Wisconsin Academy review. Volume 26, Number 1 December 1979

Madison, Wisconsin: Wisconsin Academy of Sciences, Arts and Letters, December 1979

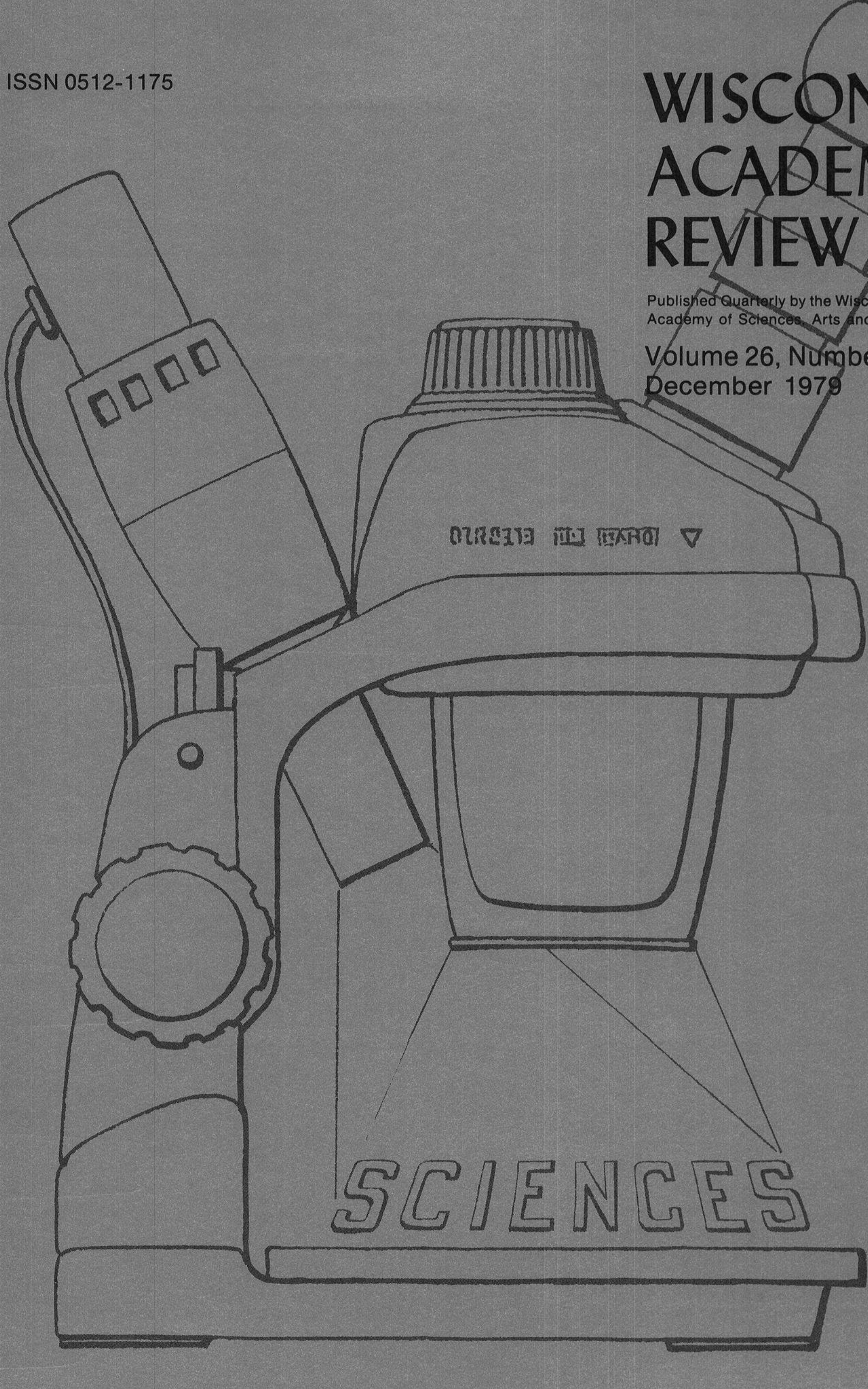
https://digital.library.wisc.edu/1711.dl/M7VWMQPYN447R8P

ISSN 0512-1175

WISCONSIN ACADEMY REVIEW

Published Quarterly by the Wisconsin Academy of Sciences, Arts and Letters.

Volume 26, Number 1
December 1979



A CATALYST AND CLEARING HOUSE

"In these days of increasing specialization, I suspect that it does an entomologist good to talk to a Shakespearean scholar. And the Shakespearean scholar may well benefit from his talk with the entomologist."

So spoke then UW President E. B. Fred at the Academy's 83rd Annual Meeting held April 24, 1953. His address reaffirmed the usefulness of the "free and unguarded exchange of information, ideas and opinion" among humanists and scientists. That address, still timely now, after 25 years, appeared in the first issue of the *Wisconsin Academy Review*.

Walter E. Scott and his wife Trudi brought out that first issue of the *Review*, printing 600 copies at an estimated cost of $220, exclusive of postage for distribution.

Said Scott in that issue, "Unless this type of publication is desired by members of the Academy and found worthy of support by the people of the state, it must either be reduced in size or abandoned."

The *Review*, both desired and found worthy, was neither reduced nor abandoned. We would like to feel it is still meeting the goals stated by Scott in that winter 1954 issue: "The obvious purpose for this publication is to build the Academy's membership strength and increase its potential service to the state as a catalyst and clearing house for all worthy activities in the fields of sciences, arts and letters."

We hope the entomologists and the Shakespearean scholars agree.

—Elizabeth Durbin

REVIEW STAFF

Publisher .... **James R. Batt**
Editor .... **Elizabeth Durbin**
Editorial Assistant .... **Elisabeth Holmes**
Circulation Manager .... **Sue Davis**
Poetry Consultants: James Stephens, Arthur Hove, Mark Lefebvre, and Edna Meudt.

ACTIVE	**$15 annual dues**
SUSTAINING	**$20 or more contributed annually**
FAMILY	**$20 annual dues (Husband & Wife)**
ASSOCIATE	**$5 annual dues (Students only)**
LIFE	**$200-$500 in one lifetime payment**
PATRON	**$500 or more in one lifetime payment**
CONTRIBUTING	**$500 or more contributed annually**
LIBRARY	**$15 annual dues**

MEMBERSHIP AND SUBSCRIPTION INFORMATION

Your membership will encourage research, discussion and publication in the various areas of the sciences, arts and letters of Wisconsin. Please send dues payment, along with name and address to: W.A.S.A.L., 1922 University Avenue, Madison, WI 53705. Academy members receive the annual TRANSACTIONS; the quarterly REVIEW; the bimonthly newsletter, TRIFORIUM; and occasional monographs or special reports. Members are invited to submit manuscripts for publication consideration or for presentation at Academy meetings.

The REVIEW is also available by subscription at $10.00 per year. Additional copies are $2.50 each.

The Wisconsin Academy of Sciences, Arts and Letters is affiliated with the following organizations:

- **Association of Academies of Science**
- **American Association for the Advancement of the Humanities**
- **American Association for the Advancement of Science**
- **Educational Press Association of America**

EDPRESS

THE WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS

The Wisconsin Academy of Sciences, Arts and Letters was chartered by the State Legislature on March 16, 1870 as an incorporated society serving the people of the State of Wisconsin by encouraging investigation and dissemination of knowledge in the sciences, arts and letters.

Published quarterly by the Wisconsin Academy of Sciences, Arts and Letters, 1922 University Avenue, Madison, WI 53705.

Correspondence related to the REVIEW or other Academy publications (change of address, single copy orders, undelivered copies, Academy membership) should be sent to the W.A.S.A.L. office listed above.

Second class postage paid at Madison, WI.

Printed by Community Publications, Inc. McFarland, WI

The date of this issue is December 1979.

WISCONSIN ACADEMY REVIEW

Published Quarterly by the Wisconsin Academy of Sciences, Arts and Letters.

Volume 26, Number 1
December 1979

CONTENTS

ON THE COVER . . .

Ronald Daggett, cover artist for the anniversary issues, is both scientist and artist, an especially felicitous combination. A professor of engineering at UW-Madison, now retired, he heads his own plastics firm in Verona. Perhaps his most publicized achievement in plastics was the development, with Dr. Vincent Gott of UW-Madison, of a heart valve for implantation in humans with faulty hearts. With new developments in heart surgical techniques, artificial valves are no longer as widely used as they once were, but Daggett and Gott can take credit for ushering in the era of exciting developments in Wisconsin in the new field of bioengineering.

A watercolorist, who finishes his work at the site, Daggett spends weekends and vacations visiting small towns where he sets up his ingeniously-designed (by him) combination seat and easel before an evocative village street scene, an old mill, a harbor busy with boats or a railroad yard. When he repacks his easel/seat/suitcase to leave, he has usually not only made a picture but a new friend or two as well.

25th

ABOUT THIS ISSUE . . .

This first in the four-issue 25th anniversary series of the *Wisconsin Academy Review* is devoted to science and focuses, as the 25th anniversary committee decided it should, on the past, the present and the future. We wanted not only to feature people closely associated with the Academy's history, but also to bring that history up to date and indicate directions the future might take.

So much of the Academy history is associated with men and women who were great scientists and great teachers. This theme runs throughout the issue. The example of a great teacher, whether in a high school chemistry classroom or before a world audience, is a great possession.

"Great Possessions" is the title **Nina Leopold Bradley** gave to the reminiscences of her father, Aldo Leopold, written by members of the family. "Great Possessions" also was the title Leopold himself gave to the book that became *Sand County Almanac.* Leopold died before that book came out and before the first issue of the *Wisconsin Academy Review* was published in 1954. But in the second issue of the *Review,* Joseph H. Hickey reported on the organization of the Aldo Leopold Memorial Trust by the Kumlien Club of Madison, "in memory of the great Wisconsin teacher, scientist, writer, and conservationist whose life was dedicated to the preservation of plant, wildlife, and other natural resources for the beneficial use and enjoyment of the whole people." The club conveyed to the trust a 40-acre tract of woodland in the Baraboo hills to be retained as a natural area "memorializing the great Wisconsin leader who died in 1948."

All of the five Leopold children have received bachelor's degrees from UW-Madison; four of them later received PhDs and three have been elected to the National Academy of Science.

A. Starker Leopold is a professor with the Museum of Vertebrate Zoology at the University of California at Berkeley. **Carl Leopold** is now a plant physiologist at Cornell University, Ithaca, New York. **Charles Bradley**, a retired geologist, and his wife, Nina Leopold Bradley, living close to The Shack, direct the research at the Leopold Memorial Reserve.

Paul Thompson undertook the time-consuming research and writing of the article, **"The Boy Astronomer of Cottage Grove,"** because he just got interested. He stumbled upon the story of John Mellish while working on another project, followed some intriguing leads, established contact with Mellish's daughter in California, and completed a biography of an almost forgotten, self-taught scientist.

Thompson brings a broad background of experience to his own Editorial and AV Service, which provides editorial, photographic and consulting services to individuals and organizations. His clients include state and private associations for whom he prepares brochures, press releases, reports and newsletters. In addition, he writes newspaper and magazine articles, educational materials such as film strips, and books for young people. A novel for teenagers is being published this spring by Franklin Watts.

Hector F. DeLuca

Hector F. DeLuca, who wrote about **"The Vitamin D Story,"** outlining his own and Harry Steenbock's research, did his PhD work with Professor Steenbock, one of the Academy's most important benefactors, on the relationship between vitamin D and alkaline phosphatase.

DeLuca has published over 450 scientific papers, has over 100 patents issued or in progress, and has received awards, literally too numerous to mention, from this and other countries. He is a member of the National Academy of Science.

Dr. DeLuca was born in Pueblo, Colorado and attended a small country high school of about 80 students. He enrolled at the University of Colorado on scholarship and in 1951 received his BA with honors in chemistry.

His several hobbies are an interesting reflection of the man. He enjoys keeping his 130-acre Iowa County farm in order; he builds and sails catamarans on Lake Mendota, is an avid skier, and enjoys rebuilding sports cars, especially Alpha Romeos.

continued on page 43

Great Possessions

Those with memories of Aldo Leopold, as a man, a father, a teacher and a scientist, possess special treasures. Here are some of them.

INTRODUCTION
by Nina Leopold Bradley

In the spring of 1948, a week before the grass fire that took Dad's life, a letter came to him from Oxford Press accepting his collection of essays for publication. He had received refusals from two other publishing houses, so this was great news. And it came, as we now know, just barely in time. *Great Possessions*, Dad's title, was to be a book. *A Sand County Almanac*, the title given by the publishers, Dad did not live to know.

To Dad's children he did leave great possessions, both literary and personal. Dad and his chief sawyer, Mother, pulling together, themselves brought our family together in common goal.

About the time we Leopolds were teenagers, Dad purchased a worn-out farm in the sand counties of south-central Wisconsin—known to us as The Shack. The only building on the place was an old chicken shed; the land had been destroyed by poor farming, the woods were diseased.

To reconstruct the old shed and make it reasonably habitable was one of the first jobs for the family to tackle. With windows and doors from the local dump, boards and old bridge pilings left on the sandbars by the river and boulders dumped by the glacier, we rebuilt the chicken shed and made it into The Shack. While we built a shack, Dad and Mother were building a family of kids who enjoyed each other and who were learning the joys and satisfactions of work and cooperation.

And from the day of purchase, a main objective was to rehabilitate the land by restoring the pre-settlement ecosystem. What grew here before it was lumbered and "corned" to death? How do we win it back? As we planted, watered, nurtured, over a period of 15 years the landscape began to change. There were discouraging setbacks: drouth, floods, high rabbit populations, which played havoc with the pine plantings. But ever so slowly the land was recovering, we children were learning something about ecology and Dad was writing essays.

The following are anecdotes, written by family members, drawn from family experiences during the years our great possessions were stacking up.

THE LEOPOLD HUNTER'S LUNCH

by A. Starker Leopold

AFTER WE SETTLED in Wisconsin about 1925, Dad took me, and sometimes other family members, on many a hunting excursion. We had happy times in pursuit of jacksnipe and pheasants in marshlands near Madison, of ruffed grouse in the central sand counties, and of cottontail rabbits in woodlots. Usually, in early November, we drove to Burlington, Iowa, to hunt ducks for a few days at Crystal Lake Club with uncles Carl and Fritz. Some years at Christmas time we would go to a cabin on the Current River in southern Missouri for bobwhite quail.

On one-day forays we took a standard lunch: a bread and butter sandwich and a pork chop apiece. As noon approached, Dad signified the lunch stop by gathering wood for a fire. In the game pocket of his hunting coat he carried a kettle about the shape and size of a brick, open at one end with a wire bale to hang it over the flame. The kettle was filled with water (or snow as the case might be), and when boiling, a cylinder of "erbswurst" was dropped in to create a thin pea soup. While this was transpiring, each of us cut forked sticks and grilled our pork chops over the fire. The soup was served in the kettle lid, which was passed around, sandwiches and chops were consumed in short order, the fire was extinguished and the hunt resumed.

As a teenager I seemed to live in the land of famine, and these hunting lunches served more to stimulate my appetite than to satiate it. But this was the established order of things, and it never occurred to me to question it. In point of fact, Dad often made fun of hunters who indulged in big lunches. One of his favorite jokes was about an old German uncle in Burlington who set out for a day's duck hunt with a bulging basket in the bow of the boat, containing sandwiches, cheese, pickles and other goodies, covered over with a tea towel which hid the food but not the emerging necks of wine bottles. This picture created great mirth as we broiled our pork chops over the fire. Secretly I was a bit envious of my great-uncle, but that fact was never mentioned.

After I left home for college our fall hunting trips were few. But when occasionally I made it to Madison for Christmas, I specifically noticed that the lunches were more ample and that we returned to the car to eat rather than carrying the food in our pockets. The last year Dad and I hunted grouse together in central Wisconsin (1943 I believe), lunch as it emerged from the car consisted of a bulging basket containing sandwiches, cheese, pickles and other goodies, covered with a tea towel which hid the food but not the emerging necks of wine bottles.

When I reminded Dad of our old uncle in Burlington he laughed slyly and admitted that tastes change, even among Leopolds.

It is a fact, patent both to my dog and myself, that at daybreak I am the sole owner of all the acres I can walk over. It is not only boundaries that disappear, but also the thought of being bounded.

WATCH YOUR LANGUAGE, PLEASE

by Carl Leopold

MY FATHER HAD a dry and reserved sense of humor; many things which he found amusing he would roll over in his mouth quietly, and enjoy the flavor with a quiet chuckle or a small introspective smile. Once in a while, however, he would run across some splendid incongruity, which would cause him to burst out in marvelous, hilarious, almost boistrous laughter. These occasions always slightly startled me, and always warmed and pleased me.

I recall one early spring day when we were working together with shovels on the sand hill, turning grass sods to release the pines we had planted from some of the competition from grass around their bases; as we worked along in the spring sunshine, we heard an unusual sound in the woods below us—a curious sort of knack-knack sound. We talked it over, and decided that the sound was that of someone shoveling. We were always highly protective of the plants on our land, and especially so of the pines, which were always alluring to Christmas tree hunters. So at once we gave up our cultivation work, and struck off through the woods towards the sound of the knack-knacking.

Emerging into a little clearing on one of the small ridges that run through the floodplain woods, we came upon a group of two middle-aged couples. All were slightly stout, the men wore brightly colored baseball caps, the women voluminous slack-pants, and the hair of one of them was ornamented by curlers, which were partially hidden with a scarf. And the women each held several of our precious white pine seedlings, roots bare to the dry air, while the men dug assiduously to relieve our woodlot of yet another young pine.

"Do you have permission to dig those pines?" growled my father, a

Robert A. McCabe

In a widely reprinted photograph, Leopold examines a red pine near The Shack.

clear note of anger sounding in his voice; quite enough to cause my pulse to be elevated.

One of the men raised up from his labors and replied slightly defensively, "Oh, we aren't going to destroy them; we are going to plant them around our house."

"So, you'll dig them up on my place and put them on your place." (His voice was now full of cynical ire—the worst danger signal—beware!) "Well, Jesus Christ . . ."

"Oh, please," interrupted the man who had answered already, "Please, you know there are ladies present!"

This last was too much. My father tilted his hat back, leaned against a tree, and raised his voice in the most marvelous, boistrous, rolling laughter. On and on—the situation was a precious vignette, the trespassers so unsure of his meaning after the cutting anger, and my father dissolved in splendid, glorious laughter.

To close the vignette, the trespassers were instructed to plant the trees back again just where they had each been dug up, and my father and I went back to clearing grass sods. And as we worked on, he kept bubbling up in little repeating chuckles, relishing the after-flavor of our little brush with social ethics.

SALARY?

by Nina Leopold Bradley

IT WAS THE middle of the Depression. Dad had resigned from the Forest Products Laboratory and for two years had been working on his manuscript for *Game Management.* In rented office space he was writing without salary except when a consulting job yielded some remuneration.

At home was a family of five children. Mother was making every effort to keep expenses at a minimum, but feeding five healthy, well-exercised young people drains the pocketbook. Although it could be felt by all, financial strain was not a subject for family discussion. Dividends from a few stocks and bonds kept the gang housed, fed and clothed, but only just.

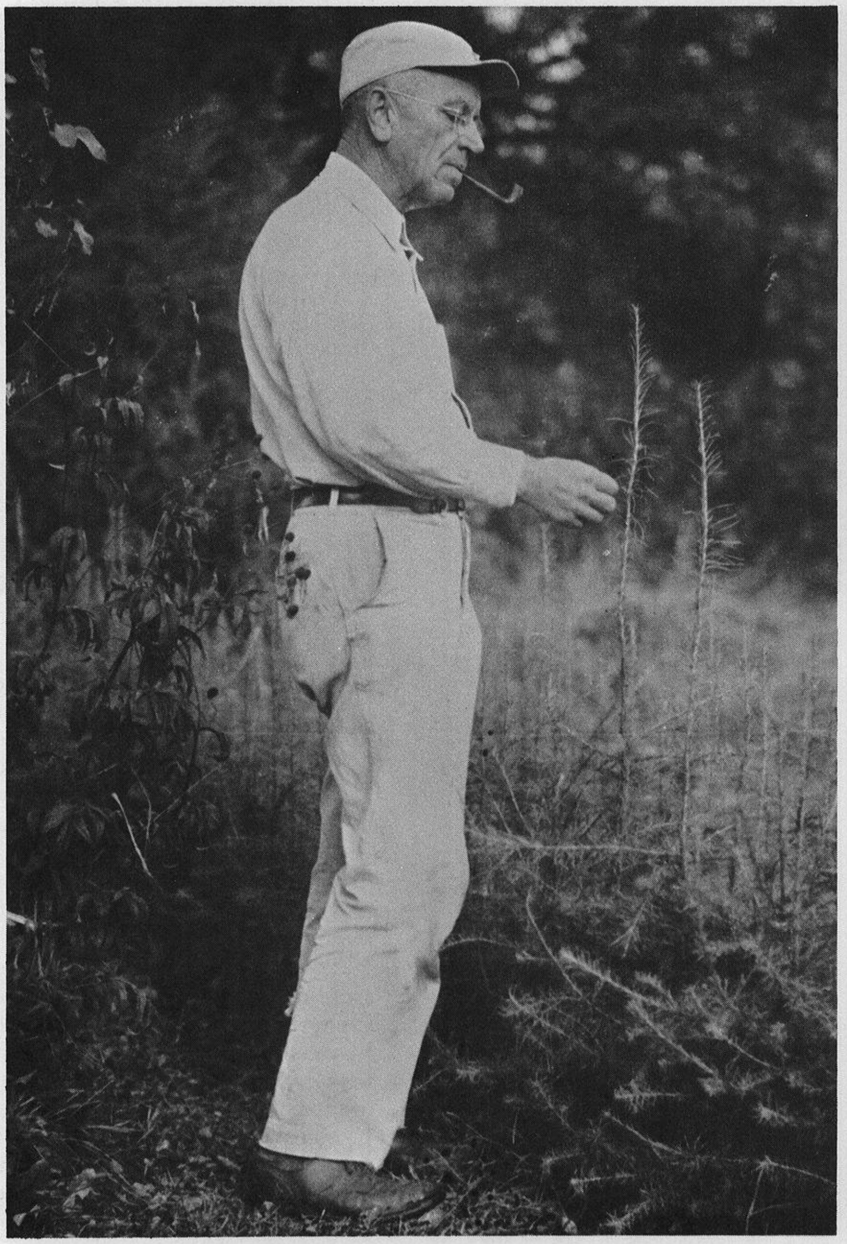
As Dad's manuscript neared completion, secretarial help was minimal and each of us took turns typing the index, two-finger style. I have a vivid memory of my father sitting before the old Remington typewriter, poking away at the keys, letter by letter, word by word.

