. "Go on taking math courses until you fail one" was his advice. Tommy said that titrating his skill to the level of "C" in advanced differential equations was as far as he followed that prescription. Growing expertise with quantitative and rigidly deductive reasoning nonetheless began to move Tommy's thinking from a focus on natural history and taxonomy to questions about distributions and dynamics.

Well, it was a transition. In my trips around the ponds and collections from here and there, I began to find species that couldn't be named because they hadn't been described in the literature. So I could name them. Was it common sense or was it because I saw Hutchinson doing this or it seemed in the literature that this is what people did? If you find something new you describe it. You make it public. And you do it in a description and words

and descriptive figures. Neatly drawn, nicely realistic figures. It just seemed natural to write papers. So during my college years I wrote several papers describing new species and, incidentally, interesting things about ones that had already been described. Those began edging into the kind of ecology that had to do with where and in what kind of situations species are successful and what kind they aren't. And what I did in my Ph.D. thesis goes back to what I did in college.

The rotifers occurred in different quantities, different proportions. You notice that. Some places are better for rotifers. Some places aren't. There are relationships. There are patterns. That's the art of it. Recognizing patterns. You can't have pattern without quantity, I guess.

Hutchinson found Tommy a job during the summers of his junior and senior years with the New Hampshire Fish and Game Department doing limnological surveys of lakes over 10 acres in area. Tommy and his crewmates lived in Fish and Game cabins and crisscrossed the state watershed by watershed with truck, boat, outboard motor, and sampling gear. At each lake they tried to find the deepest spot, at which they measured light transparency by Secchi disk, and measured vertical profiles of temperature and oxygen. They also took vertical plankton tows and quantified the collections according to settled volume (1938).

GRADUATE SCHOOL

At the end of the summer of his senior year, with his B.S. in biological science from Yale in hand, Edmondson drove directly from New Hampshire to Madison, Wisconsin, in a used Pontiac that he bought in New Hampshire for $75. Christened "True Love" (true love never runs smooth), his chariot delivered him just in time to register for the fall semester so as to attend Chauncey Juday's limnology course and to begin a year of study and research at the University of Wisconsin. Hutchinson knew that Tommy wanted to do his doctoral work at Yale and he wanted Tommy to do a Ph.D.

with him. But Hutchinson thought that Tommy ought to get some different experience somewhere. Wisconsin would be a good place to go. And it was different.

Evelyn Hutchinson has described the philosophical divisions between his approach to science and that of the "Midwestern limnologists" in his autobiography *Kindly Fruits of the Earth: Recollections of an Embryo Ecologist* (Hutchinson, 1979), further documented by Cook (1977). Despite their differing approaches to science, by Tommy's personal account, Hutchinson never spoke ill of Birge or Juday.

But it was quite plain that he didn't agree with their way of working. And he was quite frank about saying that you don't get anywhere by getting a lot of data, finding there's a lot of variance and then going out and getting more. You just get more variance. He had things to say about the program of doing oxygen and carbon dioxide one year and phosphate the next year and things like that. He thought a more integrated study of a single lake would have been better.

But there was no denying that Madison and the field station at Trout Lake were among the foci of the North American limnological world, and that is where Tommy was sent to begin a sabbatical away from the Hutchinson lab.

Tommy's recollections of Juday were of "a very kind man, very, very considerate as far as I was concerned." After two semesters in Madison, Juday offered him a fellowship to work at the Trout Lake biological station during the summer of 1939, and Tommy assumed that he would get the type of job that involved rowing boats around to collect samples for the surveys that they did.

