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Three generations of limnology at the University of Wisconsin–Madison

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Introduction

Many scientific roots for limnology in North America lie in Wisconsin. The first two generations of limnology are the 'Birge and Juday' generation and the 'A. D. Hasler' generation. General information and history of these generations can be found in NOLAND (1950), BROOKS et al. (1951), SELLERY (1956), FREY (1963), BECKEL (1987), and EGERTON (1987); most information presented herein on these generations came from these sources.

The transition from the first generation to the second at Wisconsin is easy to identify. The first school declined through aging, death and the pressures during World War II, and a second, very different school emerged. Birge and Juday focused on how lakes work and on comparisons among lakes, while Hasler focused on experimental limnology and on fish. Each of these generations lasted for about 40 years; Hasler was 57 years younger than Birge and 37 years younger than Juday. The present group at Wisconsin is closer in age; age structure is stable and any temporal transition among people and approaches is fuzzy.

The arena for the Wisconsin limnologists was and is primarily the lakes of southern and northern Wisconsin and the University of Notre Dame site in the Upper Peninsula of Michigan. Most research has been on the Yahara lakes, including Lakes Mendota and Wingra in urban and agricultural drainages, and on lakes in the Northern Highland Lake District including Trout, Crystal, and Peter and Paul Lakes in forested catchments. The Hasler generation and the present limnologists also studied Lakes Michigan and Superior since the late 1960s, when the University of Wisconsin became a Sea Grant College. The present limnologists also study the rivers, streams, and wetlands of Wisconsin.

The purposes of the present assessment were to briefly present some of the salient features of the first two generations of Wisconsin limnologists, and to reflect on some of the scientific roots and directions of the present group at the Center for Limnology. This small contribution is made in full recognition that limnology has many scientific roots and as a science is flourishing at many sites around the world (see for example ELSTER 1974, and others).

First generation – Birge and Juday

Edward A. Birge (1851–1950) began limnology in North America more than 100 years ago and was among the founders of the field globally. Chancey Juday (1871–1944), Birge's close colleague in research, taught the first limnology course at Wisconsin, was the first president of the American Society of Limnology and Oceanography, and produced the first set of graduate students including Hasler, who led the second generation.

Interestingly, the first published book relevant to Wisconsin's lakes was by Louis Agassiz who published a book on Lake Superior fish and geology in 1850 (AGASSIZ 1850, LURIE 1960); Birge later was to study briefly under Agassiz at Harvard before coming to Wisconsin, and was Agassiz's last student (SELLERY 1956).

Like many leaders or founders in a field they, like François Alphonse Forel on Le Léman Switzerland (EGERTON 1962), published prolifically. Birge and Juday produced many early limnological papers from 1895 to 1941; they co-authored about 1500 pages mostly in the Transactions of the Wisconsin Academy of Sciences, Arts & Letters. They had many interdisciplinary colleagues across the campus, but had only 13 graduate students.

Birge, in popular essays, referred to the physical, chemical and biological processes as the 'housekeeping' in a lake or 'house' (SELLERY

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1956). In many respects the metaphor 'house' resembled that of the 'microcosm' pioneered by their contemporary Stephen A. Forbes in his paper "A Lake as a Microcosm" (FORBES 1887). Birge and Juday's early studies were interdisciplinary in that they packaged biological, chemical, and physical limnology of a lake as an entity, i.e., a microcosm, a house. Later, the same properties were studied in more than 500 lakes in the Northern Highland Lake District. A quote (BECKEL 1987) that in many ways characterizes their approach is "If enough data are gathered, the data will speak for themselves." Unfortunately, their extensive comparative studies in the northern lakes were not fully synthesized before they died.

Birge became interested in the crustacean plankton in a small pond while a student with Agassiz at Harvard, and these interests persisted from his earliest years in Wisconsin. He was a strong teacher and eventually chaired the Zoology Department, became dean of the College of Letters and Sciences, and acting president of the University. He became very busy. Hattie Bell Merrill, an assistant professor in the Zoology Department, ran his zooplankton laboratory and collected zooplankton across South America in the early 1900s prior to her death in 1915 (HARTRIDGE 1997).

Birge also brought Juday to Madison from Indiana University in 1900 to conduct research in the Natural History Section of the Wisconsin Geological and Natural History Survey, but it was not until 1905 that Juday's health allowed him to be very active at Wisconsin. In 1909 Juday was the first to teach Limnology at Wisconsin. He collaborated with Birge in research papers beginning in 1908, and by the time the program was going strong at Trout Lake in the 1930s, Juday was the primary research leader; he was the director of the Trout Lake Station in the Northern Highlands from 1925 to 1941.