Shift now to the mid-thirties; the years of financial depression and drouth seemed to be fading from the land but there were scars which would persist for some time. Dad was employed again, this time by the University of Wisconsin, but a professor's salary in those days was pretty lean and our family had not yet recovered from the earlier financial draw-down of two years without regular salary. In addition it was college time for my two older brothers who had dreams of fraternity life and wardrobes to fit the pattern of new social challenges. In other words financial pressures had not lessened. They had only become more complex.

This was the setting the day a

This is a plea for the preservation of some tag-ends of wilderness, as museum pieces, for the edification of those who may one day wish to see, feel, or study the origins of their cultural inheritance.

Aldo Leopold at his Sand County farm, inspecting a small nursery of tamaracks prior to transplanting.



Robert A. McCabe

letter arrived from Washington offering Dad the directorship of the US Biological Survey (now the US Fish and Wildlife Service). It was an important opportunity for it carried not only prestige but a chance to have more than casual influence on the future of wildlife and wildlife research in the United States.

Who knows what competing goals Dad was nurturing? Even though operating on minimal funds, he nevertheless did not immediately sign on the dotted line. This fact alone suggests competing inner thoughts. He became moody and silent. He sat and looked at the wall, lost in thought, or paced up and down. He wrote to Washington for more information and continued to think about it. We could all feel the strain of a major decision in the making and kept out of his way.

Who knows what Mother thought? It is a fact that she was the one who had to wrestle with the skimpy budget and try to make ends meet. She would have been less than human if she had not yearned for a more comfortable margin of security.

Finally one evening Dad walked to the telephone and through the operator made contact with his brother, Carl, in Burlington, Iowa. In those days a long distance call was a major budget item but Carl, being nearest in age, was Dad's closest confidant and it was normal for them to make contact before an important decision. From my bed off the first landing of the stairs I listened carefully to the conversation, which went something like the following:

"Hello . . . . Hello Carolo! Yes, this is Aldo . . . . In Madison . . . . I have just had an offer from D.C. to head up the Biological Survey . . . . Yes, we would have to move to Washington, but that would be just a base for operation all over the country . . . . Yes, I would have supervision of wildlife research for the United States . . . . Yes, quite exciting—marvelous challenge, good staff . . . . What? Salary? Umm, I'm afraid I forgot to ask."

A SHORT STORY OF A MAN HUNT

by Charles C. Bradley

IN RETROSPECT my getting acquainted with Aldo Leopold was in essence a search for four people.

There was the man who would take me off in a corner during a party and engage me in intense conversation for a few minutes. Then there was the man, somehow different, I would think about in the quiet of my room **after** the party. There was Leopold the teacher-scientist, and finally there was the man I came to know after he died, the one who wrote *A Sand County Almanac*.

My father and Aldo were good friends, and it was through their association that I eased into the extended Leopold family circle.

It was a big circle and thus very flattering to my youthful ego to be sought out of the mob for a few minutes of private conversation. Had I been more observant I might have noted that Aldo managed this kind of contact with most of the individuals at the gathering. It was one of his ways of giving depth and meaning to a type of occasion that often promotes only shallow relationships.

Those conversations were models in the conservation of time, yet I sensed no attempt at efficiency, only a warm, gentle persuasiveness.

"It's good to see you again. Let's go over here where we can talk. I haven't seen you for a long time. What have you been doing with yourself? Is that so? Did you enjoy it? What did you find most interesting? Have you read what so-and-so says about this?"

A handful of adroit questions and there I was telling him the story of my life, my fondest dreams, my craziest ideas, and, all too often, revealing the depth of my ignorance. But with no feeling of censure from him. He just changed the subject when he sensed any trace of defensiveness on my part. The conversation might last as long as ten minutes and would end on an upbeat as smoothly and easily as it started. I'd go home knowing I'd been to a great party—such interesting people!

Then came the aftermath as I lay awake at night thinking about the party and my conversation with Aldo Leopold. Never did I have a talk with him without the need to mull it over afterward. First there was the feeling that I had somehow learned. But **what** had I learned? All I could remember was me talking and talking about myself. Then I would remember the gentle pressure of the questions coming at me and realize the extent to which my mind had been pushed: pushed for clarity, pushed for accuracy, pushed for depth of understanding, pushed to the point where ignorance emerged as the limiting factor to that line of conversation. Then I would recall the erratic and illogical statements I had made as the defensiveness of ignorance set in. These were disturbing thoughts, and I could almost hear the hiss of my ego deflating itself. What **had** I

Every farm woodland, in addition to yielding lumber, fuel and posts, should provide its owner a liberal education. This crop of wisdom never fails, but it is not often harvested.

learned? Well, I had learned quite a bit about me, but that seemed not to be a matter for undue exultation. Ultimately I did learn to be less defensive about my ignorance. Over the years perhaps the most important thing I learned was that learning is at best a hit-or-miss proposition unless you know where your knowledge ends and your ignorance begins.

But what had I learned about Aldo Leopold? With considerable chagrin I would have to admit I had discovered little beyond sensing a man of personal warmth and a mind that pushed and pushed.

Several times I remember saying to myself, "Now, damn it, Bradley, you get in there and carry the conversational ball. Ask your own questions. Make him talk about himself." It was a great game: stimulating, fascinating, but somehow there I'd be again, talking about myself, trying to cope with a modern Socrates who certainly knew how to ask a nifty question.

Since I was in a different field I became only slightly acquainted with Leopold the scientist. It began the day I said to myself, "Bradley, it would be stupid to go through the University of Wisconsin without having taken a course from A.L." So, without prerequisites, I signed up for old "118," the beginning course in wildlife ecology. Again I am chagrined to realize how little I learned, either about Leopold or ecology. It was a fascinating course but with my lack of background, plus a youthful habit of avoiding study, I had a great deal of trouble holding it together. It kept falling apart at exam time, which, by the way, was daily—not necessarily a formal quiz but still that disconcerting after-feeling of "M'gosh, I was examined! Was I found wanting? As usual?"

A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise.

Of course I really did learn something. Take for instance that day the professor led the class on a field trip to The Shack. That was the day when, without too much effort on my part, I became the star of the class. The day started as did most meetings with Aldo Leopold: with an innocent question. "Where are your binoculars?"

I answered truthfully, and with becoming modesty, "Oh, my eyes are very good, I really don't need field glasses."

He smiled, "Well, I can lend you mine if you need them."

At The Shack the class, numbering 20, followed the leader as he walked the sandy floodway to the edge of the Wisconsin River. There, running up and down the strand, was a pert little bird pecking at the flotsam of each wave but managing to stay dry-shod by fast and dainty footwork.

Innocent question No. 2: "Now what do you think that is?"

Nineteen pairs of student binoculars went up and there was a long, intense silence as they watched, all glasses swinging in unison to the rhythm of the dancing bird, searching for clues to identification. It suddenly dawned on me that for once the answer to the question was in my bag and that this would be the day I could hold up my head in "118."

Not wishing to make a big splash—just a decent impression—I paused for an interval and then said in a whisper loud enough to be heard by all, "That's a sandpiper, isn't it?"

Nineteen pairs of binoculars came down and 19 pairs of eyebrows went up as I became the center of rapt attention. Then a student whispered back loudly enough to be heard by all, "Of course it's a sandpiper but what **kind** of a sandpiper?"

For those who have never experienced it, let me say that it is a stunning sensation to find yourself suddenly standing naked in class. But there I was—no binoculars, not even having really looked at the new bird guide lying so cozy and useless in my pack.

The professor's binoculars had not come down. He was still carefully studying the bird. Was there a flicker of a smile on his lips? Whether or not he was aware of my grand slam, I am sure he was aware, great teacher that he was, that education by one's peers is often more pungent and durable than anything a professor can dream up. So back to the original question. The answer by general agreement seemed to be that the sandpiper was a "spotty," just in case anyone is interested at this late date.

Happily I can't remember my grade in the course, but I'm glad I took it. I carry with me an enduring memory of a teacher who spent little effort on oratory and pedantry but concentrated on creating the opportunity and mood for independent learning, taking keen pleasure in watching students respond to the mood and seize the opportunity. Perhaps his greatest wisdom as a teacher lay in his capacity to refrain from telling too much for fear of destroying the joy of discovery. However from this style of teaching, while I learned a little about ecology and more about myself as a student, Leopold the person remained visible only tangentially.

So there was Aldo Leopold, the fascinating conversationalist who lifted my spirits. Aldo Leopold, the gentle enigma who prodded my

A view of The Shack taken in 1940, showing Leopold (right) and Robert McCabe in front.

Lyle K. Sowls

afterthoughts, troubled my sleep, and left me somehow more mature and more humble after each contact.

Than abruptly he was dead and a copy of *A Sand County Almanac* was in my hand. From that book emerged my first clear view of the man I'd never been able to uncover for myself. What if he'd never taken the time to write it?

Tell me of what plant birthdays a man takes notice, and I shall tell you a good deal about his vocation, his hobbies, his hay fever, and the general level of his ecological education.

25th

by Howard A. Deller
with photographs by Don Staples

WISCONSIN'S NEW

Located now at UW-Milwaukee, the largest research collection of geographical materials in the Western Hemisphere puts the state on the world resource map.

A beautifully colored 1831 terrestrial globe made by America's first globe maker, James Wilson and Sons of Albany, New York. This globe is part of a matched pair, the other being a celestial (star) globe. In the AGS Collection there are over 70 rare and special globes.

From the banks of the Zouga in Darkest Africa, the Reverend David Livingstone wrote vivid accounts of his most recent discoveries to be read before an appreciative audience of merchants, bankers, publishers and lawyers meeting together at the headquarters of the American Geographical Society (AGS) in New York City.

Many of Livingstone's letters were later published in the transactions and other publications of the AGS, thus becoming part of that society's famous library, a library which, since its inception in 1851, has grown to include well over 660,000 items worth an estimated 30 million dollars.

All this is of interest to us as citizens of Wisconsin because we collectively have become the trustees of this massive collection. The library and map collection of the American Geographical Society, the largest research collection of geographical materials in the Western Hemisphere, now occupies the entire east wing of the third floor of the University of Wisconsin-Milwaukee's beautiful Golda Meir Library.

In this short article it is not possible to discuss why the AGS decided to donate its historic collection to a major public institution, how UW-Milwaukee won out over the approximately 25 major institutions interested in obtaining the collection, and how the collection, after a lengthy legal battle, was moved nearly 1000 miles to its new home in Milwaukee. All these topics are part of another story, which is told in dramatic detail by the library director, William C.

GEOGRAPHICAL CENTER

Roselle, in a recent and widely available publication, *Current Geographical Publications*, published in December 1978 by the UW-Milwaukee Library.

Almost overnight, UW-Milwaukee has become a world center of geographical research, possessing as it now does a vast collection of geographical materials rivaled only by the great libraries of the Royal Geographical Society in London and the Societe de Geographie in Paris. In the future, for anyone studying historical cartography, map librarianship, the history of the Age of Exploration, or any one of the major subfields of the science of geography, this will be the place to visit.

According to Dr. Barbara Borowiecki, the former chairman of the geography department and, along with William Roselle, one of the two people most instrumental in bringing the collection to Milwaukee, this incredibly rich research library will attract students and researchers from all over the world. Already, even before the collection has fully opened, a brilliant young scholar from England has spent five weeks in Milwaukee studying the characteristics and organization of the AGS map collection as part of his research in map librarianship. In addition, graduate students from Brazil, Canada, Iran and Latvia are now working in the collection in various capacities.

All kinds of answers

But this unique collection is not only for scholars and researchers. It must be remembered that the society and its collection were founded and nurtured over the years by lawyers, merchants, ministers, journalists, bankers and others who were vitally interested in obtaining practical information about sundry peoples and places around the globe. As one of the greatest storehouses in the world containing this type of practical data, the AGS Collection can be expected to be of continuing value to people with many and various interests. Information on overseas market conditions, on the resources of remote areas, and on the customs, traditions and habits of foreign peoples will be readily accessible.

Much time and energy will be required to unpack the collection and get it ready for full public use. Now hard at work on this task are AGS Collection curator Dr. Roman Drazniowsky, his growing staff and about eight part-time student workers. Thousands of maps have to be taken out of their packing cases; several thousand boxes of books, serials and pamphlets must be unpacked, cleaned and shelved; and numerous other jobs have to be performed before the collection can be opened to the public.

The collection will become available in stages as materials are readied for use. The map library should be open by the first of the year, the book and serial collection in about a year thereafter and the photograph collection in about a year and a half.

Of the three major sections which make up the collection, the map library is in many ways the most unique. Consisting of over 350,000 maps, it is well balanced and reflects the development of cartography in every country and region. General reference maps, topographic maps, maps of the world's major cities, hydrographic and aeronautical charts and an incredible variety of thematic maps dominate the collection. Also present however, are such invaluable reference tools as atlases, gazetteers, globes and cartobibliographies.

A world of maps

All of the atlases, maps and reference materials are cataloged and arranged in accordance with the AGS Collection's cataloging and filing rules, a system based on region-subject and chronological sequence. Not only are all the flat maps cataloged, but tens of thousands of maps in books and scientific journals are cataloged as well. With over 560,000 catalog entries, the map library is one of the largest and finest research collections of its kind in the world.

Even before the map section was fully opened, the staff was fulfilling several requests for materials and information per week. Typical of such requests were those for:

- a modern base map of Nicaragua to be used by a graduate student in his research on that region;
- several early maps of Israel to be used in an exhibit honoring Golda Meir, the former prime minister of Israel;
- the location of a large farm in South Dakota which the wife of a faculty member had just inherited;

- a 1779 map of New Spain (Mexico) to be used as the cover design for the newsletter of an international professional fraternity;
- information on 19th century guidebooks and guide-maps in the AGS Collection to be used in a forthcoming book on that subject;
- geological maps of China compiled in 1961 by the Tokyo Geographical Society; (These were requested by a company involved in petroleum exploration.)
- confirmation of the existence of a short railroad line near La Crosse in the 1880s; (The historian who requested this had spent an entire day in Madison looking through various map collections without any luck. We found the information for her in about 20 minutes.)
- historical and recent maps on land ownership by Indians in the southern regions of Mexico;
- a series of maps tracing the pattern of geological exploration in Antarctica from the 18th century down to the present day.

The unique map catalog allowed the staff to answer quickly each of the above requests. Similar rapid access to the books and serials is assured by several similar catalogs. Like almost every other library, the collection has a dictionary catalog, providing access to books by author, title and subject. The AGS Dictionary Catalog was begun in 1857, and consists of over 300 drawers containing cards referring to approximately 90,000 books and 33,000 pamphlets.

90,000 volumes of periodicals

In addition, there are about 90,000 volumes of periodicals. During the almost 130 years of the collection's existence, 9800 different serials have been received, many of which are now out of print and virtually unobtainable. But the collection is not only strong from a historic standpoint. At the present time approximately 440 geographical serials are received, more than are received by the Library of Congress or any other library in the country. Hundreds of other serials in such fields as history, economics, international relations, anthropology, geology and meteorology add depth and richness to these holdings.

A special research catalog permits quick access on a regional and topical basis, not only to books, but to periodical articles, pamphlets, government documents and technical reports. Patterned after that of the Berlin Geographical Society, the *Research Catalogue* was begun in 1923, by John Kirtland Wright, the librarian and later director of the society.

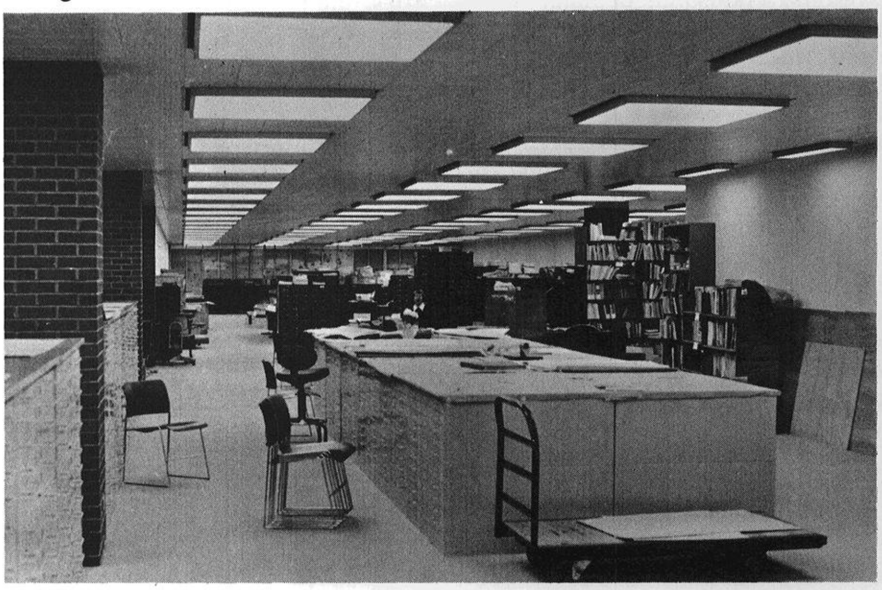
The major American retrospective bibliography in geography, the *Research Catalogue* includes references for the 50-year period from 1923 through 1971. It has been photographed and published in book form by G.K. Hall & Co. in 19 volumes and is available in many libraries throughout the world. It is regularly updated by *Current Geographical Publications*, the principal current geographical bibliography published in the United States. Issued ten times a year, this annotated bibliography excels in the relatively quick reporting of new publications of geographic interest.

45,000 photographs

Over 45,000 photographs comprise the third major part of the collection. Most of them have been donated by individuals, but some have been purchased and many are the gifts of such firms as Shell Oil, Fox Film Corporation, the New York Times and Eastman Kodak.

Access to photographs is possible through a photo catalog, with photographs listed according to both region and topic. Not only are the photographs in the collection so cataloged, but, up until the late 1940s, even photographs in books and journals were noted. This is a veritable gold mine for scholars doing historical research. If one wants photos of Indian wigwams in early Wisconsin, bamboo water-mills in China, sugar-mills in Brazil, Israeli salt works along the shores of the Dead Sea or Pygmies in the rainforests of the Congo, these can be

The new map cabinets are designed to hold the over 350,000 maps in the AGS Collection. Temporary office area for the staff is shown in the background.



quickly and easily located using the photo catalog.

The AGS Collection is certainly a great research library and a valuable addition to the scholarly resources of the University of Wisconsin System, but it is also more than this. There are thousands of museum-type items that will inevitably lead to the collection's becoming one of the state's top cultural attractions.

Teeming treasures

The beautiful old maps, antique globes and rare 19th century photographs have already been proclaimed in the media as priceless treasures. The attention given to Giovanni Leardo's Mappa Mundi of 1452, the Mercator map of 1538 and the early 17th century Hondius globe, however, tends to obscure the tremendous extent and richness of this part of the collection.

There are thousands of other lesser known items of great interest. For example, there are approximately two dozen maps made by the Jesuit priests resident in China, Japan and India from the 16th to the 18th centuries. Just one of these, the Portuguese Jesuit Ludovico Georgio's map of the Chinese Empire, dated 1584, is an incredible work of science mixed with art. Oriented with west at the top and hand-painted in vibrant colors, this map has detailed sketches of such features as the five central lakes mentioned by Marco Polo, elephants along the borders with Burma and India, Mongol tents north of the Great Wall and deer cavorting on the western grasslands. Also shown on this map are four small pictures of the wind-carriages (four-wheeled vehicles with sails) which so impressed the westerners when they first made contact with the Middle Kingdom.

Maps by other Jesuits such as Matteo Ricci and Martino Martini are also present in the drawer which contains the rare maps from China. There, too, is a rare ink-rubbing of one of the oldest original Chinese maps. This extremely accurate map was engraved on a stone tablet in the old imperial capital of Ch'ang-an in the year 1137 AD. The rubbing was made by the famous China scholar, George Cressey, and was presented to the collection in 1933.

Pictured is one of the approximately 700 photographs in the Western Collection. Most of these are rare, early Western landscape views by such photographers as Carleton Watkins, Timothy O'Sullivan and Eadweard Muybridge.

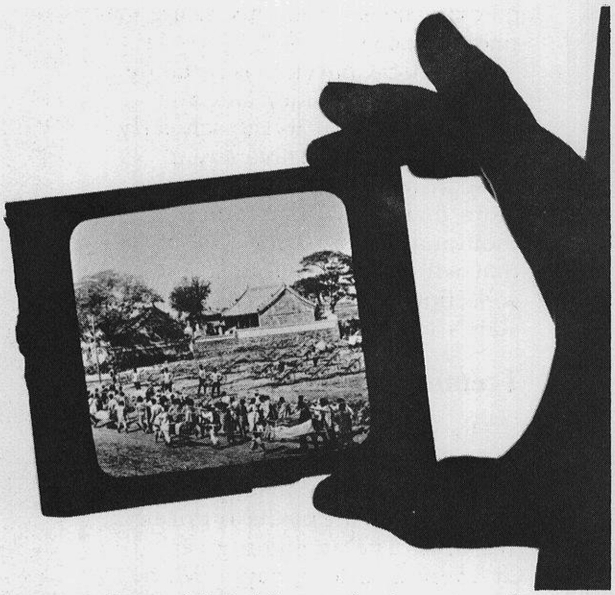
Sailing charts and stereopticons

Several beautiful Spanish and Portuguese sailing charts from the Age of Discovery can also be found in some of the rare map drawers. It is amazing that so many survived. When they were new and still in use, they were considered state secrets and, along with the ship's logs and code books, were weighted with lead. If it ever appeared that a ship was about to be captured, these items were the first to disappear into the "briny deep."