When I asked him what was I to do he said "You are to investigate the sessile rotifers of the region." I've never worked harder in my life in terms of spending every waking hour doing something. I won't say that there haven't been other times like that in my life, but there's never been any time when I spent more than 24 hours working: going to the lakes, collecting, coming back and making full identification and lots and lots of notes. Notebooks

full not only of new species but good descriptions of old ones. At one time I thought I was writing a monograph of the sessile rotifers. That never eventuated. So that was that summer. And that was the basis for a lot of my Ph.D. dissertation because my dissertation has a lot of data I published in Ecological Monographs about the association of species. How many times this species occurs with others and with the different substrates. Much of that came from Wisconsin. It's clear from the paper how much came from Connecticut and how much came from Wisconsin.

Tommy originally had applied for an assistantship in Madison for the fall and winter semesters during the 1938-1939 academic year but initially did not get one because first choice went to Wisconsin residents. But by the time he arrived a shortage had developed and he was luckily able to claim a teaching assistantship. It was during his first term in Madison that he met his future wife, Yvette Hardman. Yvette had received her undergraduate degree from Bennington College, and then moved on to Minnesota where she earned an M.S. in microbiology. She arrived at Madison the same time as Tommy, with the goal of a Wisconsin Ph.D.

They were both in Juday's course, but they never spoke until a couple of months into the semester when she met him in the hall. They were both going to a seminar and Tommy said, "Where is room so and so?" Yvette replied, "It's the room we've been meeting in all term." She joked that she married him to make sure he didn't get lost for the next 60 years. She used to refer to him as "the Yale Hayseed" because "he came from this classy eastern college but he obviously had hayseeds in his hair," a vestige no doubt of his boyhood in southern Indiana. But her fascination grew at Juday's final examination when this bucolic Son of Elihu shuttled repeatedly back and forth to collect fresh blue books only to cram them with voluminous answers. Then, too, he owned a car, a phonograph, and a unique collection of records, including Bach organ music.

In fall 1939 they would separate for a year, Tommy returning to New Haven and Yvette staying on at Madison, until 1940, to complete her Ph.D. in the Department of Agricultural Microbiology. They wrote, although Tommy averred to being a better correspondent than Yvette. Upon receipt of her degree, Yvette returned to her alma mater in Vermont to replace one of the science faculty who was taking a sabbatical. After her first year as a fill-in she accepted the offer of a three-year appointment on the faculty. She commuted regularly by bus to New Haven to visit. The couple married in 1941 shortly before America would join the war.

It was during this period that Tommy made a chance observation that would have profound consequences. He was collecting the bladderwort *Utricularia* because he knew it was a perfect habitat for the sessile rotifer *Floscularia conifera*. *Floscularia* fashion their tubelike dwellings by stacking up pseudofeces in small pellets. Tommy noticed that all but the smallest animals had a dark band around their tubes. It occurred to him that it had rained the night before and that those pellets must have been made while the water was muddy (1989). The smallest animals, without the dark rings, must have settled after the storm. Aha! What if he were to create an artificial cloud of, say, carmine particles? The animals might lay down an unambiguous time marker and open the way to studies of growth rate, recruitment, and other population dynamics. It worked (1945). That brainstorm led in turn to the idea that the sequential arrangement of eggs within the tube coupled with rates of egg development might hold the key to deciphering birth rates in situ. But that next idea would have to gestate for nearly two decades, awaiting the right opportunity to test it.

Tommy's preliminary exams had been scheduled as four-hour sessions on four successive days, Monday through

Thursday. His wedding to Yvette followed immediately on Friday. Tommy explained, "I didn't want to be distracted." There was a scheduling conflict nonetheless.

I had been sitting in on Ralph Kirkpatrick's courses of harpsichord. He was giving courses in the School of Music as a visiting professor of music and he let me sit in. But since I was going to miss the Friday class that time, I thought I would explain to him why I wouldn't be there. For years after he took great delight in telling people that I had asked his permission to get married.