In 1885 Birge was described by a student F. A. Pike (SELLERY 1956) as follows: "My zoology teacher is the smartest man I have. His name is Birge, not only is he an excellent lecturer and thoroughly acquainted with his subject, but he seems to know Greek and Latin, and is well brought up in all modern literature. He is a small black-haired man with bright eyes, and is energetic. He is a man who does not talk without saying something. He is just and his advice, I think is sound." MORTIMER (1956) describes his major limnological contributions: "he will be chiefly remembered because he laid bare the mechanics of stratification, and showed (with Juday) how the living processes of photosynthesis, respiration, and decay combined to produce a concurrent stratification of the dissolved gases" and "for their chemical analyses and crop estimates of plankton" and "the extensive survey of water chemistry and plankton in northeastern Wisconsin".

Second generation – Hasler

Arthur Davis Hasler (1908–2001) was hired and came to the University of Wisconsin at Madison in 1937 as an instructor while Birge and Juday were still active and while Juday was in charge of the Trout Lake Station. Birge and Juday did not nurture or foster Hasler as the future for Wisconsin limnology. By the time Birge and Juday had died, so had the limnology program they had created and developed. The transition to the second generation was not one of building on tradition and passing the wand (EGERTON 1987). Hasler had a background in physiology as well as limnology. He decided not to follow in the traditions of the first generation, but rather to move in new directions such as experimental limnology, applied limnology, and fish ecology and behavior.

Hasler initiated research projects in experimental whole-lake manipulations; he did these primarily at the University of Notre Dame properties in the Upper Peninsula of Michigan. He had been exposed to what he thought of as very primitive whole-lake experiments in 1933 (BECKEL 1987) while he was a graduate student working at Trout Lake with Juday. His best known whole-lake experiment was the liming of Peter and Paul Lake in the 1950s. He divided this hourglass-shaped dystrophic lake in half and limed one side. One side was treated and the other served as a reference. The treatment was maintained for many years by a succession of graduate students.

Fish were a major part of Hasler's vision of limnological study. His best-known science is on the homing behavior of anadromous Pacific salmon. He discovered that salmon use olfaction to find their natal stream and that they are imprinted to the odor of that stream as young fish before they migrate to the ocean. During these investigations he also determined that fish discriminate stream odors, that they have sun compass orientation in open water, and that artificial imprinting could be used in fisheries management. This fish behavior research was probably instrumental in his nomination to the U.S. National Academy of Science.

Hasler, like Birge and Juday, had many collaborators across the biological, chemical and physical sciences. He must have been influenced by a professorial colleague, Aldo Leopold, whose writings (MEINE 1988) did much to stimulate individual responsibility for conservation in North America. Hasler was a strong advocate for the idea that cultural eutrophication is reversible, and he worked hard in the Madison community and the State to have the sewage diverted around Lake Mendota. He taught responsibilities for 'our' waters both in courses he taught (limnology, ecology of fish) and to his graduate students. Hasler, unlike Birge and Juday, mentored many graduate students; 53 Ph.D. students received their degrees with him.

He was an institution builder; he obtained the funds to build two new research laboratories to facilitate and catalyze limnology at the University of Wisconsin–Madison. One was built on the shores of Lake Mendota (1962–1963) and a second on the shores of Trout Lake in the Northern Highlands (1966–1967). These physical structures did much to maintain and stimulate limnological research at Wisconsin.

Hasler fostered international science and limnology. His stories of interactions with Karl Von Frisch after World War II (BECKEL 1987) and how he helped Kuznetsov get his paper (KUZNETSOV 1968) on biogeochemical cycles published in Limnology and Oceanography from behind the Iron Curtain are especially enjoyable.

Hasler retired in 1978 and continued to come into the Lake Mendota Laboratory daily into his 90s. In contrast to the rocky transition from Birge and Juday to Hasler, the traditions and facilities were passed responsibly by Hasler to the present limnologists with care and interest.

The present

The recent development of limnology at Wisconsin probably parallels similar changes at many limnological institutions around the world. Our present program is, in many ways, a response to the activities in the global community of limnology and ecology rather than a linear descent from Wisconsin's first two generations. Yet, there are roots that have come, in part, from our own institutional history.