Other lesser known items within the collection include such things as: three engravings of Christopher Columbus, the earliest dated 1722; a book of photos from G. Rohlf's expedition to the Libyan Desert in 1873; stereopticon views of the American West taken by the official photographer of the One Hundredth Meridian geographical survey of 1871; a beautiful 1756 engraving of Henry VIII's flagship, the Great Harry; and a collection of 50 photographs of "Lhasa and Central Tibet," taken in 1903 and donated by the Imperial Russian Geographical Society of St. Petersburg.

These and similar items will periodically be put on display in the special new exhibit area being built near the entrance to the AGS Collection. While some of the precious globes and a few selected maps will be kept on permanent display, exhibits based around certain themes will also be developed. As was the case in New York, it is expected that some rare items will occasionally be loaned out to other institutions in the state of Wisconsin and throughout the country. In the past, such national organizations as the Metropolitan Museum of Art, the National Gallery in Washington and the Cleveland Museum of Art periodically borrowed items for special exhibitions.

The range of possible exhibits is almost limitless. Educational exhibits revolving around some of the following items have already been discussed: propaganda maps, early Dutch nautical charts, mythical animals portrayed on early maps, maps of Arctic exploration, battle maps, computer cartography and planetary mapping.



Hundreds of hand-painted glass slides such as this one make up a unique part of the photo collection. Labeled "The Siege of Port Arthur," the slide was taken during the Russo-Japanese War of 1905.

Gifts beyond price

One of the first exhibits to be presented will be a very special one: an exhibit to honor all those thousands of people who, over the years, have done so much to aid the growth and improve the quality of this great national resource. If there is one outstanding fact about this collection, it is that most of the items in it were donated by individuals and organizations. Very little was ever purchased outright. Even the famous Medieval map of the world by Giovanni Leardo, which is now worth over a million dollars and which has become, in the public mind, the symbol of the collection, was the gift of a private citizen.

Entire libraries have been given. In 1891, for example, General J. Watts de Peyster donated 247 volumes, stating that more were to come under the condition that they be kept together as the "de Peyster Collection." In the same year, Judge Charles Patrick Daly of New York City gave his collection of 682 volumes, 1541 pamphlets, 17 atlases and 36 maps: 2276 pieces in all.

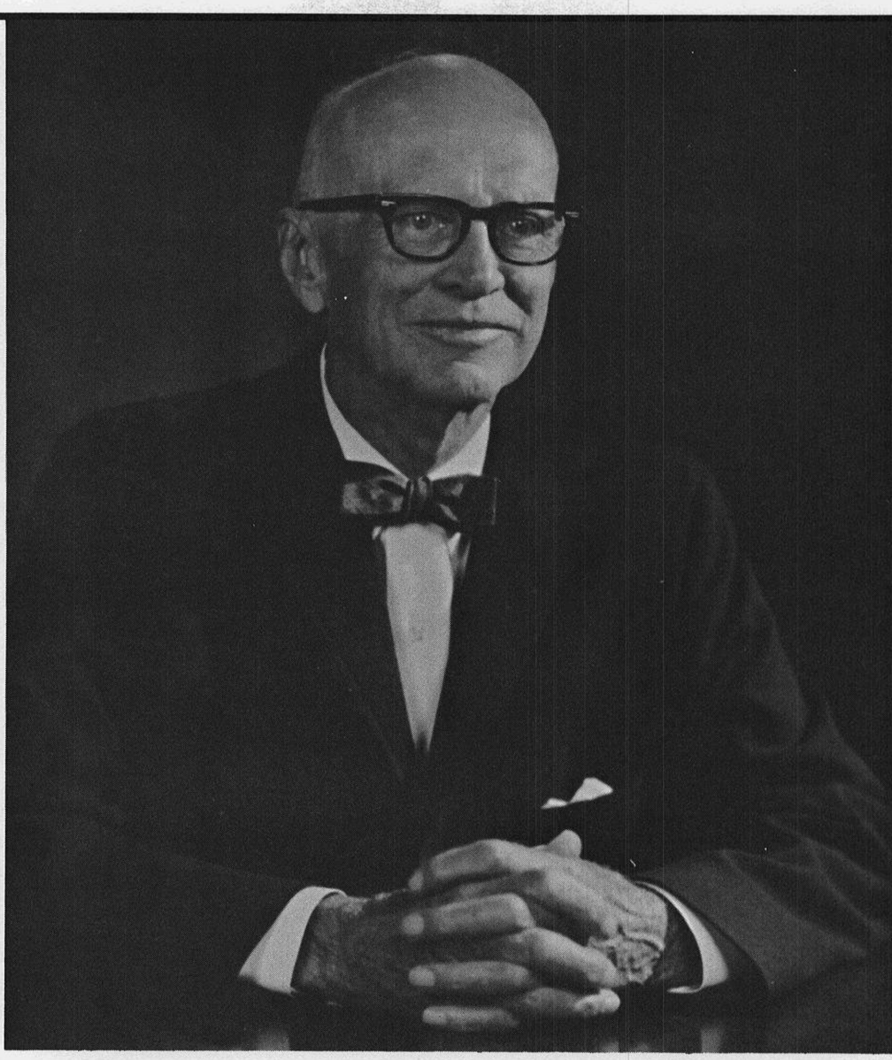
AGS Collection secretary Kathy Pett displays an 1803 bird's-eye view engraving of New Orleans. In this beautiful, hand-colored picture, the American flag is shown flying for the first time over the main buildings of the city and on ships in the harbor (the Louisiana Purchase had just taken place). The slogan held aloft by the eagle reads, "Under My Wings Every Thing Prospers."

A Who's Who of history

A list of people who have donated items reads like a veritable *Who's Who* of American history. Samuel F.B. Morse, the inventor of the telegraph and a former president of the society; Cyrus W. Fields, who laid the first trans-Atlantic cable, thus allowing President Buchanan to communicate instantly with Queen Victoria; John C. Fremont, western explorer, adventurer and politician; Albert Gallatin, Jefferson's secretary of the treasury; H.M. Stanley who "discovered" AGS corresponding member, Dr. Livingstone; Robert E. Peary, the Arctic explorer and another former president of the society; and two US Presidents named Roosevelt are among the thousands who have contributed to this great collection since its creation in 1851. The history of the collection has blended and mixed with the history of this nation until the two have become inseparable.

The move of the AGS Collection from the East Coast to a mid-continent location marks a major turning point in the history of the science of geography in the United States. It also represents a challenge and an opportunity for the people of the state of Wisconsin. We now have within our midst what UW-Milwaukee library director Roselle rightly likes to call a "national treasure and an international resource." Will we make the most of it?

Howard A. Deller is literature analyst for the AGS Collection.



Edgar L. Obma

Harry Steenbock—student and humanist

by Aaron J. Ihde

HARRY STEENBOCK WAS a complex person. Noted as a scientist, he was less well-known to the public as a patron of the arts and as a catalyst of youthful careers. Basically he was a timid person, generally uncomfortable with people but warm and even outgoing with a small circle of friends whom he trusted. He was a hard worker who sought to excel in those areas that became his major interests.

Born August 16, 1886 on a farm in Calumet County, he came of second generation German immigrants having a strain of Swedish lineage. Harry's paternal grandfather, despite seven years in the Prussian army, had been disillusioned with the failure of the revolts of 1848 and had emigrated to Wisconsin where he married in 1852 and purchased farm land. Here, near New Holstein, they cleared land, developed their farm and raised a family. When son Henry married in 1883, they turned the farm over to him and retired in New Holstein.

In 1884 a daughter, Helen, was born to Henry and Christine Steenbock. Harry followed two years later. The parents concentrated their love and affection on these two children, both of whom showed early signs of unusual brightness. Harry and Helen developed a closeness which persisted to the time of Harry's death in 1967. No doubt, in a farm environment in a family where the German language was spoken routinely, brother and sister had little opportunity to develop close friendships outside the family. When the children started school they were temporarily handicapped when they faced compulsory use of the English language.

Henry Steenbock settled on a 150-acre farm near New Holstein following sale of the original farm and two abortive business ventures. The grade school years of the children were spent in a nearby country school where a single teacher taught all eight grades in one room. She would hear recitations in a particular subject while the remaining students studied for coming recitations, or listened to recitations or engaged in mischief. Harry, a serious student, did well in his studies and had extra time to read extensively in the books on the single shelf which constituted the school library.

Upon completion of grade eight, Harry joined his sister, who had finished a year earlier, in a seven-mile horse and buggy trip to Chilton High School. The family's commitment to education is clearly evident, since most children in rural Wisconsin never went beyond eighth grade—in fact, many dropped out of school earlier. This was particularly true of sons who were considered essential for work on the farm as soon as they were sturdy enough.

In winter, when cold weather prevented the daily trip, the Steenbock children and two other country girls rented rooms in Chilton where they "kept house." Both Steenbock children finished high school in three years. Helen, a year ahead, stayed in Chilton an extra winter to keep house for the younger students.

When Harry's graduation approached in 1904 Henry, having had an attractive offer for the farm, asked his son if he wished to remain on the farm permanently. Harry had had a sample of the intellectual life and preferred to continue his education. The farm was sold; the family moved to Madison where Harry and Helen entered the University of Wisconsin in autumn, 1904.

Harry's success in his studies, particularly his aptitude for chemistry, attracted the attention of E. B. Hart, chairman of the agricultural chemistry department. "Steenie" completed a senior thesis dealing with artifical digestion of cereal products. Upon graduation in 1908 he was offered an assistantship in agricultural chemistry. This involved laboratory instruction and research. In 1910 he was made an instructor in agricultural chemistry but his responsibilities after 1909 were entirely in research. He did no more teaching until 1914.

From 1908 until 1911 he was heavily involved with Professors Hart, George Humphrey (of animal husbandry) and E. V. McCollum in the college's single grain-feeding experiment with dairy cattle. Harry Steenbock was to devote his lifetime to leadership in discovering the importance of trace organic compounds (vitamins and amino acids) and minerals in nutrition. He was never away from the College of Agriculture except for a *Wanderjahre* in 1912-1913 when he spent a semester at Yale with physiological chemist Lafayette B. Mendel and another in Berlin with Carl Neuberg.

Always a hard driving investigator, he was well-read in the current literature, meticulous to an extreme degree and strongly motivated to break open new ground. He had, long before he retired from active research in 1956, acquired an international reputation in nutritional biochemistry. His work led to more than 250 research papers as well as a series of patents dealing with irradiation of foods. These brought about vast improvements in human nutrition as well as in the nutrition of farm animals.

Besides, his work had an ongoing influence which transcended his own work in the laboratory. He served as the major professor of 48 students who completed the PhD, as well as MS candidates, senior thesis students, biochemistry minors and a flow of postdoctoral fellows.

IN THE EARLY TWENTIES when Steenbock and his students were uncovering the nature of the fat-soluble vitamins in milk, butter and other foods, he became concerned about the potential for irresponsible commercial exploitation of the knowledge. When he published the research on enhancement of vitamin D in foods by irradiation with ultraviolet light in September 1924, he announced his intention to patent the discovery and had already engaged the services of a Chicago patent attorney to write the application. He had no personal interest in potential profits or in management of the patent but viewed the patent as a device to prevent commercial abuse of the knowledge while bringing income to the university to support further research. He offered to assign his patent to the university but the regents were uninterested.

Commercial firms quickly took notice. Quaker Oats sought a contract for exclusive rights, which might have netted royalties approaching a million dollars. Steenbock preferred to explore other alternatives, but learned that universities had little experience with such problems. At this point Carl Miner, head of a Chicago consulting firm, suggested the creation of a trust independent of the university but established to manage the patent and support university research with the proceeds.

Steenbock proposed to Harry Russell, dean of the College of Agriculture, that such a trust be formed. Charles S. Slichter, dean of the Graduate School, reacted favorably and began lining up potential support among Chicago and Eastern alumni. A tentative proposal brought to the regents in spring of 1925 was now favorably received and a Certificate of Incorporation was issued on November 16, 1925. Steenbock's unissued patent was assigned to the new Wisconsin Alumni Research Foundation (WARF) on February 18, 1927. A basic patent was finally issued in August 1928 to be followed by three derivative patents—two issued in 1932 and the last in 1936.

WARF proved to be a significant social innovation. It took on management of the Steenbock patents and later patents arising out of university research. It licensed the patents, defended them against infringement, created a laboratory to monitor proper use of the patents, invested the royalties in income-producing property and channeled income into the Graduate School for support of research.

As a private foundation, WARF was in a position to exploit patentable university research without having to meet the restrictions faced by a public institution. It operated outside the university system, yet was committed to benefit the university. No member of the faculty, administration or governing board can serve on the WARF Board of Trustees, thus freeing the foundation of potential conflict of interest.

In the beginning the WARF trustees decided not to commit royalty income directly to university research but to invest royalties in income-producing stocks and bonds. Consequently, the university benefits from foundation grants on a continuing basis rather than having grants stop when patents expire. The foundation invested its funds very shrewdly, resulting in a substantial flow of benefits to the university without impairing capital. The whole venture developed out of the wish of Harry Steenbock to have his discoveries serve as seed for further discoveries.

ALTHOUGH DR. STEENBOCK came from a family in modest circumstances, he was a wealthy man at the time of his death on December 25, 1967. Despite lack of an acquisitive nature he valued wealth for the good it might do.

His personal needs were modest and he considered his professor's salary quite adequate for those needs. He remained a bachelor until his seventh decade, living with his parents in a comfortable home purchased in Nakoma after becoming a professor. His father lived until 1942, his mother until 1946.

In March 1948 Steenbock married Evelyn Van Donk, holder of two university degrees who, prior to World War II, had been associated with him in his laboratory. During the war she had taken a position at Lederle Laboratories in New York. Together they had nearly two decades of happily married life spent in work, travel, collection of art and support of worthy projects.

Although he expected no income from his patents, WARF persuaded him to accept 15 percent of the royalties. By careful investment he built this into a sizable estate. Yet he looked upon wealth as an opportunity to enable worthy organizations to achieve objectives not normally attainable. In his later years he quietly made contributions—such as the double keyboard piano purchased for the use of the university's distinguished Gunnar Johansen, support for music and art in Madison and several gifts to the Wisconsin Academy of Sciences, Arts and Letters.

He was particularly interested in the Academy's creation of the Junior Academy of Science, since this agency supported the development of scientific interests among Wisconsin's youth. He felt that the future health of science lay in encouragement of the younger generation and took careful notice of the Academy program. He was also interested in the efforts of the senior Academy to expand its base of operations in serving the population of the state. He was favorably impressed by the *Wisconsin Academy Review*, created by Walter Scott in 1954 and edited by him for the next decade, since the *Review* played an important role in demonstrating the Academy's functions to its membership. He took a less-than enthusiastic view of the *Transactions*, which he felt merely served a small part of the membership.

After his death Academy members were pleasantly shaken to learn that his will not only assigned $100,000 to the Academy as a direct bequest, but made the Academy his residual legatee after trusts had been set up for his widow, his sister and a cousin, and payments had been taken out for specified organizations. Among beneficiaries of his estate were the University of Wisconsin (his oil paintings and scientific library together with funds for maintenance); Lawrence University (for music and art); Chilton and New Holstein High Schools (for scholarships); the UW Arboretum; Madison Music Association; Madison Art Foundation; Calumet County Home for the Aged; Wisconsin Historical Society; and the National Audubon Society. The Academy's share of the estate was received in stocks and bonds then having a market value approaching $900,000.

Harry Steenbock was a generous man. He was also a humanist. Although he is best remembered for his contributions to science, he deserves also to be remembered for his careful selection of organizations to utilize his benefactions for ongoing progress in education, music, arts and the environment.

Author's Note

This article is based to some degree on personal recollections of Dr. Steenbock when I was a graduate student taking a minor under his direction and later as a friend and fellow faculty member in the university. For facts about his life I have drawn heavily from the biography written by his doctoral student, Howard A. Schneider, and published in *Journal of Nutrition*, Vol. 103, pages 1235-47 (1973), and from the Memorial Resolution prepared by Robert Burris and nine faculty associates (UW-Madison Faculty Document 186, March 4, 1968).

Aaron J. Ihde is professor of chemistry and history of science at UW-Madison.

The vitamin D story: a tribute to Harry Steenbock, the scientist, the inventor and the teacher

by Hector F. DeLuca

IT IS RARE when one person can influence and mold a field of investigation in so many ways. Such a person was Professor Harry Steenbock, who can easily be considered the key individual in the development of the vitamin D story, from its inception in 1919 until the present time. Professor Steenbock's contributions were severalfold. Most notable, of course, are his basic scientific discoveries as outlined here; his recognition of their potential usefulness to mankind, thus contributing an extremely important series of inventions; and his development of the talents of young people, thereby molding the future research in the field. This story will encompass all three aspects with special attention to the molding of current investigations.

European scientists had for many decades during the 1800s considered the possibility of devising chemically defined diets based on analytical values for protein, carbohydrate and salts. Most notable are the efforts of Magendie, Liebig and others. In each case, carefully prepared, highly purified, chemically defined diets, when given to experimental animals, resulted in failure to thrive and death. This led to the widespread opinion that something vital was missing from the chemically purified diets. Other examples of the effect of diet on health were also well-known. For example, the disease beriberi appeared in high proportions and was especially noted in the prisons of the Dutch East Indies. Eichmann, a Dutch physician, was sent to the East Indies to provide a medical explanation for the disease. Eichmann demonstrated that the disease resulted from the feeding of polished rice and that when the hulls, along with polished rice, were fed to the prisoners, beriberi was prevented. Eichmann incorrectly concluded that polished rice contained a toxin which was neutralized by the hulls. This misconception was corrected by his countryman Grijns who studied the problem, following the work of Eichmann, and showed that the hulls possessed a required substance that prevented the disease. In Scandinavia, Holst and Frolich (1907) were concerned with the problem of scurvy found in sailors on long-term voyages. They could prevent or cure that disease by the administration of fresh fruit. Still, the concept of vitamins did not really take hold.

Professor Steenbock began as a student at the University of Wisconsin in the College of Agriculture. He became associated with Professor E. B. Hart, chairman of the department of agricultural chemistry. A problem of major concern to Professor Hart—nutrition of dairy cattle—caused him to question whether the dietary adequacy of a forage crop could be ascertained by chemical analysis. This in turn led to the famous three-grain experiment carried out in 1910-1911 under the direction of Professor Hart and including young Harry Steenbock as a student. This experiment involved feeding three lots of dairy cattle a forage made solely of either wheat, corn or oats. The three rations had the same analysis for protein, carbohydrate, fat and salt. This experiment demonstrated clearly that the cows maintained on wheat forage did very poorly, losing weight, with some of them dying. The cows on oats were in better physical condition, but the best group was that fed corn. The evidence that chemical analysis of the major dietary constituents could not describe completely the adequacy of a forage ration produced the inescapable conclusion that there must be micronutrients—yet to be discovered—that contributed to the adequacy or inadequacy of a diet. This concept undoubtedly left a very deep impression on young Harry Steenbock. The possibility of vital substances in the diet led Funk to coin the name "vitamine" to describe micronutrients that might be required for health and reproduction of animals.

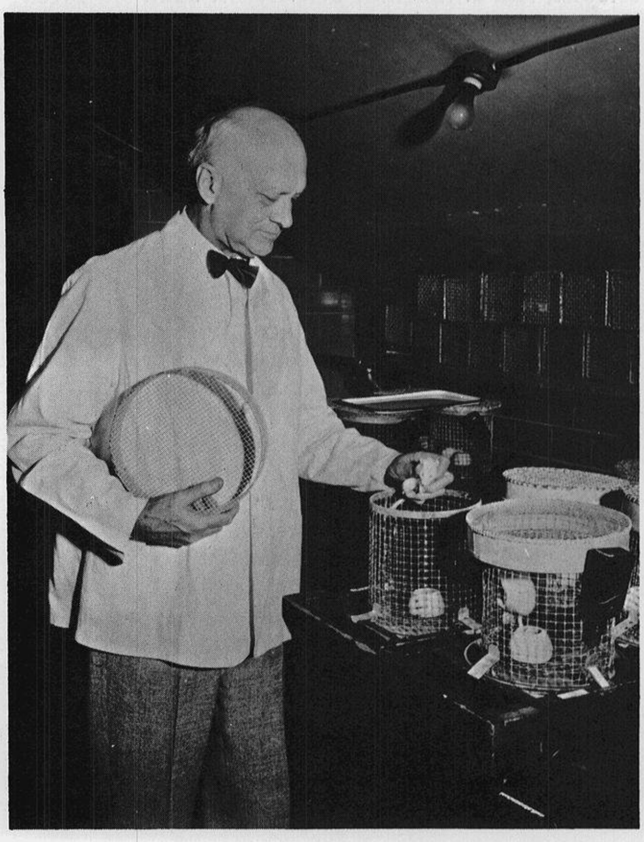
Because of the conclusions from the three-grain experiments, work to identify these micronutrients at the Wisconsin Experiment Station was begun with a small animal, the experimental rat, under the direction of Elmer V. McCollum. McCollum very cleverly utilized the rat to great advantage in demonstrating the existence in cod liver oil and butter fat of a substance necessary for the health and well-being of the rat. To carry out these experiments, McCollum designed a chemically defined diet of which the fat content was either lard, cod liver oil or butter fat. The animals having lard as their source of fat did very poorly, developed eye lesions known as xeropthalmia, lost weight and died. On the other hand, those receiving butter fat or cod liver oil performed exceedingly well. McCollum correctly drew the conclusion that a fat-soluble substance, required for health and reproduction in animals, did exist (1913). He later called this substance fat-soluble vitamin A, allegedly following discussions with Harry Steenbock. McCollum (1916) and Osborne and Mendel at Yale (1917) later demonstrated by similar experiments the existence of a water-soluble vitamin substance, which they called vitamin B complex. These findings essentially ushered in the vitamin discovery era and set the stage for the beginning of Professor Steenbock's career on the faculty at the University of Wisconsin. McCollum left the university and Professor E. B. Hart assigned the rat colony to Professor Steenbock so that he could pursue the nutritional factors.