It was uncommon for graduate students at Yale to be married, and to have a commuter marriage at that. It took three different buses to get from Bennington, Vermont, to New Haven, but Yvette made the trip regularly, if not religiously. She was there in New Haven on December 7, 1941, in bed before a delightful fireplace according to Yvette, both of them listening as the New York Philharmonic performed the Emperor Concerto of Beethoven when the program was interrupted in its last movement with the news that the Japanese had bombed Pearl Harbor. Tommy was infuriated. Not until the broadcasters repeated the musical program with the same pianist to an uninterrupted conclusion seven years later would the indignity subside.

THE WAR

Perhaps it is not surprising at a time of war, but the young couple gave little thought about what to do when Tommy finished his degree. In June 1942 he defended his thesis in New Haven and took his typewriter to Bennington, intending to prepare manuscripts for publication. He was even offered a contract appointment at Bennington College with a start date of July 1. But before he could begin, he was approached by Albert Parr and whisked away for a top-secret assignment by the U. S. Navy. Parr had been head of the oceanography

department at Yale and had just been selected to be head of the American Museum of Natural History in New York. The navy had engaged Parr to head a secret research project, but there was a problem. Parr was Norwegian, and as a noncitizen he could not get the clearances to receive a briefing or see the research dataset. The project was going to involve quantitative analysis of wave height and surf to help the navy predict wave conditions in various parts of the world. Having passed his course in differential equations, Tommy found himself declared a physical oceanographer. He would have to move to New York, and again Yvette would become a commuter. But the salary was $5,000, huge for a newly minted Ph.D. in those days.

Edmondson headed off to Washington, D.C., to receive a briefing from John Bardeen, the future Nobelist of transistor fame. Bardeen explained that there was a big rush, so there was no time to set up any new research. The project would consist of a literature search for all that was known about wave height and surf and wind conditions. It had to be completed within a year.

> So this outfit consisted of one small room in the American Museum and I hired an assistant. We bought the very latest model Monroe mechanical calculator to do all this fancy statistical work. And she's out there plugging away at that hour after hour. And I'd be looking at maps and measuring things. It was totally ridiculous because what can you do? We got a lot of different things about wave height and empirical formula relating wave height to fetch and all that. So this thick report was finished and as far as I was concerned totally useless. We did what we were asked to do.

Project complete and still a civilian working for the Navy, Tommy moved to Woods Hole Oceanographic Institution, which had become a congregating point for Yale graduates and faculty doing research relevant to naval warfare. One of us (J.T.L.) described his sea- and air-going, depth-charging exploits in support of Maurice Ewing's SOFAR zone research

in a previous account (Lehman, 1988). He wasn't doing rotifer studies but he was doing scientific work of an interesting kind, and in the company of very interesting people. Throughout the war Yvette remained at Bennington, and the couple shared infrequent visits. When peace returned and conditions seemed stable, however, she quit Bennington and moved to Woods Hole to join Tommy in a research project that would ultimately provide important clues about Lake Washington's response to nutrients.

AFTER THE WAR

George Clark invited Tommy to stay on at Woods Hole for a while to join him in a study of marine productivity. Together they built some concrete tanks and fertilized them with nitrate and phosphate, stirring and sampling them each day. They found a small estuary with little tidal exchange that they fertilized as well, with the goal of enhancing oyster production. When Yvette arrived, she worked on the response of the oysters to the food supply generated by fertilization while Tommy concentrated on responses of primary production and population structure (1947).

This was a time of transition. The legions who had gathered during the war were starting to disperse, and Tommy began to assess his prospects as well. He learned of an opportunity at Harvard to help launch a new teaching approach that would offer introductory biology to all entering students. That seemed interesting, so he accepted a position as lecturer in September 1946 and joined Edward S. Castle in a team effort, with Tommy accepting primary responsibility for some lectures and most of the laboratory sections. He and Yvette returned to Woods Hole in the summer but he had already concluded that he did not want to work with marine systems. His love was limnology, and unfortunately the habitats around Cambridge did not offer the range of

opportunities he craved. There was Walden Pond, of course, but Thoreau had already taken care of that. So he was primed when he received a notice that the Department of Zoology of the University of Washington at Seattle was planning to hire three junior faculty, including an invertebrate zoologist with freshwater interests. Tommy pulled out an atlas of the state and discovered a series of promising-looking lakes along the coastal plain, including Lake Washington, which he recognized from the work by Sheffer and Robinson (1939). But then, peering east of the mountains into the Grand Coulee he was fascinated to see a lake at the closed end of a drainage called Soap Lake. That did it. He sent a letter of application supported by letters of recommendation from Hutchinson and others.