From Birge and Juday we continue to study the 'housekeeping' of lakes as entities under the terminology of in-lake processes and ecosystem structure and function. Studies of new processes and more complex interactions are apparent. In a manner similar to Birge and Juday and the lake districts they chose to study, we continue to take advantage of a comparative approach using the myriad of lakes in the region that seemingly serve as an ecosystem 'museum' of type specimens. As elsewhere, comparisons are focused on new questions and are analyzed with more powerful computing and statistical methodologies. Like Birge and Juday, we continue to pay attention to the geological origin and setting of the limnological systems.

From Hasler we continue to depend greatly on the use of whole-system experiments to unravel limnological mechanisms. The perspective remains, here and elsewhere from the earlier whole-system experiments, that limnological systems are sufficiently complex that they must be studied intact. As at other institutions, smaller grain experiments are carried out with enclosures (limnocorrals) and other such devices to examine a greater range of limnological drivers. Questions have evolved to include anthropogenic forces such as acid rain, fish and water quality management by stocking predators, dam removal on rivers, pollutants, and

watershed inputs, and to more complex limnological interactions such as those in foodweb dynamics, climate change and variability, and habitat structure in the littoral zone. From Hasler we continue a strong tradition in fish as a part of limnology, but studies have become more ecological and consider fisheries as well. From Hasler, as well as from the broader changes in our science, we mix fundamental studies with their applications and we have a feeling of responsibility for the water environments.

Limnology has evolved greatly in the last 30 years around the globe and at Wisconsin. New elements are being incorporated into limnological programs. In our case, the primary new elements are the incorporation of (1) long-term regional ecology of lakes and lake districts including the landscape in which lakes are imbedded, (2) ecosystem theory and modeling of interacting limnological processes and the interaction of waters with land use in their catchments, (3) river and wetland ecology into what had been Wisconsin's early tradition on the limnology of lakes, and (4) a human and social science perspective to increase our understanding of limnological systems in a human dominated world.

Other, more operational changes, necessary for the growth in the science, include institutional changes and increases in funding and human resources. For us, a significant step occurred in 1983 when the Center for Limnology was established to give an institutional identity and a more efficient administrative structure to the 80+ years of limnological programs at the Lake Mendota Laboratory and the Trout Lake Station. This change opened the way for significant growth in faculty, program, and facilities during the 1980s and 1990s. The present faculty members are Steve R. Carpenter, James F. Kitchell (Center Director), John J. Magnuson (emeritus since 2000), Emily H. Stanley and Jake Vander Zanden. All are faculty in the Department of Zoology but serve in interdisciplinary graduate programs such as the Limnology and Marine Sciences Graduate Program and the Water Resources Management Masters Program. Many other faculty across the university provide the breadth and depth required for limnology at Wisconsin today. In addition, the Center has a permanent staff of Ph.D.-level researchers: Thomas M. Frost (deceased in 2000) who was Associate Director of the Center responsible for the Trout Lake Station, Timothy K. Kratz who is Trout Lake site manager for the Long-Term Ecological Research Program, and Barbara J. Benson who is the data and information manager for the Long-Term Ecological Research Program. In 2002, Tim Kratz is responsible for the Station and James A. Rusak is the Trout Lake site manager for LTER.

"History provides a context to help us understand the present and insights to help us shape the future." (MAGNUSON in BECKEL 1987) I still believe this; I like to think that the present limnologists at Wisconsin have been shaped significantly by the history and the roots of the 'Birge and Juday' and the 'Hasler' generations of Wisconsin limnology. It is a gift that I personally appreciate very much.

Conclusions

Today, our individual limnological endeavors and institutions around the world benefit from an international community of colleagues. Birge stated in 1936 that Juday "was the first and for years the only limnologist in the country, and we knew the fact though we did not discover the word for a good many years." (Birge 1936 "A House Half Built", quoted in BECKEL 1987). The word 'limnology' had been christened in 1892 by Forel (FOREL 1892). Forel and Birge both viewed limnology as the study of lakes, which is not surprising because both lived in small cities on the shorelines of lakes (Lakes Geneva and Mendota). They were two of the rare, early colonists of a new science who operated independently of each other. Limnology has changed in the last 100 years, not only its definition, but also in the type and range of questions, the technology of our tools, the number of participants, growth in educational and outreach activities, the ease of communication, and the diversity of our histories and intellectual roots. One way that 'SIL' can and does play an important role in fostering limnology is by enriching the knowledge of our collective histories and scientific roots.

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