Another important factor in the development of Professor Steenbock's career was his work with Professor E. B. Hart on lactating goats and cattle. Using the lactating goat, Steenbock, working with Professor Hart, became concerned with maintaining a positive calcium balance in animals subjected to loss of calcium through lactation. Steenbock learned that goats in the open air and sunshine had positive calcium balance whereas those maintained indoors had a clear loss of calcium as a result of lactation. Steenbock correctly drew the conclusion that light in some way influenced the utilization of calcium. This important observation undoubtedly played an important role in his major discovery of the vitamin D irradiation process. In 1921 Steenbock and his colleagues made the important observation that ultraviolet light irradiation of lactating goats would result in correcting the negative calcium balance of lactation.

Rickets: a major medical problem in the Western world

At the turn of the century, rickets appeared in major proportions in Western civilizations, especially North America and Northern Europe. This disease was characterized by deformed bone and twisted limbs of young growing children, knobby ribs known as rosary ribs, poor growth, poor teeth and sometimes convulsions and death. The industrial revolution had converted an agricultural society into an urban one, keeping workers indoors away from sunlight. Furthermore, the industrial plants were polluting the atmosphere with smoke and other solid matter in an area where already little enough sunlight reached the skin. Failure

Professor Harry Steenbock is shown handling one of the white rats inherited from Professor Elmer V. McCollum who had used them in experiments resulting in the discovery of vitamin A and other findings which ushered in the vitamin discovery era.



UW Photographic Media Center

of sunlight to reach the skin of the population in adequate amounts undoubtedly accounted for failure to synthesize vitamin D in skin. This resulted in an epidemic of rickets.

The discoveries of McCollum and of Osborne and Mendel concerning the existence of vitamins undoubtedly inspired Sir Edward Mellanby in Great Britain to consider the possibility that rickets might be a nutritional disease. Mellanby maintained dogs on a diet composed primarily of porridge, bread and milk. The dogs were kept indoors away from sunlight. They developed rickets almost identical to the human disease. Mellanby then demonstrated that the cod liver oil used by McCollum to cure the deficiency of vitamin A could also prevent the boney lesions of rickets (1919). He then concluded that the prevention of rickets is a function of the fat-soluble vitamin A. McCollum, on the other hand, recognized the possibility that these might be different activities resulting from different compounds, and by means of aerating the cod liver oil and heating it, he was able to destroy the ability of cod liver oil to cure eye lesions and promote growth, but retain the ability to heal or cure rickets. McCollum correctly concluded that the antirachitic activity must be the result of a new fat-soluble vitamin which he called vitamin D (1922). The work of McCollum by itself could not have clearly established this point if it had not been for the painstaking experiments of Steenbock and Nelson (1923), who not only confirmed the conclusions of McCollum but clearly demonstrated that aerated cod liver oil lacked vitamin A activity but retained full antirachitic activity. In addition, Steenbock and Nelson, drawing upon Steenbock's previous experience with sunlight, demonstrated that ultraviolet light could, like the aerated cod liver oil, alleviate the symptoms. Thus Steenbock and his colleagues played an important role in demonstrating the existence of a new vitamin that prevented and healed rickets in animals and man.

While all of these experiments were being carried out, another line of investigation was taking place in the medical world. Hulshinsky and Chick independently demonstrated that rachitic children being studied in Vienna could be cured by merely exposing them to sunlight or to artificially induced ultraviolet light. Therein came the basic confusing problem facing nutritional science in general, and Steenbock and his students in particular. How could ultraviolet light equal cod liver oil in its ability to cure rickets? How could this cure on one hand be the result of a vitamin and on the other the result of sunlight? The brilliance of Steenbock as an investigator is clearly demonstrated by the next series of events. There is no question that Steenbock himself conceived the idea—that ultraviolet light in some way induces antirachitic activity—from his experience with lactating goats and from his experience using ultraviolet light to heal rachitic lesions by irradiating the animals. Professor Steenbock's conviction that ultraviolet light somehow induced the antirachitic vitamin was fortified by the experiments of Goldblatt and Soames (1923) who showed that rachitic rats irradiated with ultraviolet light developed in their livers extractable material that could cure rickets in other rachitic rats, whereas the same extracts taken from rachitic rats had no healing powers. In one simple discovery, Steenbock and his colleagues completely clarified the confusing picture and at the same time provided an important means of eliminating rickets as a major medical problem. Steenbock (1924) demonstrated clearly that the irradiation of food and other biological material with ultraviolet light could induce antirachitic activity. This basic discovery is reported in a series of three papers detailing the activation of food for antirachitic activity by ultraviolet light. Steenbock then extended this observation to a wide variety of foods, the most important being milk. Steenbock's work was confirmed quickly by Hess and his colleagues. Steenbock recognized the importance of his discovery not only from an academic point of view but also from a medical point of view. He realized that irradiation of food could serve as a vehicle whereby rickets could be eliminated. He also recognized that abuses of this discovery could be made with the irradiation of substances that would not benefit man. For example, irradiation of cigarettes would most certainly not be useful (even though this was suggested by an interested commercial firm). This then prodded Steenbock into applying for patents of the discovery of the irradiation process. With these patents Steenbock conceived the idea that they could be used to generate substantial amounts of income that could be returned to scientific research. This led to the establishment of the Wisconsin Alumni Research Foundation, an important organ for the state of Wisconsin, the University of Wisconsin and the nation. The discovery by Steenbock that the irradiation process results in antirachitic activity also provided the important technology for generating large amounts of the antirachitic substance so that organic chemists could isolate sufficient quantities to determine its structure. It is unfortunate that Professor Steenbock himself could not have played a more direct role in this identification work. Nevertheless, his work resulted in the chemical identification of vitamin D_2 by Askew *et al* (1931) and Windaus and his colleagues (1932).

The work of Steenbock in the vitamin D field did not remain dormant. Besides extending the irradiation discovery to lactating animals, chickens and other foods, Steenbock explored the idea that antirachitic activity derived from one material might be different from that derived from another (1932). The chicken proved to be a discriminating organism that failed to respond adequately to irradiated ergosterol, unlike the rat, but responded very well to cod liver oil or to irradiated preparations of cholesterol (contaminated with 7-dehydro-cholesterol). Steenbock concluded that another form of vitamin D must be present in cholesterol and cod liver oil. This basic experiment was solidified by a student, Waddell, who provided firm evidence for another vitamin D which later became known as vitamin D_3 (1934). This was isolated and identified by Windaus in 1936.

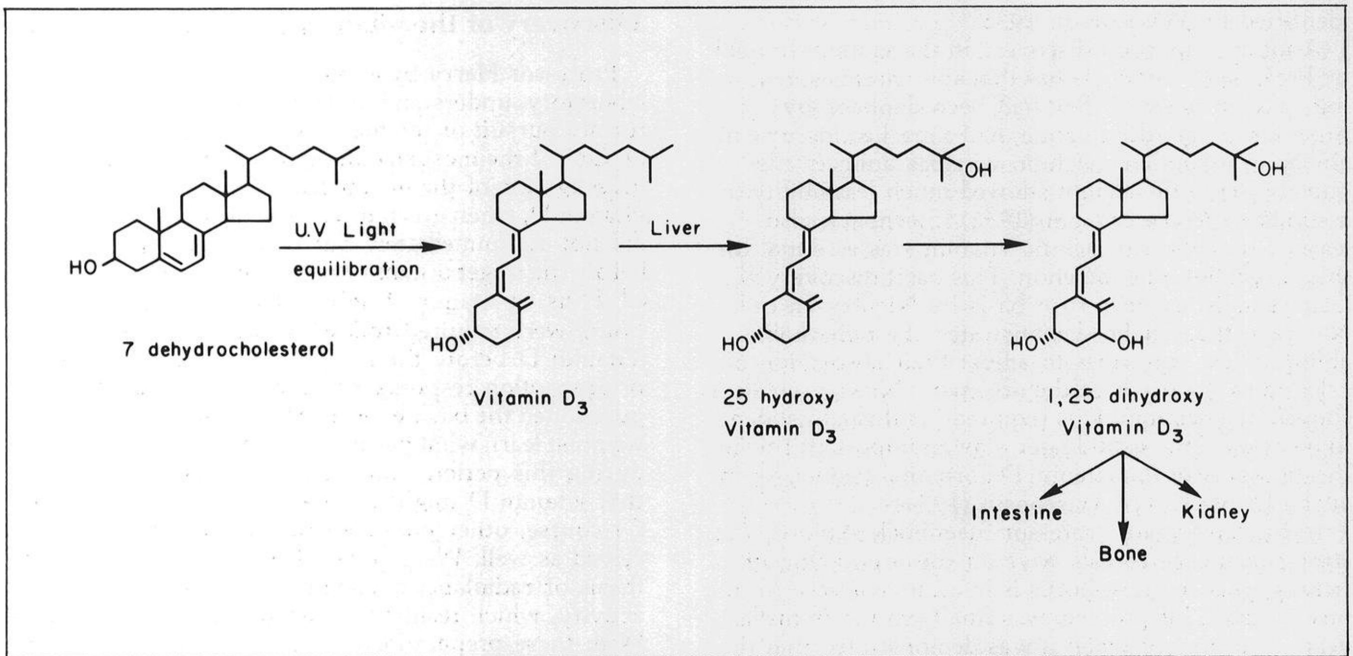
Another important discovery in the vitamin D field by Professor Steenbock was that adult animals, requiring calcium because they had been depleted by previous dietary deprivation, had a marked increase in ability to assimilate calcium, whereas animals adequately fed with calcium showed much less ability to assimilate dietary calcium (1932). Steenbock also learned that the antirachitic vitamin was essential for this adaptation phenomenon. This basic discovery was later established on a firm basis by Nicolaysen in Norway (1937), who demonstrated the remarkable ability of the intestines to adjust their absorption of calcium to the needs of the organism. Nicolaysen also showed that vitamin D is required for this adjustment to be made. This would later play an important role in the discovery of the vitamin D hormonal system, again at the University of Wisconsin (1974).

In his later years Professor Steenbock explored the strong influence cereals have on the production of rickets because phosphorus is in an unavailable form: phytic acid. This problem was finally solved in his last years as professor when it was demonstrated that the rachitogenic action of cereals occurred because the presence of large amounts of calcium made the phytic acid form of phosphate unavailable (1955).

Steenbock, in ill health during much of the 1940s, returned to his work on the function of vitamin D in a typically systematic way. He realized that to investigate the physiology of vitamin D function, there was need for the design of a chemically defined diet wherein calcium, phosphorus levels and vitamin D content could be exactly modified. Professor Steenbock contributed a final tool to investigate the mechanism of action of vitamin D by providing a series of chemically defined diets and observing their physiologic effects in the presence and absence of vitamin D. His interest in studying the mechanism of action of vitamin D was then passed on through his students. I was especially fortunate to be among them as one of Professor Steenbock's last graduate students. I was able to learn from him the physiology of vitamin D action and to investigate the problem of cereals and rickets and contribute to its final solution. Together with other students in Professor Steenbock's laboratory, I was next able to investigate the mechanism whereby citrate in the diet can cure rickets with the ultimate demonstration that the antirachitic activity of citrate was by means of complexing calcium, which made available phosphate from the phytic acid form in cereals and resulted in the healing of rickets (1956). Finally, as a postdoctoral fellow, I investigated the mechanism whereby citrate accumulates in tissues following vitamin D administration, focusing my attention on the subcellular action of vitamin D. This led to the demonstration that vitamin D in some unknown way prevents the rapid oxidation of citrate, causing its rapid accumulation in tissue. Most important, the stage was set for our investigations of how vitamin D might function.

Discovery of the vitamin D hormonal system

Professor Harry Steenbock provided support, laboratory, understanding and background knowledge for my pursuit of the mechanism of action of vitamin D. One of the most striking phenomena that led to our investigation of the metabolism of vitamin D was that vitamin D, when given to vitamin D-deficient animals, did not act immediately but required some 20 hours before the target organs of intestine and bone responded. Thus, in vitamin D-deficient animals, some 20 hours were required following the administration of Vitamin D before the intestinal calcium transport or absorption response could be registered. We questioned the biochemical basis for this lag. We knew we must learn what happens to the vitamin D molecule during this period, since it was entirely possible that vitamin D might be changed before it could act. Of course, other possible explanations were conceived as well. We proceeded with the chemical synthesis of radiolabeled vitamin D of high specific activity, which resulted in two different preparations. With these preparations we could demonstrate quite clearly that before intestine and bone could respond, vitamin D disappeared from the blood and tissues (1964). Instead there appeared modified forms which could be separated from vitamin D by the modern tools of chromatography. When these new forms of vitamin D were obtained in quantity and given to vitamin D-deficient animals, they proved to be more active and acted much more rapidly than the original vitamin D compound. It became clear that vitamin D must be metabolically altered before it could function. This led to a massive effort in my laboratory to isolate and identify these forms. In 1968 we successfully isolated and chemically identified the first of these, which has now proved to be the major circulating form of vitamin D, namely, 25-hydroxyvitamin D_3 (25-OH-D_3) (Figure 1). Chemical synthesis of this compound by our group proved its structure and provided a means for synthesizing radiolabeled 25-OH-D_3. The radiolabled 25-OH-D_3, when administered to vitamin D-deficient animals, was also rapidly converted to a more polar group of metabolites that appeared prior to the response of intestine and bone. This suggested that multiple activation steps were responsible for the final functioning of vitamin D. The discovery of biologically active metabolites of vitamin D, and the isolation and identification of 25-OH-D_3, resulted in the infusion of a large number of laboratories into the investigation of the metabolism of vitamin D. Simultaneously three laboratories then reported the existence of a metabolite in the intestine, more polar than 25-OH-D_3, that might be considered an active form. Variable reports on its biological activity appeared, casting some doubt as to whether it was an active or inactive form. We therefore conceived the idea that it would be most important to isolate the active form of vitamin D from its target tissue of action. Since the intestine is a target tissue, we initiated a massive attempt at isolation and



identification of the final tissue active form. From 1600 vitamin D-deficient chickens given a single dose of radioactive vitamin D, we isolated 2 micrograms of the intestinal metabolite in pure form and, by means of modern techniques of mass spectrometry and microchemical reactions, we chemically identified it as 1,25-dihydroxyvitamin D_3 (1971) (1,25-$(OH)_2D_3$) (Figure 1). We confirmed this deduction by chemical synthesis completed approximately one year later. At the same time, we isolated and identified a number of other metabolites of vitamin D that are currently being investigated for their biological role. However, the 1,25-$(OH)_2D_3$ proved to be the most potent form of vitamin D known: ten times more active than vitamin D_3 itself and twice as active at 25-OH-D_3. In a series of investigations we learned that the liver was the site of the initial hydroxylation of vitamin D to produce 25-OH-D_3. Kodicek in Great Britain was responsible for demonstrating that the kidney was the site of the second hydroxylation reaction. Furthermore, by removing the kidneys from vitamin D-deficient animals, we demonstrated that 1,25-$(OH)_2D_3$ must be the metabolically active form of vitamin D in stimulating the intestine and bone (Figure 1). The question of whether 1,25-$(OH)_2D_3$ is further metabolized before it stimulates the intestine to absorb calcium, the bone to mineralize or the bone to mobilize calcium remains to be established. Further metabolites of 1,25-$(OH)_2D_3$ have been isolated from our group but their biological importance has not yet been determined.

The 25-OH-D_3 can be converted further to 24,25-dihydroxyvitamin D_3 (24,25-$(OH)_2D_3$) or 25,26-dihydroxyvitamin D_3 (25,26-$(OH)_2D_3$). These two dihydroxylated vitamins are less active than 25-OH-D_3. Furthermore, current evidence suggests that they

Figure 1: A schematic demonstration of the activation of vitamin D as discovered at the University of Wisconsin-Madison by Professor Harry Steenbock and further elucidated by his student, Professor Hector F. DeLuca, department of biochemistry.

represent likely pathways for inactivation of the vitamin D molecule since they are less potent and are more rapidly eliminated. There have been suggestions by others that these forms of vitamin D play special functions but so far that remains to be established.

Of considerable importance was the discovery in our group that the need for calcium strongly regulates the production of 1,25-$(OH)_2D_3$ (1971). As serum calcium concentration falls, the production of 1,25-$(OH)_2D_3$ rises and the production of 24,25-$(OH)_2D_3$ falls. Thus, as the need for calcium rises, the organism responds by producing large amounts of the major calcium mobilizing hormone, 1,25-$(OH)_2D_3$. Since parathyroidectomy eliminated the response to low blood calcium in stimulating the production of 1,25-$(OH)_2D_3$, and the injection of parathyroid hormone could stimulate production of 1,25-$(OH)_2D_3$, it became apparent that the parathyroid glands were the controlling factor in regulating production of 1,25-$(OH)_2D_3$ (1973). Thus the sequence of events, in terms of regulating blood calcium, is that low blood calcium stimulates production of parathyroid hormone, a peptide hormone that then stimulates production of 1,25-$(OH)_2D_3$ in the kidney. The 1,25-$(OH)_2D_3$ then stimulates the intestine to absorb calcium; together with parathyroid hormone, it stimulates the bone to mobilize its calcium and stimulates the kidney to reabsorb its calcium. The rise in serum calcium then supresses parathyroid hormone secretion, shutting down the mobilization of calcium through production of the active hormone derived from vitamin D. The major calcium regulating hormone in the body is 1,25-$(OH)_2D_3$ with the parathyroid glands and parathyroid hormone serving as the chemical sensor and messenger respectively.

There are other factors that regulate production of 1,25-$(OH)_2D_3$. For example, during the stress of egg production in birds the sex hormones stimulate production of 1,25-$(OH)_2D_3$ to mobilize calcium in the small intestine and from bone for production of eggs and egg shells. Low blood phosphorus also stimulates production of 1,25-$(OH)_2D_3$ or its accumulation in blood. The 1,25-$(OH)_2D_3$ is also known to stimulate phosphorus absorption, giving a rise in blood phosphorus. Clearly the vitamin D hormonal system plays a basic role in the regulation of both calcium and phosphorus metabolism and is a central system to be considered in disorders of calcium and phosphorus metabolism and in metabolic bone disease.

In view of the new vitamin D endocrine system, it has become apparent the major vitamin D hormone could be of considerable significance in the therapy of bone diseases. This has led to a rush in the chemical synthesis of important analogs of 1,25-$(OH)_2D_3$. This rush has been led by our own research group, spearheaded by Professor Heinrich K. Schnoes of the department of biochemistry. We have synthesized two important analogs that are currently being used or studied for use in the treatment of bone disease. One of these is 1-alpha-hydroxyvitamin D_3 (1-alpha-OH-D_3)

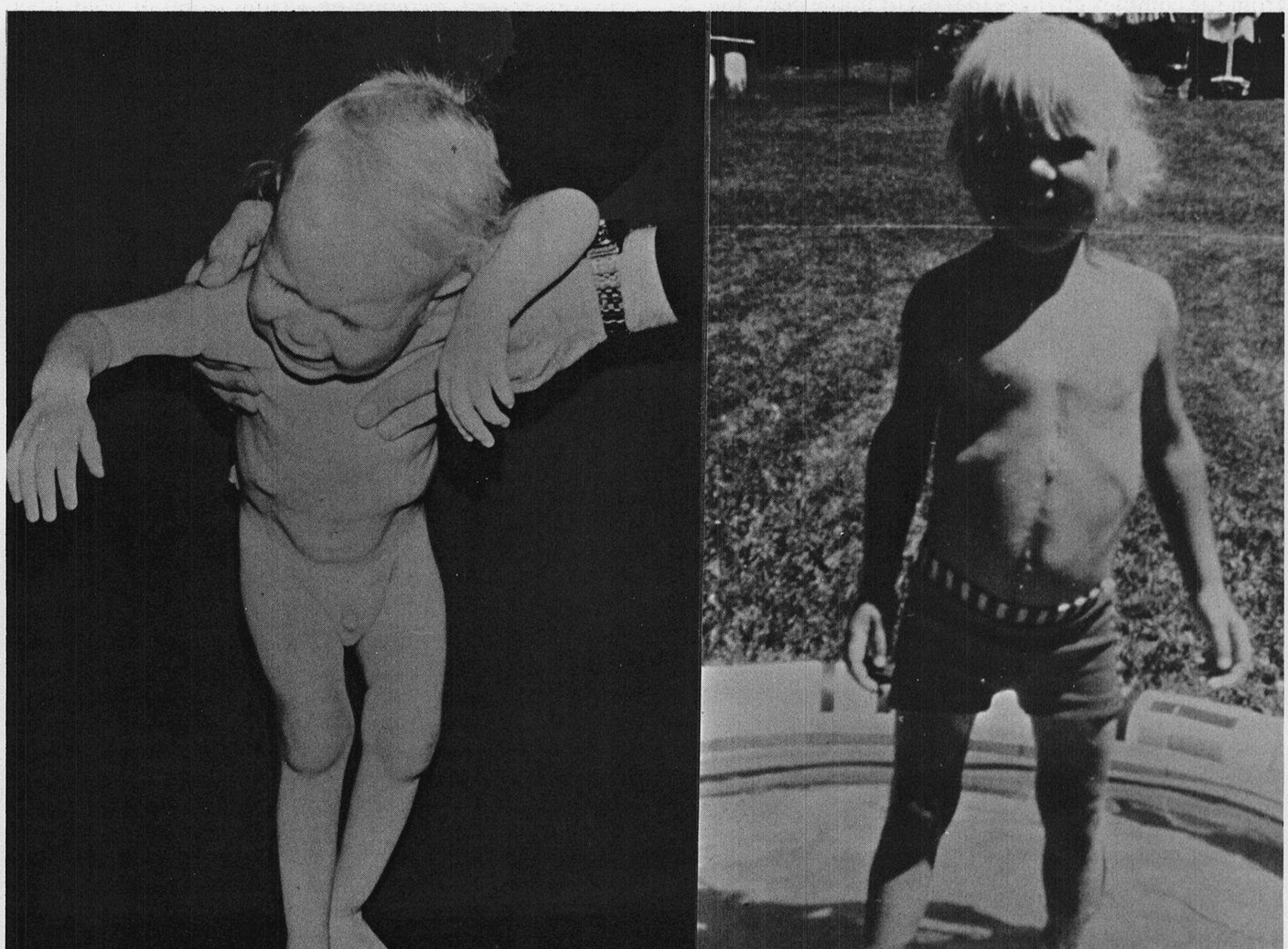


Figure 2: Response of a child with total kidney failure to administration of the vitamin D hormone 1,25-$(OH)_2D_3$ is dramatically illustrated. The picture at left shows the child prior to treatment and the picture at right shows the child 14 months later. During that interval the child received 0.5 micrograms of 1,25 $(OH)_2D_3$ daily. Had the child not received the vitamin D hormone, he would not have grown and he would be suffering a severe bone disease despite normal intakes of ordinary vitamin D.

and another is 1-alpha-hydroxyvitamin D_2 (1-alpha-OH-D_2). These compounds rely upon the patient's metabolic capability to insert a hydroxyl group on the 25-position in the liver. This appears to be easily done in a large number of disease states where the primary problem is a defect in 1-hydroxylation. The 1-alpha-OH-D_3 is being sold commercially in Europe under the trade name of "1-Alpha" by Leo Pharmaceuticals in Copenhagen, whereas, 1-alpha-OH-D_2 has not yet achieved commercial importance. On the other hand, 25-OH-D_3 is being marketed in Europe by the Roussel Company and 1,25-$(OH)_2D_3$ is being marketed in the United States and Europe by Hoffmann-La Roche under the trade name of "Rocaltrol".