Some weeks later the University of Washington zoology search committee sat down with a large stack of applicant folders before them. They gave each file a scan, made a few remarks, and tossed it in the waste basket. Tommy's file had just been tossed away when Arthur Whiteley jumped to his feet and exclaimed, "Wait! I know that guy." Whiteley had been a graduate student at Madison before the war and attended Juday's limnology class with Tommy in 1938. Evidently Tommy had made an impression on somebody other than Yvette.

In those days the universities were not in the habit of bringing applicants to campus for interviews; instead a representative of the department would make a tour of prospective candidates and conduct interviews in the field. That duty fell to Arthur Martin, associate chair. Martin arrived at Harvard a few hours earlier than he had arranged but managed to track down Tommy in the library. They interviewed in the stacks, and Martin agreed on the spot that Tommy could be the department's limnologist.

UNIVERSITY OF WASHINGTON—EARLY YEARS

Tommy's research interests during his first decade in Seattle were not directed at the large lake bordering the campus. Instead, he formed a strong interest in Hall Lake, a small but deep lake where ammonium and bicarbonate that accumulated at its depths from respiration and decomposition inhibited full vertical mixing in a phenomenon called biogenic meromixis. And he indeed gave his attention to the endorheic (internal drainage) region of the Grand Coulee, particularly to Lake Lenore and Soap Lake. But his first doctoral students, George Anderson and Gabriel Comita, chose to complete their Ph.D.s on Lake Washington, studying phytoplankton and zooplankton, respectively. Anderson later joined the oceanography faculty at Washington, but his experience with the lake proved seminal. While lazing in his sailboat during the summer of 1955, Anderson reckoned that the lake did not resemble the conditions he recalled. Using a sampling vessel of opportunity, he filled an emptied Rainier beer bottle with surface water and brought it to Edmondson. There it was: a virtual monoculture of the cyanobacterium *Oscillatoria* (now *Planktothrix*) *rubescens*, a harbinger of cultural eutrophication.

The discovery of an indicator species not previously seen in the lake opened new dimensions of curiosity and anticipation. Tommy knew that the appearance of *Oscillatoria* had presaged the onset of nuisance algal conditions in Lake Zurich as well as the string of lakes at Madison, Wisconsin. Lake Washington was poised to deteriorate in classical style owing to its increasing load of nutrients from secondary-treatment wastewater discharges. He felt he knew what was going to happen, and so he did what he said scientists were supposed to do. "Find things out and tell people about them. And have them printed somewhere." He announced his predictions in the October 13, 1955, *University of Washington*

Daily ("Edmondson Announces Pollution May Ruin Lake"), describing the likely events foretold by the appearance of *Oscillatoria*. He defined his own interest as observing and analyzing the transitional nature of the lake and adding to the research done in Germany and Switzerland (Lehman, 1988). He followed up with a publication in the first issue of the new journal *Limnology and Oceanography* (1956), and with additional acts of public education (see below).

Before immersing his laboratory in the study of Lake Washington, however, there was the unfinished business held over from his doctoral studies. His work with *Floscularia* gave him the idea that if development rates were known, birth rates could be deduced from the ratio of eggs to females (hence the egg ratio method). He articulated the theory in 1946, complete with proposed experiments (1946), but he had not found the right place and time to put theory to practice. Then, too, before moving to Seattle he had accepted editorial responsibility for producing a new edition of his beloved Ward and Whipple, and that opus was not finally completed until October 1958.