Use of the vitamin D metabolites

As with Professor Steenbock's discovery that resulted in the elimination of rickets as a major medical problem, the second development in the vitamin D story, namely, the vitamin D metabolites and their analogs, also has its medical importance. It is clear from the complex changes that occur in the body that a number of disease states could be the result of, or associated with, a disturbance in the vitamin D endocrine system. For example, patients who have lost use of their kidneys and are maintained on hemodialysis obviously suffer from a lack of 1,25-$(OH)_2D_3$. In children this is dramatically represented by a serious failure to grow as well as by severe rickets and bone disease. In adults this results in what is known as a secondary hyperparathyroidism and osteomalacia, which is failure to mineralize remodeling bone. The entire syndrome of bone disease associated with chronic kidney failure is called renal osteodystrophy. It is in efforts to cure this disease that the primary application of the vitamin D metabolites has taken place. Rocaltrol or 1,25-$(OH)_2D_3$, 1-Alpha or 1-alpha-OH-D_3, and even 25-OH-D_3 in large amounts, are being used to treat this disease in an extremely successful manner. This is illustrated by the plate showing the growth response of a child treated with 1,25-$(OH)_2D_3$ for a period of 14 months by Dr. Russell Chesney at University Hospitals (Figure 2). This extraordinary growth effect is associated with marked mineralization of bone, which would not have occurred if the child had not received 1,25-$(OH)_2D_3$.

Clearly the vitamin D hormonal system plays a basic role in the regulation of both calcium and phosphorus metabolism and is a central system to be considered in disorders of calcium and phosphorus metabolism and in metabolic bone disease.

The response of these children to the vitamin D metabolite or hormone, 1,25-$(OH)_2D_3$, is truly a remarkable phenomenon. Similar but perhaps less dramatic responses are found as well in adults suffering from this disease. Approximately 10 percent of the patients suffering from renal osteodystrophy fail to respond to 1,25-$(OH)_2D_3$. The reason for this is unknown at the present time.

A number of other diseases have been treated successfully with 1,25-$(OH)_2D_3$. They are hypoparathyroidism, pseudohypoparathyroidism, vitamin D-dependency rickets and x-linked hypophosphatemic vitamin D-resistant rickets and Fanconi Syndrome. Of considerable importance is the use of the vitamin D metabolites in the treatment of the most widespread of the metabolic bone diseases, namely, osteoporosis. Current clinical trials are under way at the Mayo Clinic and at Creighton University in Omaha to test the possibility that 1,25-$(OH)_2D_3$, given to postmenopausal osteoporotic females, might markedly alleviate the negative calcium balance and, in long-term, prevent their bone loss. It is also possible that increased accretion or accumulation of bone may result from the judicious use of the vitamin D metabolites. The possibilities are very great that the vitamin D metabolites and their analogs will be of great importance in the treatment of metabolic bone disorders. An additional feature is that the vitamin D metabolites markedly stimulate muscle strength. Thus, it seems possible that the aging population will benefit not only by improvement of their bone, but perhaps by improvement of muscle strength as well.

Vitamin D in the future

Vitamin D investigations are directed toward elucidating the full picture of how vitamin D is metabolized complete to its excretion products and how its metabolism is regulated. This will lead us to understanding of the as yet unknown functions of vitamin D and the possibility that different forms of vitamin D might carry out heretofore unknown functions. Another area of intense investigation is how 1,25-$(OH)_2D_3$ directs the intestine and bone to utilize calcium and phosphorus. Although we cannot tell at this stage whether there will be practical benefits from this investigation, we already know that there are some forms of vitamin D resistance that are found even to the hormonal form 1,25-$(OH)_2D_3$. Whether there is a necessity for further metabolism to obtain active forms or whether the machinery that responds to the active vitamin D hormone is defective remains unknown. Nevertheless, we must continue to seek the answers, as Professor Steenbock would, as to how vitamin D brings about a marked improvement in the condition of bone, muscle and other tissues.

Hector F. DeLuca is Steenbock research professor and chairman of the department of biochemistry at UW-Madison.

IN MY VIEW . . .

Science, Democracy and Doubt

by Robert H. March

I am often dismayed by the distress that surfaces whenever a controversy among scientists reaches the public media. "If even these experts can't agree," people seem to feel, "then where can we turn?"

What dismays me is not just that this shows a widespread public misunderstanding of the nature of science. In nearly a quarter century as a scientist, I have learned to live with that, and to make an effort, however feeble, to combat it. Far more serious, in my view, is what this distress reveals about our basic psychology, a revelation fraught with danger for a society that stakes its hopes on the free interchange of ideas.

There seems to be a compelling need in most people to ground their lives on a system of beliefs that stands above question. This is understandable, for the world is a strange and threatening place, and only a fool feels fully in control of his or her destiny. Surely, this is one of the prime movers behind religion. In most religions, doubt is anathema.

In Western society, however, we are taught to turn not to religion but to science for a basic working understanding of the natural world. In the public eye, a scientist becomes a sort of minor high priest, within certain narrow limits of specialization. Every utterance is supposed to stand on the authority of unquestionable fact, painstakingly checked and rechecked by objective observers in full control of their emotions.

But controversy is in fact the very **essence** of science. A field of research that does not enjoy competing schools of thought, alternative interpretations of the same body of data, the clash of rival ideas and personalities, is a field that has ceased to contribute to the advancement of human knowledge. It is already a "fossil" science, and its practitioners are merely caulking the cracks and tidying up the facade of an edifice whose basic structure has long been completed.

Even the facts on which science is built are themselves suspect. This is not to say that the standards of scientific observation are shoddy; they are indeed among the most stringent of any form of human activity. Before they see print, a scientist's findings are reviewed by co-workers and colleagues, and by referees appointed by the journals to which the work is submitted. Inconsistencies or disagreements with others may not be passed over, but must be mentioned and dealt with. Yet despite all this care, something like 20 percent of all scientific papers turn out to be dead wrong.

For this reason, scientists are acutely aware that facts can be slippery things. They tend to be highly skeptical about the smug certainty often exhibited by journalists or political pundits, whose conclusions are usually grounded in a "data base" far less secure than that of science, and who do not always feel obliged to give full weight to contrary indications or alternative explanations.

Even well-established facts rarely stand on their own two feet, outside a theoretical context. When I assert that "the sky is blue," I am making a host of tacit assumptions about the reliability of color vision and its relation to the wavelength of light, and dismissing as

A field of research that does not enjoy competing schools of thought, alternative interpretations of the same body of data, the clash of rival ideas and personalities, is a field that has ceased to contribute to the advancement of human knowledge.

irrelevant such temporary, local or personal factors as clouds, air pollution or color blindness. These assumptions are harmonious with my world view, and have met the test of time, so I can make the statement with some confidence and expect most people to nod agreement. But this is rarely the case in the frontier areas where real progress in science is forged. Here distinguishing between what is essential and important, and what is extraneous or trivial, is often a matter of taste, intuition and judgment. The best and most creative scientists are usually those who dare to press these qualities to the utmost, and as a result they are often wrong.

A few years ago Richard Feynman, one of America's most gifted theoretical physicists, was giving a public lecture to an audience of widely varying backgrounds. One spectator, refusing to be cowed by Feynman's towering reputation, pointed out a mistake in spelling on the blackboard—one wrong letter in a ten-letter word. "I hope," the critic interjected, "that your physics is better than your spelling." Feynman counted the letters and replied "Nine out of ten? Naw, my spelling's still better than my physics!"

Hardly a scientist reaches professional maturity without having been forced to surrender a cherished belief, or admit in public to a serious mistake. Nobel prizes are rarely awarded for discoveries that confirm accepted wisdom, but instead go to those who upset the applecart.

For this reason scientists, whatever ideology they may espouse, are usually staunch defenders of democratic free expression. It is no accident that so many prominent Soviet dissidents come from the ranks of science. In Argentina, the names of scientists are conspicuous on the list of "missing" political prisoners.

In our own nation, the resistance of scientists to political repression was one of the rocks upon which the witch hunts of the McCarthy era foundered. Edward U. Condon, though hounded from the directorship of the Bureau of Standards by a vindictive Richard M. Nixon, never ceased to play a prominent role in public life. An appeal to the Supreme Court by physicist Bruce Dayton won the right to foreign travel for America's own "refusniks," dissidents who had been denied passports. And the condemnation of J. Robert Oppenheimer proved a pyrrhic victory, leaving his accusers isolated and reviled in the scientific community.

So if science has a "message" to offer us in our day-to-day lives, it is the opposite of the one it is usually asked to deliver. It is to learn to live with doubt and always question the premises of every orthodox belief. Certainty is not to be found this side of the grave. Embrace confusion and controversy, for that is the stuff life is made of.

Robert March is professor of physics at UW-Madison.

BONES

by Credo Enriquez

The study of bones
in winter
in Wisconsin
is inevitable:
Blond men
Dissecting tables
Snow.

Somewhere the professor writes
A bone is a perfect object.
Later he will pass out samples
from a corrugated box
marked Floor Wax.
It is snowing outside, softly
a Liszt-snowing
the trees vibrating
from the weight
of new snow-meat.

On the table the bones:
Matching clavicles
A sacrum sawn in half
Symmetrical ribs
The humerus and fibula
The vertebrae in ascending order
All rich brown on the objective tiles.

25 years of science in Wisconsin schools

by Kenneth W. Dowling

Science has not always been important in the elementary and secondary school curricula. Natural philosophy, which examined questions pertinent to science, was included in classic education, but science education as it is known at the present time is derived from a strategy called object teaching. This procedure was designed to improve the mental faculties of students by requiring them to memorize the characteristics of innumerable objects in their natural surroundings. Through a series of changes and varied purposes, the science curriculum evolved from that beginning to become a study of the scientific process and the knowledge that process has produced.

By 1954, the time of the first publication of the *Wisconsin Academy Review*, science education in Wisconsin had, perhaps from lack of motivation for further innovation, settled into a predictable pattern. At the elementary level, students were given a descriptive introduction to natural phenomena involving, as far as possible, teacher demonstrations and occasional student activities designed to demonstrate that the facts presented by the teacher or the textbook were correct. At the early secondary or junior high school level, general science prevailed. This consisted of a series of topics related to the needs of society and the ways in which science, applied through technology, met those needs.

At that time a seventh, eighth and ninth grade series of science textbooks, authored by Professor Ira C. Davis of the University of Wisconsin-Madison, dominated the general science program in Wisconsin. Beyond ninth grade, the standard program for college-bound students was biology, chemistry, physics and occasionally advanced science. Seldom was earth science taught, even though it had been introduced near the turn of the century and had been popular for several years. Of course, the rate of attrition in the science sequence was high, with a few of the better students completing the entire sequence; but even these had a weak academic preparation in the science fields.

Reaction to Sputnik

In 1957, the Russian space program, demonstrating dominance over that of the United States, spurred intense political activity aimed at improving this country's capability in science and technology through training of more and better scientists. Congress created the National Defense Education Act in direct response to this need. Money suddenly became available for school programs in science, mathematics and foreign language.

At about the same time the National Science Foundation, an agency of the federal government, received large sums of money for science education programs directed toward teacher training and program improvement. Universities throughout the country were granted funds to hold summer institutes and academic year institutes for science and mathematics teachers, with full stipends and travel allowances. These programs put a heavy emphasis on academic subject matter to upgrade the knowledge of teachers, who were then expected to carry this newfound knowledge back to their classrooms. In all cases, full credit was given and, in many cases, institute work led to graduate degrees.

In concurrence with programs for teacher education, the National Science Foundation launched a program of science curriculum development with the Physical Science Study Committee's physics curriculum that was soon followed by programs in chemistry and biology. The Biological Sciences Curriculum Study, started at that time, is still in existence as a non-profit corporation in Boulder, Colorado. Not far behind followed major efforts to develop accelerated programs in junior high school science.

Finally, attention was directed toward the elementary school science program where a new emphasis emerged at a 1960 meeting sponsored by Dr. John Mayer, director of the Commission on Science Education of the American Association for the Advancement of Science. This meeting was held at the Wisconsin Center on the campus of the University of Wisconsin-Madison (where Dr. Mayer had previously been a professor). This emphasis stressed developing competence in the processes of science through direct experiences. It was assumed that this experience would consequently improve student ability to acquire scientific knowledge. Another response of science educators to the new interest in science and technology was the 59th Yearbook of the National Society for the Study of Education published in 1960, *Rethinking Science Education*. This book identifies the new goals for science education emerging at that time.

While educational philosophy formed the early basis for science education, the science curriculum development of the '60s rested largely upon interpretation of research in educational psychology. Jerome S. Brunner of Harvard

Teachers, and the Junior Academy

by LeRoy Lee
Director, Junior Academy

In the first issue of the *Wisconsin Academy Review*, published in the winter of 1954, John Thomson, chairman of the Junior Academy Committee, wrote about Junior Academy news and program plans. He mentioned the district meetings of senior high school students at Appleton, Milwaukee, Stevens Point and Eau Claire and a state meeting to be held for seventh, eighth and ninth grade students.

His report also mentioned the Seminar Club of Bradford High School, Kenosha, sponsored by chemistry teacher Mary A. Doherty. As well as producing a rotating issue of the Test Tube Times, the club was planning a science fair, anticipating a repeat of the crowd of 3000 that had attended the previous year's fair.

Twenty-five years later Mary A. Doherty was honored at the Academy's 1979 Annual Meeting in Kenosha with a special Certificate of Appreciation for her more than 40 years of service to youth, and to the principles of the Wisconsin Junior Academy. A tribute to her by Carl W. Bruch, one of her students, accompanies this article. Bruch is now deputy associate director for device evaluation for the Food and Drug Administration. He is responsible for collection and evaluation of data on significant hazards to public health that may be caused by the use of medical devices and diagnostic products. He also provides medical and scientific guidance and opinions for the development and interpretation of policies and regulations concerning such devices and products.

From Miss Doherty's class at Bradford High School Bruch went on to Michigan State University for a BS in microbiology and then to the University of Wisconsin for his master's and PhD. There followed an impressive career in bacteriology, microbiology and exobiology as researcher and laboratory director.

As director of the Junior Academy since 1969 it has been my experience that many of the young people whose interest in science is stimulated by Junior Academy science programming pursue scientific careers or gain a real understanding of the scientific process. Dedicated teachers such as Mary Doherty are essential to the success of Junior Academy-sponsored science congresses and symposia around the state. The Junior Academy, in the role of facilitator, along with devoted teachers, can continue to offer expanded opportunities to talented youngsters, a goal, I believe, that would also have had the enthusiastic support and approval of those early day scientists and members of the Academy pictured on the cover of the very first *Wisconsin Academy Review:* Thomas Crowder Chamberlin, geologist; Increase Allen Lapham, geologist; George William Peckham, zoologist; Roland Duer Irving, geologist; and Philo Romayne Hoy, physician and naturalist.

A teacher who mattered: Mary A. Doherty

by Carl W. Bruch

The embryogenesis of my scientific career started with the observation of the many living forms, both animal and plant, in my immediate childhood environment. Although my parents had no formal connection with any of the scientific disciplines, they encouraged my desire to grasp the beauty and workings of life around me.

My career shifted in the direction of the physical sciences, particularly chemistry and mathematics, when I took a high school chemistry course with Mary A. Doherty. Her own training had been in classical chemistry, but she was farsighted enough to recognize the role that chemistry would play in the natural sciences. By attracting my attention with her zeal and holding me with the strength of her own determination, she propelled me into a better grasp of those subjects for which even she had had no prior training. Her encouragement and recognition that I possessed the basic ability to develop a course of action to investigate problems of interest to me and reach satisfactory conclusions gave me the confidence to undertake limited science projects.

I completed my high school chemistry course during my junior year at Kenosha (now Mary D. Bradford) High School. The following summer of 1946 I worked in the local factories to gain money for my college career. Upon my return to high school in the fall of 1946, Miss Doherty quickly collared me and informed me that she was going to enter me in the scientific project competition of the annual state science talent search conducted by the Wisconsin Junior Academy in collaboration with the Westinghouse Science Talent Search. What was I going to do for a scientific project? Her question left no doubt that I would have a science project that school year.

My project dealt with the effects of organic (humus) nutrients versus direct chemical additions on the growth of geraniums in a greenhouse environment. Even now, when I snap off the dead leaves of the geranium plants in my office and smell the residual geranium oil, my thoughts immediately go back to that high school greenhouse and the joy and the excitement I had in charting the daily growth of my geraniums. With a gentle tenacity Miss Doherty challenged my controls for the experiment and my interim analyses of cumulative data. She cautioned about the basic bias that I brought to the experiment since my unshakable belief was that the organically grown geraniums would grow faster and more luxuriantly than those fed by direct chemical addition to the basic minimal sand-soil mixture. Although the experimental results followed my hypothesis, her scientific objectivity gave me an initial appreciation of the pitfall of "self-fulfilling prophecy" in scientific research.

Between basketball practice and other extramural activities, I wrote up my experiment and its results. I can honestly say that I wrote the project in my own language with Miss Doherty acting more as an adversary for some of the analyses and conclusions that I reached. As a critic she was superb, yet she had a humorous gentleness that was coupled with an intense passion to see science performed properly. I left her presence never intimidated but definitely challenged.

In the early spring of 1947 Miss Doherty entered me and another classmate in the science project program of the Wisconsin Junior Academy. I can remember rehearsing my presentation in front of her. The trip to Marquette University and the actual presentation of my findings in a large science lecture room, with a steeply sloping deck of desks to the rear, impressed me with the rigorous and stern image with which science frequently portrays itself. Actually, Miss Doherty's own humaneness enabled me to cope with the intimidating atmosphere.

And now, 33 years later, I can look back with tremendous gratification that a human being as dedicated as Miss Doherty was the turning point for my own scientific career. Her allegiance to the goals and programs of the Wisconsin Junior Academy of Science can never be doubted. I experienced a warm sense of inclusion when I learned that she had been recognized by the Academy with a citation attesting to her outstanding contribution to youth. That I was accorded the opportunity in this tribute to share her influence on my own scientific career should not diminish the contribution that she made in the lives and careers of other students who had the great fortune to pass under her tutelage. The achievement of a dream always requires good guides.

Carl W. Bruch is deputy associate director for device evaluation at the Food and Drug Administration.

published *The Process of Education* in 1962 in which he stated, "We begin with the hypothesis that any subject can be taught effectively in some intellectually honest form to any child at any stage of development." This assumption opened the door to accelerated teaching in science and led to interesting, but perhaps misinterpreted, experiments such as the attempt to teach the elements of relativity in second grade. Another psychologist, Robert M. Gagne, influenced science curriculum extensively with his 1965 book, *Conditions of Learning,* which described learning as a hierarchy of events. He influenced the shift to a new dependence on behavioral objectives for developing competence in science processes, such as observing, predicting and inferring. This was not an entirely new idea since in the '30s writers had been concerned with identifying "desirable functional outcomes" for their curricula. But with Gagne's reiteration, behaviors took on a new importance.

This period in the history of science education in Wisconsin saw more activity than any period before or since. Full Academic Year Institutes for science teachers ran from 1958 through 1974 at the Madison campus of the University of Wisconsin, with a later emphasis placed upon training of science supervisors. Programs also started at UW-Milwaukee and later at other Wisconsin universities and colleges. Corresponding training was available to teachers and supervisors of mathematics. During the same period, graduate fellowships and other assistance became available on the Madison campus, and an increasing number of students, largely under the guidance of Professor Milton O. Pella, completed doctoral degrees in science education and went on to leadership roles in all parts of the country.

Professionals group

Until this period there had been limited professional activity among science teachers in the state. However, with new training and interest, Wisconsin science educators increased their participation in regional and national professional organizations, such as the Central Association of Science and Mathematics Teachers, now the School Science and Mathematics Association, and the National Science Teachers Association. Within the state, the Wisconsin Society of Science Teachers was formed and began to grow both in membership and range of activities. In 1963 the Wisconsin Society of Science Teachers became formally affiliated with the National Science Teachers Association and has continued since then as the major professional organization for science teachers in Wisconsin. At about the same time that WSST was established, several regional science teachers' associations also organized. Most significant of these is the Milwaukee Suburban Science Teachers Association, which is still strong in the Milwaukee area.

Students feted

The increased emphasis on science also resulted in development of local, regional and state programs for outstanding science students. Competitions at science fairs became common, and students with truly outstanding work entered at the state-wide competition sponsored by Marquette University in Milwaukee. In Madison, the Wisconsin Junior Academy of Sciences developed a series of regional competitions that led to an annual state-wide competition where greater attention was paid to student research than had been common in science fairs. With the support of University of Wisconsin President Conrad Elvehjem, the United States Army initiated another annual student program, the Junior Science and Humanities Symposium, at the UW-Madison. A second annual symposium was later introduced at the UW-La Crosse. These symposia led outstanding student science researchers to a national student symposium where research projects were presented and judged and where Wisconsin students met outstanding scientists such as J. Robert Oppenheimer and Margaret Mead. With some modifications all of these programs still exist.

Although it seemed that a new direction had been set for the science curriculum, the stability of the '50s gave way to the period of turmoil in the late '60s when values of all kinds were questioned and a new concern was expressed for the increasing degradation of the environment. Whereas science and technology had been accepted as the solution to the problems of national prestige and the space age, the same coalition of science and technology was now being blamed for new problems that were being recognized. Under this social stress, the direction of science education changed from one of accelerated academic learning of the science disciplines to one of emphasis on a new scientific literacy; that is, the emphasis in science teaching shifted from the college-bound students with scientific potential to all students, who would hopefully become thinking citizens who understood the nature of science and the way science interacts with society.

A scientifically literate public

It was important to scientists and to science educators that the public learn to appreciate the role of science and the technological application of scientific knowledge to the solving of social problems. The nature of the curriculum projects funded by the National Science Foundation throughout the '60s illustrates this change of direction. The early projects emphasized academic themes. For example, the Physical Sciences Study Committee's physics course emphasized wave mechanics. Within the decade a new physics curriculum, Project Physics, was developed at Harvard University with an emphasis on the cultural aspects of physics. One of the last major projects, the Individualized Science Instructional System, was directed to a large extent to the role science plays in the life of the nonacademic student.

The changing emphasis in

science education is reflected in the response of Wisconsin schools to the major NSF curriculum projects. Adoption of these projects peaked in the 1966-67 school year when interest in preparing students for science careers was highest. In the 12 years since there has been a definite trend away from these programs (see table).

A lower priority

Many changes in science education since 1970 have resulted from withdrawal of financial support by federal sources. Where the NSF and the original National Defense Education Act had strongly supported science and mathematics, the new federal programs were directed toward all school curricula. In 1965 the Elementary and Secondary Education Act (ESEA) had been passed, which provided large amounts of money to all areas of the school program. In the same year the National Defense Education Act (NDEA), which provided matching funds for acquisition of equipment and materials for teaching science, mathematics and modern foreign language, was revised to include social studies, English, reading and language arts. Two years later NDEA was revised again to include industrial arts, physical education, art and music.

Extensive changes in ESEA in 1973, to consolidate federal categorical support for education, tended to further diminish the emphasis on science that had come from political considerations 15 years earlier. With its decreased importance in the public eye, science education became a lower priority for school administrators and teachers. As an alternative, the concern for career education and basic education grew in momentum and continues to do so to the present time. In many cases in which external financial support was not forthcoming, as it had been a few years earlier, school districts cut back science programs, recognizing that science education is often more expensive than education in other disciplines.

It is not difficult to understand why, in the midst of an intellectual reversal, Wisconsin science educators started to define a new role for science in school programs. Even in the late '60s the stress on scientific literacy was an indication of that change. As a result, the curriculum recommendation that came from the Wisconsin Department of Public Instruction in 1969 emphasized not only concepts and processes in science but, in addition, the need for students to be aware of the nature of the scientific enterprise and to understand the cultural implications of science. Unfortunately, this shift in emphasis was not compatible with the training and experience of science teachers in the schools. Not only did they have trouble in developing classroom activities concerned with scientific literacy, but they even tended to reject activities presented to them by others. Perhaps this lag in implementation explains the fact that those concerned with the quality of education, such as Dr. Carl Rogers, condemn the schools. Rogers once wrote that "Traditional education is the most rigid, outdated, bureaucratic, incompetent institution in our culture." That statement is perhaps more emphatic than it should be, but it points out the fact that school systems are slow in reacting to social pressures.

Percent of Students in Biology, Chemistry and Physics Enrolled in National Science Foundation Curricula

School Year	Program	Biology	Chemistry	Physics
1966-67	NSF	47.5	40.6	32.3
	General	52.5	59.4	67.7
1978-79	NSF	22.9	15.5	7.7
	General	77.1	84.5	82.6*

*In this statistic, Project Physics, which was not available in 1966, accounts for the additional 9.7 percent of the 1978-79 physics enrollment.

In analyzing these data it should be pointed out that although enrollments in the specialized curriculum projects peaked and then dropped drastically, the influence of such curriculum developments on the traditional printed materials produced through private enterprise was considerable. Many of the materials used in the so-called general courses strongly reflect the developments of the NSF-sponsored curriculum projects.

The systems approach

As federal programs operated through the United States Office of Education became more general, the NSF remained alone as the major resource for funding science education. By 1970 the number of NSF teacher institutes declined and remaining university programs emphasized training teachers in the specifics of the NSF curriculum project implementation. In Delaware, a project known as the Del-Mod System was funded by NSF as a total approach to improving science education and mathematics education in the entire state. A similar project, begun in Oregon, devoted itself entirely to mathematics. Another in New York

City emphasized science.

This "systems approach" to improving science and mathematics education led to another kind of regional project referred to as the "comprehensive project." These projects, with more limited objectives, were funded in several states with project directorship residing at universities. In Wisconsin, the Center for Advancement of Science Education at UW-Superior, in cooperation with the Wisconsin Department of Public Instruction, adapted the comprehensive idea to make the most effective use possible of reduced budgets. This project, referred to as the Wisconsin Implementation Network (TWIN), involved six University of Wisconsin campuses where specialized courses devoted to teacher training in specific curriculum projects were conducted.

The emphasis on implementation of NSF-sponsored curricula eventually led to severe criticism by the Congress. Several congressmen and senators, including Senator William Proxmire of Wisconsin, asserted that NSF was in unfair competition with private enterprise when it used federal funds for developing and promoting education materials in the schools. This, coupled with criticism of the content of some of the later curriculum projects, led in 1975 to severe cuts in the NSF budget for science education; many programs were discontinued. Two years of funding for the Wisconsin Implementation Network ended at that time. This abrupt end left little chance for NSF programs to develop new, and perhaps more appropriate, objectives.

The status quo

Since 1975 the science curriculum effort has been to maintain the status quo, with only local funds available for development and implementation. The reaction to this change may already be occurring. A recent report from the National Research Council indicates that in science education there is evidence that "The inquiry method may be giving way to a didactic approach to science teaching in which the student's main role is to listen, read and memorize." The NSF has been given a reduced budget to continue some programs to improve science backgrounds of pre-college science teachers, but these programs are limited to academic preparation in the sciences. There are also minor programs for information dissemination and materials development, but there is an absolute prohibition on funding for implementation of any specific science curriculum.

Quality of life

In light of the history of science education in Wisconsin and in the

Two boys in a high school chemistry class concentrate on their experiment.

Dave Roberts, West High School, Madison

nation it is interesting to predict the future. One of the men who has been very influential in the development of science over the past several decades is Dr. Paul deHart Hurd, now professor emeritus from Stanford University. Dr. Hurd recently published an article in which he identified trends in science education for the period from the present to 1985. Among many other trends, he predicts that teaching emphasis will shift from imparting knowledge for the sake of knowledge to knowledge for its potential for improving the quality of life, that is knowledge that will be used in real life rather than knowledge as it might be structured within a discipline. He no longer expects nationwide curriculum development but sees local curriculum development as the only alternative. Pure science will be diminished in favor of the relationship between science, technology and societal values. He expects the curriculum of the future to be flexible and modular in organization with an emphasis on perceptions, inferences, social values and esthetics.

In a more general sense, it might be expected that in the next few years, science education will be oriented to the future. It seems hardly possible that the heavy emphasis on information can continue to dominate the interaction of science and technology with the emerging problems of society. Rather, science education and social studies education will tend to coordinate efforts to consider social issues as they impinge on scientific investigation. The way science effects solutions to social issues will be important to both fields. Already, in the area of biology, workshops have been held for Wisconsin science teachers on issues resulting from application of new technology in research areas such as genetic disease, and genetic engineering. In these workshops social issues have had a primary focus. An interesting secondary effect of such change is the obvious need to eliminate much of the material that has been in the traditional science curriculum in order to leave time for examination of issues.

How basic is science?

Although these trends will determine the nature of science education, support for teaching science will depend on the interaction of two other important factors. On one hand, there is a very strong social pressure to force schools to stress the basics—in the most conservative sense, reading, writing and mathematics. On the other hand, the thrust toward a universal scientific literacy and the need for more career scientists is again having an impact on congressional decisions. As long as the basics trend dominates, science education will be supported to the extent that studying science can be interpreted as contributing to basic education. Thoughtful educators have already seen that studying communication and mathematical skills out of context with real experiences will not be successful. Such experiences have to be in the realm of the social and natural sciences.

For communication or calculation to be meaningful, one has to have something to communicate or calculate about. The fact that there is a weakness in application skills was demonstrated recently when the National Assessment of Educational Progress reported that nine-, 13-, and 17-year-old students are quite competent in doing arithmetic operations, but they cannot think through real situations, select pertinent data, or, in fact, solve real problems. In an address at a recent state meeting for school district directors of instruction, Dr. Donald Chambers, supervisor of mathematics at the Wisconsin Department of Public Instruction, stated that, "Lack of problem solving in real life situations is the weakness in mathematics learning."

Reading, writing about science

It may well be argued that the needed emphasis on problem solving should come from the study of science where problems are empirically solved by collecting data, analyzing data and using the results to formulate explanations. Where data are quantitative, analysis necessarily requires mathematical application. Explanation requires expository writing skills and ideally, when one question leads to another, the science student must eventually turn to meaningful reading of the hypothoses of others to satisfy a developing curiosity. Of course, to meet the need for basic education, science teaching's goals and practices would have to change from those of the descriptive programs that are so often observed.

The emphasis on basics, with or without science, is happening now, but it appears that new direct support for science education is also building. After the severe cut of the NSF pre-college education budget in 1975, only token teacher education programs remained. Now these programs are gaining strength and, interestingly, in September of this year, a House-Senate conference committee agreed to leave primary responsibility for science education with NSF rather than shift it to the newly created Department of Education. In addition, after listening to voluminous favorable testimony, the House added $4.7 million to the NSF pre-college education budget for fiscal year 1980. Within the testimony that gained this new support was a statement by Edward Moore, executive dean of Indiana/Purdue University at Indianapolis: "I believe that this generation will, between now and the year 2000, renegotiate the social contract with science and scientists. Unless strong national efforts are made quickly to improve the understanding of science by the layman, this renegotiation may lead to disaster."

This kind of thinking may make it unnecessary for science educators of the next decade to apologize to the promoters of the basics for asking to be included in relevant teaching programs.

Kenneth W. Dowling is science education supervisor for the Wisconsin Department of Public Instruction.

The boy astronomer of Cottage Grove

by Paul Thompson

In 1970, the magazine *Sky and Telescope* noted the death of "one of the most successful amateur hunters of comets in America."

The passing of John Edward Mellish at the age of 84 in a nursing home in Meford, Oregon, marked the end of a little-known but interesting chapter in Wisconsin astronomy. Mellish attracted national attention in the early part of this century as the "boy astronomer of Cottage Grove" who discovered comet after comet.

He was born on January 12, 1886, and grew up on his grandfather's farm three miles south of the village of Cottage Grove. His grandfather, Benjamin Stimson, was a pioneer resident of the township. Born in Vermont in 1829, Stimson was six when his family moved to Ohio, where they remained until 1849, when they moved to Wisconsin. He came to Cottage Grove at the age of 20.

One of Stimson's daughters, Sedora, married an English immigrant, Arthur Mellish, who settled on the farm with his wife. Three years after their son John was born, they had a daughter, May.

An 1895 agricultural census recorded that the Stimson farm consisted of 41 acres of land, including 9 acres of corn, 6 of oats, and a half acre of potatoes. The rest must have been pasture for the livestock and woodland. The census recorded 5 head of cattle, 3 draft animals and 2 "milch cows."

It was an era of kerosene lamps, outdoor privies, water pumped by hand and travel by buggy or bicycle. Hard work and fearing God was the code by which farmers lived. Education was a luxury many couldn't afford. John Mellish attended only grade school.

"All his life has been spent on the farm, doing the hard work that is the portion of every country boy," the *Wisconsin State Journal* reported when John Mellish's first comet discovery drew attention to him. "His education has been limited to what he received in the district school and what he learned unaided by any teacher in the moments he could snatch from his work."

His interest in astronomy began in 1902 at age 16 when he bought or was given a little spy glass. He used it at first to look at distant objects in the landscape, and then he turned it on the moon and stars, but the glass was too weak to see anything.

He bought a $4 telescope advertised in the newspaper and turned it on the moon, where he was surprised to see streaks (probably lunar rays) and "wavy things that looked like flames," he told a reporter later. Finding the instrument inadequate, the teenager earned money by helping an uncle who was a carpenter. He bought a $16 telescope, a two-inch refractor. "With it, I was able to see many new stars and, I tell you, I was happy then."

During this time, he was reading everything he could lay his hands on about astronomy. He soon yearned for a more powerful instrument. "I wanted so much to see some of those stars the books told of, stars that were out of reach of my little instrument."

About this time, he read a book on telescope making and determined to make one himself. He sent to Chicago for two glass disks six inches in diameter and spent the winter grinding a mirror. We can picture him working by the window or by yellow kerosene light, moving one disk over the other with emery powder in between, gradually creating a convex surface on the lower glass and the desired concave surface on the upper. By spring, he had a six-inch concave disk that could be silvered to make the mirror he needed to construct a reflecting telescope.

His telescope attracted the attention of the neighborhood, and many visitors came to look through the six-inch at the Milky Way and other heavenly sights. He wrote an article on telescope making for *Popular Mechanics* in 1905 and that brought him several orders to make telescopes.

On the evening of April 12, 1907, when he was 21, he was scanning the northern sky when he spotted a faint object, like a "tail of smoke" as the newspaper described it, where no such object should have been seen.

He notified Washburn Observatory in Madison, which confirmed that he had sighted a new comet. The discovery was front page news in the *Wisconsin State Journal*. As it turned out, Mellish had to share the discovery with another observer who had also seen the comet, but there was satisfaction enough in having the comet receive the name of 1907 II Grigg-Mellish.

As observatories tracked the comet, it became clear that it was a periodic one, having appeared before in 1742. The term periodic is applied to all comets whose orbits are closed and which appear again and again in the sun's vicinity. Most comets have such extended orbits that it cannot be clearly demonstrated that the orbits are closed, and these used to be considered one-time visitors. However, today, they are generally regarded as having closed orbits, too, but taking thousands or millions of years to make a single circuit.

That fall, the young farmer capped his discovery by spotting another new comet. This time, his name alone was attached to it.

His astronomical work opened up vistas of another kind to Mellish, for it put him in touch with professional astronomers. He confided to the *Wisconsin State Journal* that "I am going to quit the farm in a year or two and try and get work in some observatory. I intend to become a professional astronomer."

His interest was encouraged by the astronomers at Washburn Observatory, George Comstock and Albert Flint. They spoke of getting him a post as an observer at Yerkes Observatory at Williams Bay, Wisconsin.

But Mellish did not leave the farm. His grandfather fell ill that December and died the following July. Mellish may have felt his labor was needed on the farm. He also probably lacked money to take advantage of any offer of an observing post at Yerkes, for these observers were unpaid volunteers who were used to relieve the small regular staff of various observational chores.

Mellish also may have simply been reluctant to leave the world of the farm, for he always had a love of the outdoors and of wild things. He did begin a correspondence with Edwin Frost, the director at Yerkes Observatory. The patrician New Englander took a kindly interest in Mellish, as he did in many other young, aspiring observers. He became something of a scientific father figure to the Cottage Grove farmer.

Mellish continued to teach himself about astronomy, optics and mathematics. He read what books were available in the small Washburn library. Sometimes, when he could not find the answers to his questions in Madison, he sent technical queries to Frost.

He continued his optical work. He hoped to convert it into a business that would bring him enough income to free him from farm work and allow him to devote more time to astronomy. He built a 9½-inch and a 16-inch reflector for his own use. He also instructed interested local people. He wrote several articles on telescope making for *Scientific American* and thus helped popularize the craft.

In 1910, when Halley's comet approached, he must have observed it telescopically, and he was one of the first people in the state to see it when it became visible to the unaided eye. He wrote an article on the comet for the *Wisconsin State Journal*.

That year he also became a "cooperative meteorological observer" for the Weather Bureau, recording rain and snowfall and other atmospheric phenomena such as solar and lunar haloes. His notes on his monthly reports give little vignettes of farm life. In September of 1911, for example, "Lightning struck three barns [in the area], burning them. Loss about $2000. Our barn was struck the 27th. Two rafters, a post, and some boards were blown to fragments. The lightning struck in hay but did not set fire." The following January was "the most severe month in many years. Wild birds and animals were driven to the farm buildings for food."

He must have made many nature walks over the farm, for he sent Frost an article he wrote for a nature magazine on birds and their nests.

The farm work and his other activities left him too tired to spend many nights observing. There is also a hint or two in his letters that he may have been ill at times. But in 1913, his interest in observing was rekindled by a visit with Frost. "You spoke to me about looking for comets," he wrote afterward, "and I am now thinking of it everyday." Besides renewing his observing, he experimented with astronomical photography.

He was frustrated by his equipment. He wanted to do professional-level observing, and for this his instruments were inadequate. He could grind the mirrors and lenses he required, but good quality telescopes also needed accurate clock drives and other accessory equipment. He had little money to purchase them and was driven to scrounging used or broken devices from Washburn and Yerkes. He appealed to Frost to help him get a loan or a grant to upgrade his equipment; Frost promised to try, but nothing materialized.

The optical business did not bring in much money, though in 1914 he put an ad in *Popular Astronomy* describing a wide range of telescopes and mirrors that he was prepared to make.

In February of 1915, he made his third comet discovery, which he reported by telegram to Yerkes. This comet was unusual in that it consisted of several clumps of material that increasingly broke apart as it approached the sun.

This discovery may have precipitated the next turning point in his life. A few days afterward, Frost invited Mellish to spend some time that spring or summer at Yerkes. Such a stay, Frost wrote, would give him an opportunity to use the observatory's equipment and to learn more about astronomical photography from E. E. Barnard, one of the pioneers in the field.

Mellish replied regretfully that he could not come because he could not afford to leave the farm. His letter is a catalog of frustrations he was encountering at the farm. "I am having hard times, glass work is not bringing in much the last eight months, and I am really held here to attend to the place. . . . I have just started observing, last December was the first to amount to much since 1908 . . . . I will have things in shape to do something worthwhile if money does not play out entirely. I cannot get money to build a house for my telescope, so it stands outdoors all the time, which does not make the clock run very well."

Speaking of his optical work, he said, "I have thoroughly mastered the art of making perfect convex and plane mirrors, as well as concave mirrors. I have made 12-inch and 16-inch plane mirrors to well within one-fifth light wave."

He went on, "I have a splendid observing situation here, all the room I want for instruments to be mounted out of the way of all buildings and trees and there are no lights and no smoke. If I could put my time in observing, that is all I would ask, for in time I can make all the instruments I require. As soon as I get money I will make a 24-inch telescope. I cannot hope to get a larger glass, though I could make a 36-inch speculum if I had the glass."

Frost replied, "I . . . thank you for writing at length on your conditions. Let me ask how much money it would take for you to hire a man to do your work on the farm for six months, say from March 1st or April 1st, so that you could give your whole time to astronomical observations [either at Cottage Grove or Yerkes]. I have an idea that I might be able to raise the necessary money for such a project, but of course am not sure of it at all."

He went on to try to persuade Mellish to give up his optical work, "There are plenty of other men who can do that, who do not have as good eyes as you do for observing. Furthermore, there is not enough business in the manufacture of mirrors to guarantee you a good living—as it seems to me."

A hundred dollars would allow him to hire a farmhand for six months, Mellish replied, and 30 dollars a month would take care of his board at Williams Bay. "Economy in living suits me exactly. I would rather live without eating and buy books with that money if I could do it."

At Frost's urging, Mellish applied for a $300 grant from the Watson Fund of the National Academy of Science. Frost was a member of the committee handling the fund, and he used his influence on Mellish's behalf. In April, hearing that the grant was approved, Mellish wrote Frost: "I wonder if I could not get my board cheaper than what you wrote. It must be very high there. I would like to make the $300 last just as long as I possibly can."

The stay at Yerkes was a major transition for Mellish in more than one way. He never returned to the farm to live. And, two months after arriving at Yerkes, the 29-year-old bachelor was married. We don't know whether he had met his fiance before going to Yerkes or whether it was a whirlwind courtship. But on June 15, 1915, he married Jessie Wood of Glencoe, Illinois.