With the aid of a Senior Postdoctoral Fellowship from the U.S. National Science Foundation, Tommy at last headed to Europe, to the great limnological centers at Windemere, Uppsala, and Pallanza. Pallanza became his primary focus. There, Vittorio and Livia Tonolli offered living quarters within the institute building so that Tommy could monitor his experiments day and night, using state-of-the-art temperature control equipment. The monograph he completed based on those experiments (1960) made the power of his theory abundantly clear and helped to foster a revolution in zooplankton ecological studies during the next two decades (Lehman, 2000a).

LAKE WASHINGTON AND BEYOND

Tommy's studies of Lake Washington earned him the Cottrell Award for Environmental Quality in 1973, and his election the following day, his birthday, to the National Academy of Sciences. But as we stated earlier, he did not count his Lake Washington work among his finest intellectual achievements (Lehman, 2000b). His pride was reserved for his *Floscularia* experiments, for conceiving the egg ratio method, and for the future insights thus enabled. Yet Lake Washington is one of the great case studies in the revolution of thought about lake management and purposeful manipulation of lake ecosystems that swept the world in the 1970s and 1980s (1991; Lehman, 1986). The simple brilliance was in Tommy's recognition that the deterioration of Lake Washington was not inevitable. He liked to say, "Death is irreversible, not so eutrophication."

It occurred to Tommy that the river flow entering Lake Washington gave it a flushing time of less than three years, and that the mild Seattle winters allowed the lake to mix thoroughly for many months each year. He invoked a simple, first-order quantitative solution to the problem and concluded that the lake could recover within six years if the sources of nutrient pollution could be removed (Lehman, 2000b). There was also sophisticated recognition of the roles of oxygen, iron, and redox chemistry in the mobilization of phosphate, but the key realization was that people would see tangible improvement in a relatively short time. He took these ideas to political leaders and to the general public in a series of lectures, interviews, and letters to the editor. He began to work within the political process but did not become politicized. He worked tirelessly to explain scientific principles behind the environmental issues with a belief that participatory democracy requires an educated public. His faith was rewarded in 1958 when metropolitan area citizens

voted to divert all wastewater effluent from the lake in what at that time was the most costly pollution control effort in the nation, at about $2 per month per household (Lehman, 1986). The grand project began in 1963 and was completed in 1968. Lake Washington recovered so convincingly that in 1971 Edmondson was able to claim a wager made some years earlier with Karl Wuhrmann, a skeptical Swiss colleague, during their society's triennial congress in Leningrad.

With the help of the National Science Foundation and later the Andrew W. Mellon Foundation, Tommy continued to study Lake Washington even after his official academic retirement in 1986 (Lehman, 2000c). But tragically, on a rainy return drive to Seattle from a meeting in eastern Washington in 1999, Tommy took a false turn in the Cascade Range and plunged his Saturn down a cliff, with Yvette at his side. Yvette suffered broken ribs, but Tommy's neck was broken and he was paralyzed. He succumbed to pneumonia the following January.

When selecting Seattle for his academic home, Tommy looked for a place where he could reproduce his youthful experience of watching pond water and its denizens change by degrees day to day. He must have succeeded beyond his dreams with Lake Washington. By the time of his death he had assembled an archive spanning 49 years in the life of the lake (2003). In the final analysis the comprehensive nature of that dataset in all of its physical, chemical, and biological detail is a fitting gift to science and an extraordinary testament to the value of long-term ecological observation. The man who loved the rhythms of Bach's fugues with their structured repetitions and variations on a theme found in the seasonal progression of lake biota a living analogy to his musical passion. His close, continual inspection of the data as they grew is explained by his parting advice: "The trick is to recognize

that a change is occurring before it is all over so you can do the field work to show what really happened."

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