On April 30 the next year, their first child, Veronica, was born. Five days after the birth, the infant was dedicated to astronomy by placing her under the telescope at Yerkes. (This scientific christening didn't take. None of the Mellish children, as it turned out, became scientists.)

He spent 15 months at Yerkes with the title of Volunteer Research Assistant. His major project was to search for faint comets that did not approach close to the sun in their passage, and thus were likely not to be spotted.

It must have been an exciting time for the ex-farmer. He must have felt some challenge to prove himself to Frost and the other staff members.

The most famous member of the staff was E. E. Barnard, who represented an older generation of astronomers. Like Mellish, he had been a poor boy who educated himself in astronomy. He was noted as a comet spotter and as a pioneer astronomical photographer.

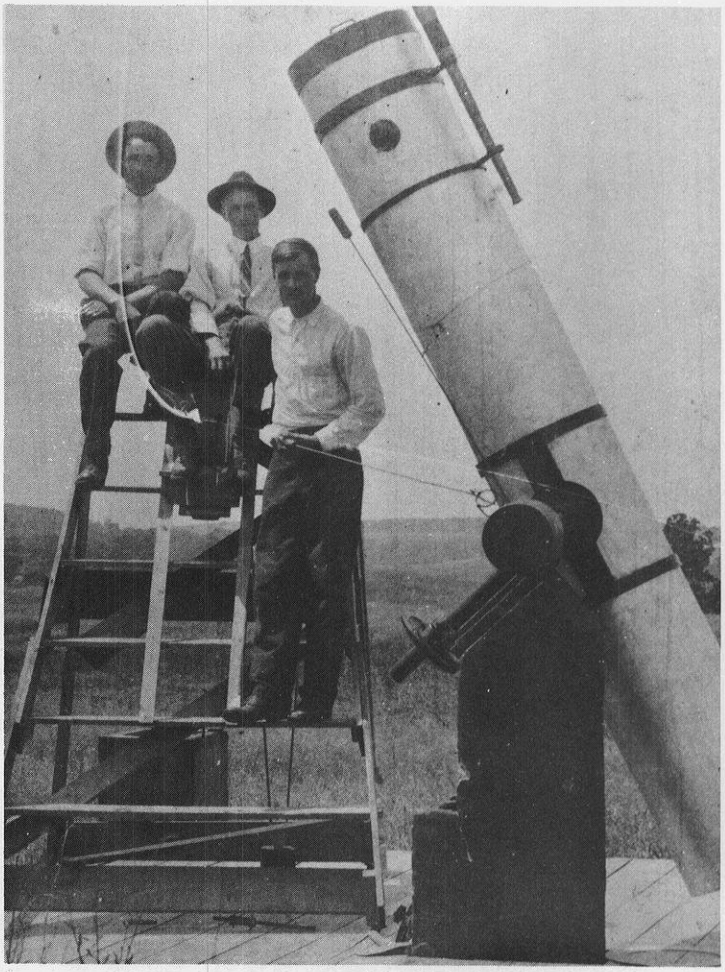
The coming generation of astronomers was represented by Edwin Hubble, an urbane, athletic and highly educated graduate student doing research at Yerkes for his doctoral degree. He was studying spiral nebulae, mysterious oval or circular patches of light whose true nature was unknown.

At the time Mellish was at Yerkes, the known universe, though vastly larger than that visualized in Galileo's day, was still a fairly cozy place. In the foreground, of course, was the solar system, whose outermost planet, Pluto, was yet to be discovered. As backdrop to the solar system were the stars, thought to form a vast wheel thousands of light years across. Beyond was darkness.

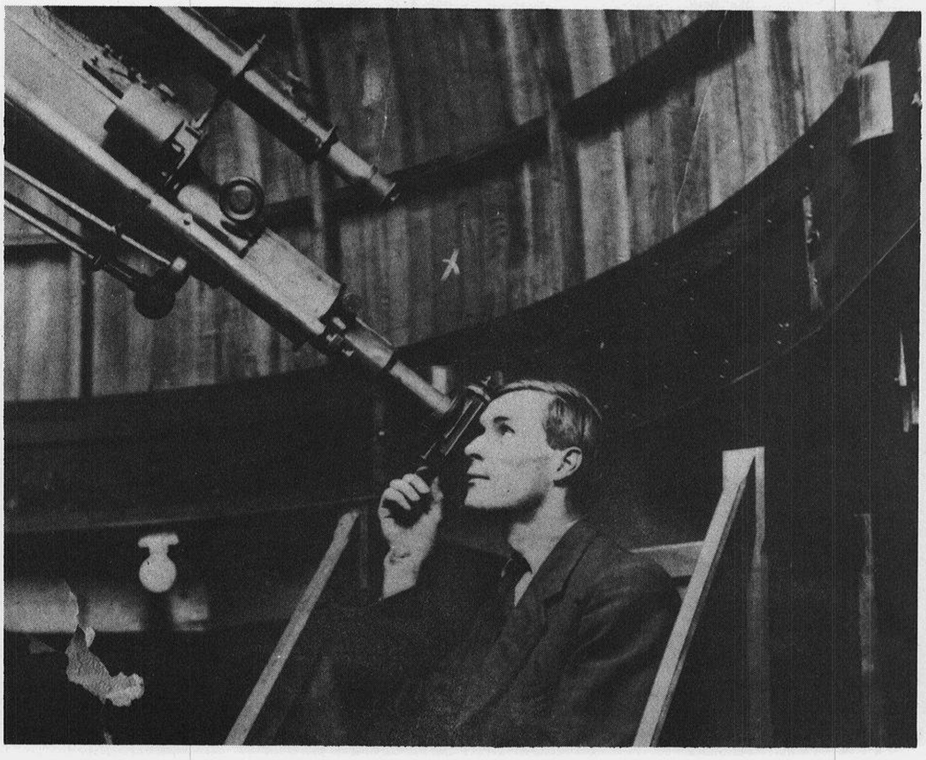
But mixed among the stars were diffuse patches of light called nebulae. Some were obviously clouds of gas, but the spiral nebulae could not be easily explained. They piqued the curiosity of scientists like Hubble. His later work, much of it done at Mount Wilson, and later at Mount Palomar, both in California, was to reveal that these nebulae were not part of our galaxy but were themselves giant star systems at enormous distances beyond our galaxy. His work increased the known size of the universe a thousandfold, while related research showed that this immensity of space was actually expanding, with the galaxies flying apart from each other like a crowd dispersing.

Hubble was three years younger than Mellish. One wonders what these two men of such different backgrounds thought of each other. Mellish may have felt closer in spirit to Barnard, whose background was similar to his own.

Since his stay was extended to 15 months, Mellish must have been doing creditable work, though unfortunately we have little record of this interesting period



Mellish is shown at right, standing, with a 16-inch reflector telescope on his Cottage Grove farm in 1912. Below, he looks through a 12-inch reflector at the Yerkes Observatory in 1915.



Yerkes Observatory

The Yerkes summer staff in 1915. John Mellish is standing in the dark suit on the left in the top row. At the far right, standing on the steps and holding his hat, is white-haired E.E. Barnard. E.B. Frost is in the second row, sixth from the left, with spectacles, buttoned suit coat and bow tie. E.P. Hubble is seated on the steps at the right, holding his leg.

in Mellish's life. He discovered another comet. More importantly, he may have been the first astronomer to observe craters on Mars.

Mars at best is difficult to observe in any detail. The disk is largest in the telescope at the time of opposition, when Mars is closest to Earth. Mars was approaching opposition when Mellish observed it in the fall of 1915.

The maps drawn in that era by trained observers of Mars showed the polar ice caps and vague dark mottlings whose nature was only guessed at. Some observers, notably Percival Lowell at Flagstaff, claimed to see a network of dark lines connecting the dark regions—the famous "canals." Lowell believed that these lines were artificial waterways bordered on each side by irrigated vegetation. Not every astronomer saw the "canals," and it has since been shown that they are largely optical illusions. Mellish got a hint of this himself when he saw canals with the 12-inch refractor at Yerkes but on switching to the 40-inch saw them break up into other shapes.

We have a description of his Mars observations from letters he sent to Eugene Cross, Jr. in the later 1960s. Cross, then a student at New Mexico State University interested in astronomy, began the correspondence after the Mariner IV flight past Mars in 1964 helped confirm Mellish's early Mars observations. Cross is now an optical research engineer at General Dynamics and a planetary observer.

Mellish observed Mars in the fall and winter of 1915. One morning early in November after sunrise, he was looking at Mars through the 40-inch refractor when "great was my surprise . . . to see the detail on Mars much better than I had ever seen it before, and I soon saw that Mars was not the level plain I had always supposed it was . . . ."

What he saw was a large crater about -50 or -60 degrees latitude in the southern hemisphere of Mars, about 200 miles in diameter and several miles deep. North of it were many bright-rimmed small craters. The high peaks on the rim of these craters were white on top, as if with snow or frost or perhaps lime or quartz.

"The first morning I saw this, I went to Barnard and told him what I had seen and he was very happy. He said, 'Now that you have shown me what you saw, I will show you my drawings, which I made in 1892-3 with the Lick 36-inch.' And he dug down in an old trunk and brought out the drawings of Mars he had never shown any other person. He said they would only make fun of him if he showed the drawings."

Barnard had viewed Mars at opposition when the planet was closest to Earth. His drawings showed dark, circular patches rather than craters as such, patches that Barnard had taken to be forests.

Mellish's best view of the craters was on November 13 shortly after sunrise, using a power of 1100. Why was he able to observe relief on Mars when other astronomers at most saw round dark patches? An article in the March 3, 1967, issue of *Science* by D. H. Harris suggests that Mellish observed Mars at a particularly favorable time for seeing relief, when the planet was approaching opposition but was not yet at opposition and the sun was casting maximum shadow detail. He was also using the world's largest refractor, a type of telescope particularly suited for planetary viewing. "Such an aperture (40 inches or larger) should permit detection of large Martian craters when the Earth-Mars geometry is optimum and seeing is nearly perfect," Harris suggests.

In a 1977 book on Mars, Patrick Moore, the well-known British astronomical observer and author, credits Barnard and Mellish with being the first to observe craters on that planet. But confirmation of their work had to wait until 1964, when Mariner IV made its flyby to take close-up photos of Mars.

Money must have been a problem for the newlywed Mellishes. Mellish had to look ahead to how he would support a family. He could not remain at Yerkes indefinitely as a volunteer, and there apparently was no staff position open for him.

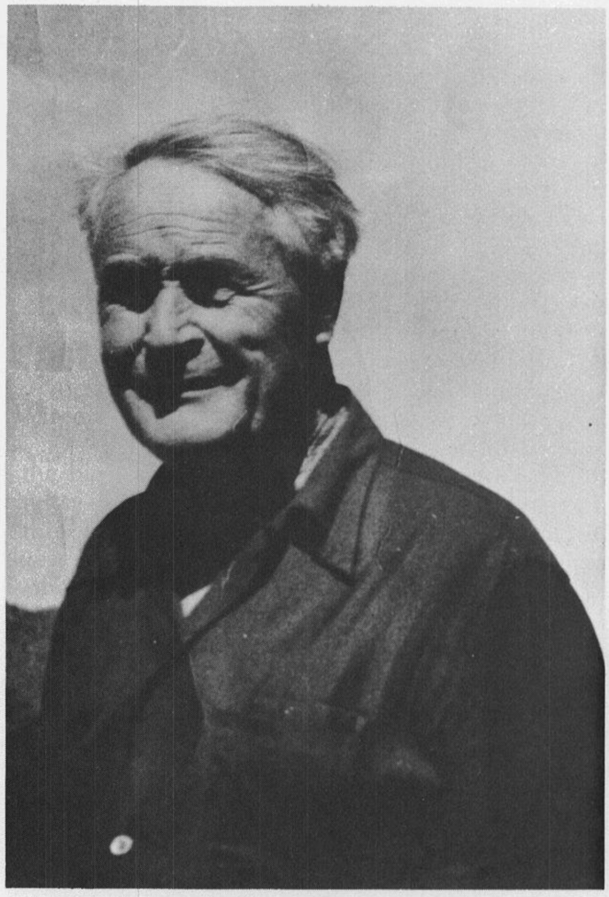
But a more modest opportunity opened elsewhere. In the fall of 1916, Frost sent a notice to *Popular Astronomy:* "Mr. John E. Mellish . . . will soon leave to take charge of the well-equipped private observatory at Leetonia, Ohio, of Mr. Elmer Harrold, Secretary and Manager of the Crescent Wood Working Machine Company. Mr. Mellish's duties will include the use of the telescope for visitors on certain public nights, but he will have ample opportunity for personal observation with his own telescopes, as well as with those of the observatory, and he will have improved facilities for continuing his work in making reflecting telescopes. Leetonia is on the main line of the Pennsylvania Railroad, not far from Youngstown and Alliance, in both of which centers there are many persons interested in Astronomy. Mr. Mellish is to be congratulated on this well-deserved recognition."

From the announcement it is clear that Mellish expected to continue his optical business, probably because his salary was small or nonexistent. Harrold did give the couple use of a large, older house rent-free.

Leetonia was a good location for telescope making, close to industrial towns where materials could be purchased. Mellish could get all the brass tubing he needed from nearby Salem. Mellish also apparently learned a great deal from Harrold about machine work and pattern making.

In 1917, he discovered another comet, a periodic one that appears every 145 years. But Leetonia turned out to be a poor place for astronomical viewing. Haze from the region's factories and mills dimmed the night sky. He often could not see the fainter stars, except when strikes shut down the mills and cleared the skies. So he was not dismayed when in the spring of 1920 Harrold decided to sell the observatory, ending Mellish's post.

His first idea was to return to Yerkes. He wrote to Frost: "I have made up my mind to go back to Yerkes again very soon if you have the room where I can work the same as I did before. I have offers from other places of room to work in, but I think and always have thought there is no place like Yerkes . . . I am and have always been sick of the thick air here, but when the strikes came on and I got views of clear skies again and again, it made me sick for Wisconsin and comet-sweeping again . . . There is no astronomical interest here any more, and I am longing to get back where others are doing something of interest, besides making money."



John Mellish in his later years.

Frost replied gently that, "I can appreciate very well how you would like to get into the clear skies of Wisconsin and I wish there was an opportunity for you here. While we should of course be glad to give you every opportunity for use of our available instruments and library, there would be no suitable chance for you to do any manufacturing, and that of course is the necessary source of income for your family. I have been trying to think of some town having a foundry and other shop facilities where you could make arrangements for doing your work."

He suggested Madison as a possibility, since it had grown considerably since the First World War, "although I should be glad if you were nearer so you could run over for a night or two when you wished to work here . . ."

He also suggested that Mellish find work with an optical firm, so he could be relieved of business details and receive a steady salary.

But Mellish did not take Frost's advice to quit his business. He stayed on in Leetonia. It must have given him some satisfaction to write to Frost the next year to report: "I have had a great rush of orders . . . . and have continually from $3000 to $5000 worth of orders ahead all the time . . . . I have orders quite frequently for refractors of short focus of 10 to 1 and up to 5 inches. I can guarantee them perfect for color and to bear a power as high as a ½-inch reflector from a merchant in S.A. . . . I ship a telescope about every six days, most of them 3-inches." A price list he sent Frost from Leetonia shows him offering reflecting telescopes up to 16 inches in diameter and refractors up to 12 inches.

In October of 1923, Mellish observed and then lost in clouds a faint, comet-like object. This proved to be the first sighting of the return of a periodic comet known as D'Arrest's Comet.

A growing family and the demands of his business took up more and more of his time. In all he had ten children, two of whom died in infancy. He continued observing from time to time and closely followed the progress of astronomy through reading. He moved to Wilmette, Illinois, near enough to Yerkes so that he was able to see his friends there occasionally. His correspondence with Frost shows that he produced reflectors up to 30 inches, as well as various optical telescope accessories for Yerkes and other observatories.

A move to St. Charles, Illinois, in the late 1920s, was followed by a move to Escondido, California in 1933. Around 1960, he moved to Cape Junction, Oregon.

The 200-inch "Big Eye" was being constructed at Mount Palomar not far from his home in Escondido in the 1930s. There is a story in the family that Mellish was invited to act as an adviser but was reluctant to do so because he disagreed with how they planned to cast the mirror. Mellish was acquainted with many of the people connected with the project, according to Cross, including Russell W. Porter. Porter first saw the Martian canal illusion when looking through Mellish's 16-inch reflector; Mellish also showed him his drawings of Martian craters.

He showed those drawings to a number of astronomers, including those at Lowell Observatory in Arizona, a center of planetary research since its founding by Percival Lowell. But, according to Cross, the professional astronomers tended to dismiss his observations because they did not fit in with prevailing views on Mars.

Mellish's interest in nature continued. He took his family on nature hikes at every opportunity. He liked to explore the mountains and desert of California and once, sleeping on the ground, woke up with a rattlesnake coiled next to him.

He also liked to do mathematical computations. A church-going Seventh Day Adventist, he told his oldest child Veronica that the mathematical order in the universe had convinced him of the existence of God.

During his career, he made hundreds of telescopes for amateurs and small observatories. As he wrote to Cross, "In my life I made and sold over 100 refractors from 3 inches to 12½-inches; I worked several 24-inch mirrors and six 36-inch mirrors and quite a number of other mirrors from 18 inches to 32 inches in diameter." We don't know the location of most of his telescopes. One mirror he ground was the 18-inch glass (since refigured by Thomas Cave) of the private Ford Observatory on Mount Peltier in California.

Cross believes that Mellish's best optical work was his refractors: "His achromatic refracting telescopes are probably the most outstanding examples of his work, being capable of remarkably fine definition by even modern standards."

After he moved to Oregon, a fire destroyed his workshop and with it his personal and professional papers. This was a heavy blow to the elderly Mellish, and he retired from business. Among his papers were the drawings of the Mars craters, a loss he felt particularly keenly when the Mariner mission confirmed that the planet was heavily cratered.

Cross relates that the principal investigator for the television experiment on Mariner IV, Edwin Marks, somehow heard of Mellish's observations shortly before the spacecraft was due to pass by Mars. He called up Mellish a few hours before the flyby and talked with him. As Cross puts it: "For those few hours, they were the only two people on Earth who knew for certain what Mariner IV was going to see."

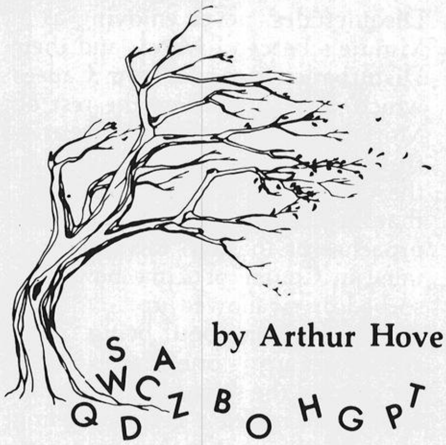
Because his drawings were destroyed, Mellish was not able to specify the exact location of the craters he observed and so it is not possible to correlate his observations with the photos relayed back by spacecraft since 1964. Several large craters near -50 latitude might fit his description.

He wrote a letter to *Sky and Telescope* in 1966 in which he said that back in 1916 he had distributed some of his Mars drawings to interested observers and asked if any of the magazine's readers had any information concerning the whereabouts of those drawings. No one responded, and apparently they are lost.

While Mellish was not a major figure in American astronomy, his personal achievements merit our recognition. Working under difficult conditions, he discovered five comets. His observations of Martian craters are receiving increasing recognition. And stubbornly following his own path, he carved out a productive career in telescope making. He was in the tradition of America's independent, self-educated craftsmen and artisans. His telescopes undoubtedly have given great pleasure to thousands of people who, like the boy astronomer of Cottage Grove, have yearned to explore the mysteries of the night skies.

Paul Thompson is a free lance writer and author of several books on scientific subjects for young people.

WINDFALLS



by Arthur Hove

Science uncorked

The zenith of my scientific career came during my elementary school days. It was then I learned that if you put vinegar and baking soda in a bottle, corked the bottle and shook the bottle, the cork would fly off in a matter of seconds.

To this day, I do not know the name of the gas formed by the commingling of the vinegar and baking soda. I do, however, recognize that it was the force generated by the expanding gas that propelled the cork toward the ceiling. Beyond that, I confess to a rather high degree of functional illiteracy when it comes to understanding, much less explaining, science.

I presume my situation is one shared by others who find it difficult to deal with science as an aspect of human endeavor. For many of us, science is indeed a genie in a bottle, something which becomes uncorked by an episode we can recognize and comprehend only in a superficial way.

Our perceptions of what scientists are and what they do have been conditioned by cartoon images that have come to us through elementary school text books or certain forms of popular culture. The same mentality that presumes the basic truth about the American republic is summarized in the story of George Washington and the cherry tree will also accept the premise that all there is to know about science can be gleaned from the anecdote about the apple falling on Isaac Newton's head or the story of Ben Franklin almost electrocuting himself while flying a kite with a key on it during an electrical storm.

These perceptions are often reinforced by our understanding of what scientists did in other times. Alchemists trying vainly to transmute base metal into gold. Quack doctors bleeding patients as an antidote to a number of often routine or unrelated diseases. Inventors strapping fabricated wings to themselves and trying to fly like a bird by flapping their arms.

The result of these episodes in man's intellectual development is that the scientist, until recent times, was often considered an eccentric—someone surrounded by an inventory of ingenious contraptions that nobody but he understood.

During the past several decades the pendulum has swung the other way. Journalism, popular biography and autobiography, combined with the establishment of history of science departments at universities, have adjusted the scales—sometimes to the point where there is a distinct leaning toward hyperbole rather than objectivity. Nevertheless, we have come to know more about who scientists are and what they do. We have been often enthralled by their particular achievements.

Many modern scientists have been lionized to the point where they seem to be creatures of superhuman intelligence, individuals who have traveled to a far frontier, a boundary of understanding well beyond the reach of all but a select and infinitely small number of people. A manifest of those who have made such a trip would include: Niels Bohr, Marie Curie, Albert Einstein, Alexander Fleming, Robert Godard, Linus Pauling, Norbert Weiner and Jonas Salk.

Some recent adjustment in our perspective has been forthcoming, however. James Crick, in his book *The Double Helix,* did a great deal to show that contemporary scientists are human and can behave in a very peculiar way, particularly when they are involved in a frantic race to be first with a given discovery—in this case the description of the DNA molecule. Journalist Horace Freeland Judson has expanded on Crick's memoir in *The Eighth Day of Creation,* a study which shows that this century's pioneering biological studies were conducted by individuals "of intelligence, originality and, often, eccentricity." A current BBC/Time-Life television series, "Connections," indicates that sometimes the great discoverers are synthesizers rather than trailblazers. "No one does it all," says James Burke, the program's writer and host. "It's only when all the bits come together that the final form comes into existence; and when it does, it causes worldwide change to occur."

Another factor influencing our current fixation on the scientist can be attributed to the oft-quoted statistic that approximately 90 percent of the scientists who have ever lived are alive now. The growth of knowledge they have produced has been exponential; it is a constant rush for even the professional on the cutting edge of discovery to keep up with the resultant increase and change in knowledge.

Although they generally receive no formal training in legal matters, scientists are governed by a large number of laws, principles and other formal rules. Quite often these become the bane of the schoolchild's existence—another one of those diabolical things students are forced to memorize with no assurance that the particular scientific proposition will be encountered again in casual reading, much less daily life. A sampling of the various examples might be instructive in evaluating your own scientific literacy. Consider the following list:
Archimedes' Principle,
Avagadro's Law, Boyle's Law,
Hooke's Law, Mendeleev's Table,
Mohs's Scale, Playfair's Axiom,
Russell's Paradox, Snell's Law and
Zorn's Lemma.

Out of this selection you are invited to supply a specific description of the scientific principle identified with the individuals mentioned. Complete your response by giving an appropriate example of how the principle may be used or demonstrated in the events of everyday life.

For those responding correctly to at least a third of the examples, there is no particular need to read to the end of this essay. For those who did not achieve such a standard (you have to look up the answers on your own), read on.

Besides laws and principles, there is a specific lingo that must be learned if one is to understand what is going on in a particular branch of science. This situation is compounded by the fact that the pace of scientific discovery has been so rapid recently that new words enter the language literally overnight. The concerns of science are limitless; so, therefore, is the potential vocabulary that can be employed to provide road signs for finding one's way.

For example, one currently exciting area of concentration and discovery is the study of subatomic particles—a study made possible through the invention of large, expensive and highly sophisticated instruments which can detect and measure the actions of infinitely small bits of matter. These unseen, so-called building blocks of the universe presently go by such dubiously euphonious, but reasonably descriptive names as neutrinos, mesons, leptons, quarks and gluons. More words to be included in the next revision of the dictionary.

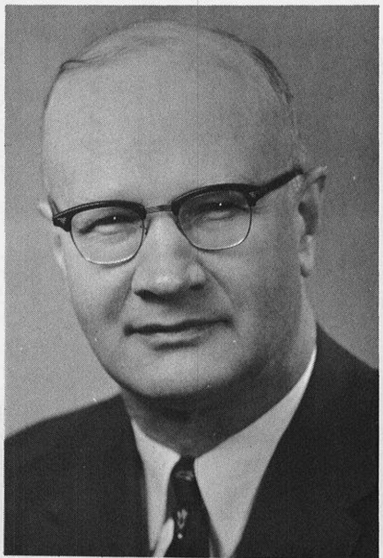
Another problem connected with gaining a full appreciation of modern science is that scientists themselves are hardly in agreement about what they should be doing and what their responsibilities are to their fellow humans. The result is frequent and sometimes volatile argument about the moral dimensions of science. One school of thought says that science by its very nature is amoral, that the scientist's responsibility is to pursue truth regardless of its ultimate impact on the safety and well-being of humans or the physical and natural environment. It is not science per se that has an evil dimension, so the argument goes. It is rather the demented people who turn science to evil ends that are to blame.

Others believe that one should thoroughly check out the potential human and natural consequences of any scientific inquiry before going ahead. If there are perceived risks involved, or if there is a high degree of uncertainty, the project should be halted, the search abandoned. This group of thinkers reflects the attitude of certain residents of Swift's Academy of Lagado who "are under continual Disquietudes, never enjoying a Minute's Peace of Mind; and their Disturbances proceed from Causes which very little affect the rest of Mortals. Their Apprehensions arise from several Changes they dread in the Celestial Bodies. For Instance; that the Earth by the continual Approaches of the Sun towards it, must in Course of Time be absorbed or swallowed up."

This concern about being swallowed up is one that extends far beyond the scientific community. It has created a general feeling of insecurity that makes many increasingly suspicious of any new scientific or technological advancement. Ironically, this same scientific "progress" has unquestionably improved the quality of daily life for a large percentage of the world's population. Such progress has simultaneously sown seeds of doubt and suspicion, particularly when it can be demonstrated that scientific advancement sometimes involves risk . . . and danger.

Carcinogens seem to be lurking in every nook and cranny of our world. Even the most seemingly benign substances have been discovered to harbor potentially dangerous elements that will cause the cells in our bodies to run amok. The result is that the heroes and heroines of science can become intellectual blackguards who appear callously indifferent to the future of the world around them.

The growing uneasiness about science has pushed the scientist out of the seclusion of the laboratory and into the arena for a closer examination. Vinegar and baking soda are being jostled about in various bottles and you can hear the popping of corks all over the place.□



UW Photographic Media Center

Aaron J. Ihde

Aaron J. Ihde reports he felt a particular fascination with his subject, **"Harry Steenbock—Student and Humanist."** Steenbock was his minor professor while Ihde earned his PhD, completed at UW-Madison in 1941. Steenbock's early years also reminded Ihde of his own boyhood in a second generation German family living on a farm in Winnebago County.

Dr. Ihde joined the chemistry faculty of UW-Madison in 1942. Among his publications is *The Development of Modern Chemistry* (1964) which deals with the history of chemistry during the past two centuries. He received the Dexter Award in 1968 for distinguished work in the history of chemistry and the Chancellor's Award for distinguished teaching at the university in 1978.

He has been a member of the Wisconsin Academy since 1944 and has held several offices including that of president in 1963-64.

From the time the final legal clearance was obtained on July 26, 1978 from the New York State Supreme Court, to the arrival on August 13 of 600,000 pieces packed in 16 moving vans, after a trip of nearly 1000 miles, the story of the American Geographical Society Collection's move from headquarters in New York City to its new location at the UW-Milwaukee Library, is a logistically fascinating one. **Howard Deller**, the author of **"Wisconsin's New Geographical Center"** knows it thoroughly as he knows the collection itself.

Deller was born and raised in the Milwaukee area. He has a master's degree in geography from UW-Milwaukee and is now working on his PhD in the area of historical geography. He is a free lance writer as well.

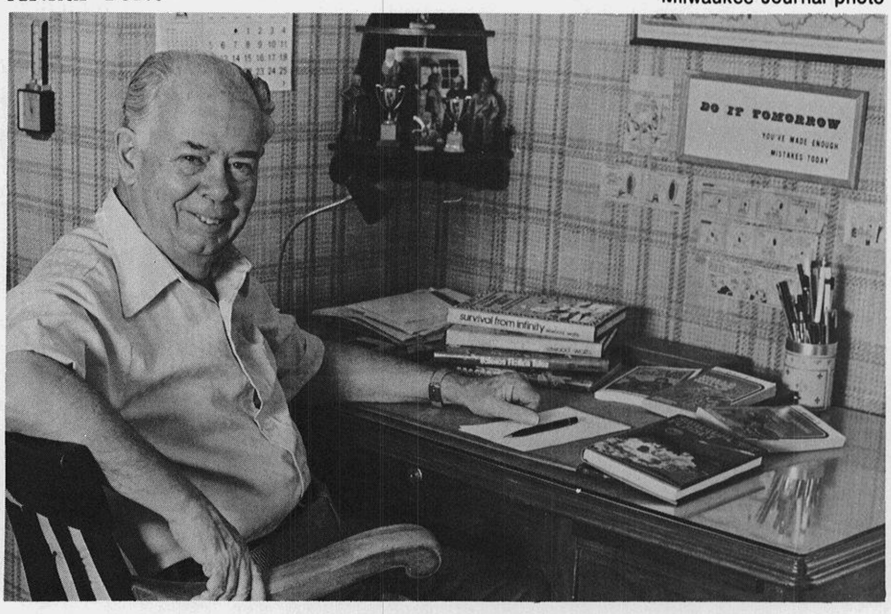
For nine years, he was a member of the geography department at UW-Waukesha. He has also taught courses at UW-Milwaukee and Mount Mary College.

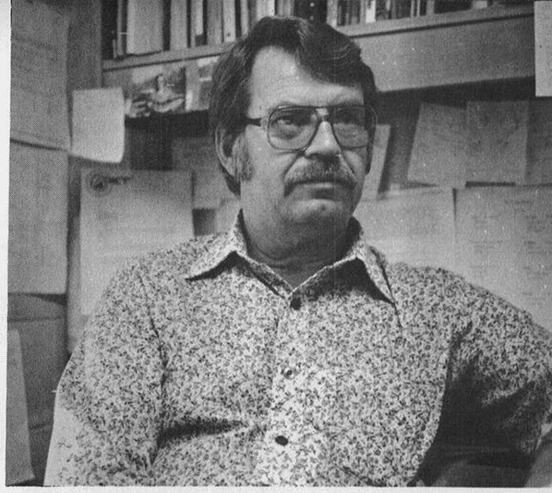
Arthur Tofte, who wrote **"Try On a Future with Science Fiction,"** knows his subject from outside and inside. From a reader's perspective he has reviewed 110 science fiction books for the *Milwaukee Journal* in the past two years. As a writer of science fiction, he has an equally impressive record as detailed in his Bookmarks/Wisconsin essay.

Tofte interrupted his fiction writing to spend 31 years in the advertising department of Allis-Chalmers, a Milwaukee firm. After retirement and a stint of traveling, he settled behind the typewriter again and has been turning out science fiction ever since.

Arthur Tofte

Milwaukee Journal photo





Kenneth W. Dowling

Kenneth W. Dowling, author of **"25 Years of Science in Wisconsin Schools,"** began his career teaching junior and senior high school mathematics and science in the state. In addition to his present position as education supervisor for the Wisconsin Department of Public Instruction, he is and has been active in numerous organizations ranging from the Wisconsin Junior Science and Humanities Symposium to the Agency for Instructional Television.

He has published articles in educational journals and newsletters and is the principal author of "A Guide to Science Curriculum Development," and author and/or editor of other publications in the field. This past year he has served as the Academy's vice president for sciences.

Robert H. March's essay, **"Science, Democracy and Doubt,"** dispels a popular myth about science's role in society. A physicist, March's first professional job was as a lab technician for Enrico Fermi.

March came to UW-Madison in 1960 as a research associate with a half-time appointment at Midwest Universities Research Association. Now a full professor, he has spent time during the last two decades as visiting scientist at the Lawrence Berkeley Laboratory, Fermilab, Stanford Linear Accelerator Center, University of California-Irvine and the European Organization for Nuclear Research.

In addition to scientific papers, March has written some 70 popular articles as well as the book, *Physics for Poets*, and has earned two writing awards, one from the American Institute of Physics and one from the US Steel Foundation. *Physics for Poets* has been translated into Spanish, Japanese and Polish. March is also a folk singer and song writer.

Walter E. Scott, the Academy insider whose words grace the final page of this anniversary issue, has worked for the Academy in many other capacities than that of first editor of the *Review*. As just one example, he served as president in 1964-65.

Professionally, Scott was a trained biologist who made an outstanding contribution in the field of public administration with the Department of Natural Resources. In 1975 he retired after nearly 39 years as a conservation warden, game manager, editor, assistant to the director and secretary of the DNR.

A native of Milwaukee, he received a BA degree in biology and an MA in philosophy from Kalamazoo College, Michigan, and an MS in political science from UW-Madison. In World War II he served in the Army Counter Intelligence Corps.

In retirement, Scott's long list of activities, and the people who seek him out for advice, keep him and his wife Trudi constantly busy.

OLAF HOUGEN WAS EIGHTY-FIVE LAST NIGHT

by Lenore M. Coberly

Olaf Hougen was eighty-five last night.
Years, of course, not feet.
Although, among the bowed shadows of students
in that candle lit room, he seemed that tall.

Oh, some stood higher, richer,
but they had learned from him
to look clear-eyed unafraid at greatness
and to know which way was up.

Simple accolades and laughter
that remembered only the times between
problems unsolved at midnight
seemed to confound him.

As he rose and faced the praise
he saw Japan, Texas, Norway,
microbiology, thermodynamics, theology and time
in the faces of those he had taught.

Leaning forward, we waited for him to say
something quotable, sentimental, gay—
something we could later relay
linking ourselves with his special day.

But he lifted us out of ourselves
into the place where an honest man
looks straight at the way things are
and sums them up as an engineer can.

He begged us to take note of the colleague
who never had gone far away
as others, privileged, had done.
He only stayed and made things run.

He asked us to remember another teacher
who taught less glamorous stuff
like how to keep your eyesight
in a chemical engineering lab.

Those were the men, Olaf said,
who were remembered at last
by wandering, wondering students
in the grasping, blinding world of work.

Remember? Remember—
he asked for a calculation of
the height of a gas absorption column.
The student put on the board precisely
one hundred and seven and three-tenths feet.
Hougen's single comment was,
"I certainly would hang onto
that three-tenths of a foot."

The teacher was eighty-five last night.
Years, of course, not feet.
Although, among the bowed shadows of students
in that candle lit room, he seemed that tall.

BOOKMARKS/WISCONSIN

Try on a future with science fiction

by Arthur Tofte

There is a slight misconception that science fiction-fantasy stories are something new. Not so.

Science fiction (or imaginative fiction) has enthralled listeners since aging hunters told tall tales to their young ones in prehistoric Stone Age caves. Homer, Virgil and Aristophanes were all good story tellers. Yet it was not until the 17th century that stories got away from the lords and fine ladies, and began to tell about real people living real lives.

It has been claimed (and refuted) that Mary Shelley's *Frankenstein* was the first modern science fiction story. The science part of imaginative fiction was given its first big break by Jules Verne (1828-1905). H.G. Wells (1866-1946) gave it another push with his *Time Machine* in 1895.

As a literary form, science fiction had to struggle at first to attain its own identity. For example, a few science fiction stories were appearing in adventure-type pulp magazines early in the century. *Under the Moons of Mars* appeared in *All-Story* magazine in 1912 under the byline of Norman Bean. Later, the author used his own name—Edgar Rice Burroughs.

In April 1926, Hugo Gernsbach introduced *Amazing Stories*, the first magazine devoted exclusively to science fiction. Within a few years there were more than a score of magazines featuring science fiction and fantasy.

Some say the first real attention given to science fiction was on October 30, 1935, when a young, 23-year-old upstart named Orson Welles gave a radio broadcast of H. G. Wells' story, *The War of the Worlds.* It almost caused a panic. In recent years science fiction has had a tremendous spurt in popularity. The films "Star Trek," "Star Wars," and "Close Encounters of a Third Kind" can claim some of the credit for this.

Even the experts in the field find it difficult to define the genre: the term is used as an umbrella to cover many different kinds of stories. Much of it is unquestionably pure fantasy. Or it deals with sorcery. Or mysticism. Or witchcraft. Or magic. Or the weird. Or the metaphysical. Or the supernatural. Or whatever you might think of as unnatural, alien, eerie or simply out-of-this-world.

A question that used to be raised by so-called literary critics was, "Is science fiction an acceptable form of literature?" Obviously, much science fiction is written strictly for story-excitement value. On the other hand, few literary forms offer an author a greater opportunity to express his personal beliefs about how we humans could do a better job of improving our way of life. By setting the story in a different world in a different time, the author can speak as freely as he feels he needs to about social reforms, political shenanigans, ecological ideas and elimination of war and crime and bigotry. He can even depict as yet untried psychological experiments. Many science fiction writers have done exactly these things, frequently with intriguing, thought-provoking results.

Not all science fiction by any means is great literature. But many of our best writers are now engaging in it, and their work stacks up very well against mainstream writing. With increased popularity, payments to authors have gone up too, and top authors are attracted. Robert Heinlein, for example, has just sold *The Number of the Beast* for a hefty $500,000. Many science fiction novels have gone recently for advances well above $100,000.

How much science is there in science fiction? Many of the best science fiction stories deal with quite unproved ideas, such as faster-than-light travel, teleportation, cloning of humans, thinking robots, time travel and aliens that look like lizards but have an intelligence superior to humans.

In the 1920s, when modern science fiction got its start, writers filled their yarns with scientific terms and far-in-the-future science developments. E.E. "Doc" Smith was a classic example. His stories had thin plot lines, but were crammed with what the youthful readers of that period (post World War I) wanted: science in story form. Much of it was pseudo-science. The readers, however, ate it up. Today, writers of science fiction largely avoid detailed descriptions of space-hardware or "how it works." They go on the premise that readers now are more sophisticated. As a result, what science is brought in is usually well-documented. Some of the top writers in the field are science professors.

There are several things that set science fiction apart from most other forms of writing. It challenges the imagination. It stirs curiosity about life as it may be lived in the future. It might even help us to learn how to prepare for the uncertain times ahead. One more thing it does—it questions many of our modern economic, moral and political practices and often offers possible solutions.

Arthur Tofte, a prolific producer of science fiction-fantasy, is most interested in writing juvenile fiction and non-fiction.

A sampling of science fiction by Wisconsin writers

by Richard Boudreau

Between Appleton and Neenah-Menasha a passenger train screams to a halt as a down-and-outer named Martin scrambles off the tracks. A trainman steps down, approaching Martin, who shrewdly perceives at once who it is. The demonic conductor makes the standard offer, "anything you want," for the usual price, a "promise to ride the train when the time comes."

It seems fitting that one of the most famous of Robert Bloch's short stories takes off into fantasy land from Wisconsin's Fox River Valley. "The Hell-Bound Train" appeared in the *Magazine of Fantasy and Science Fiction* 21 years ago, and won for its author the coveted "Hugo" award (named for Hugo Gernsback, father of popular science fiction).

It seems ironic, too, because the story is not science fiction at all, but fantasy, along the lines of such familiar tales as Stephen Vincent Benet's "The Devil and Daniel Webster." Few people would question Bloch's abilities as a spinner of tales of horror, but calling him a science fictionist presents problems. In "Broomstick Ride," for example, he has a team of Earthlings investigating a planet called Pyris, which has reached the level of development of our post-feudal times, complete with witches and sorcery (which might, of course, be technological expertise). It's certainly fantasy, less certainly science fiction.

Even in his true-to-the-genre science fiction Bloch generally ignores gadgetry or alien creatures and climates to concentrate on their effect on the psyches of his heroes. In one of his first attempts in the field, "The Strange Flight of Richard Clayton" *(Amazing Stories*, March 1939), he tells of a man sealed into a windowless space capsule ready for a ten-year journey to Mars. At blast-off his instrument panel is destroyed, leaving him with no way of determining time or distance. By the time the capsule stops vibrating, Clayton is white-haired, wrinkled and aged. He emerges to find that he had never left Earth, having been sealed in the capsule but a single week.

When we move from Bloch's tales to those of Stanley G. Weinbaum, a generation earlier, we are clearly in the mainstream of science fiction. Reading his stories is like entering a fairy land of the imagination, as if Shakespeare had turned his Forest of Arden into a delightful solar system of comic—and cosmic—eccentrics. In his best, "A Martian Odyssey" and "Valley of Dreams" (both 1934), we meet Tweel and his relatives, human-size avians, combining attributes of the woodpecker and the ostrich; an inorganic, yet living Martian pyramid-builder; the push-cart beings; and finally dream beasts who fulfill one's fondest dreams—and then devour the helpless victim.

In another related pair of tales, "Parasite Planet" and "The Lotus Eaters," we find ourselves on the planet of Venus where human life is possible only along a thin area between unchanging sunlight and unchanging darkness. In its summer zone one must wear a transkin suit and breathe only filtered air to avoid being infested by spores. And there humans must watch out for the mudspouts which erupt to suck down everything in sight; for Jack Ketch trees which constantly sling their nooses out to pull in sustenance; for dough-pots, masses of dough-like protoplasm, sometimes as big as buildings, which engulf everything in their paths; and mysterious, dangerous Triops who inhabit the ice-covered mountains at the edge of the dark side of the planet.

Weinbaum's imagination is fantastic; his scientific data accurate, impressive and jolting. He seems to have worked out where the inhabitable places of our solar system lie and the various adaptations that would be needed for humans to exist there. In "The Mad Moon" we are on Jupiter's minor moon, Io, experiencing its one-third Earth gravitation and meeting its peculiar creatures, the large, shmoo-like (this is before Al Capp, remember) loonies and the rat-like *mus*

This heading for the book review section of the Wisconsin Academy Review was drawn in 1956 by Aaron Bohrod, noted Wisconsin artist (who also contributed several covers to the fledgling quarterly journal), at the request of Walter Scott, first editor.

---

sapiens, popularly called slinkers.

Entirely different from Weinbaum's science fiction is that of Wisconsin-bred, Madison-educated, Clifford D. Simak. His is more reportorial and less imaginative, except within a greater scope. In "Desertion," for example, his imagination makes a giant leap—and then lets the situation work itself out. Humans are physically changed, adapted, to meet the demands of Jupiter's harsh environment. Once adapted, they experience an existence superior to their former one and do not return, leaving other Earthlings in the dark about the success of the adaptation.

In "The Big Front Yard" Simak depicts a handy-man's house invaded and made over by rat-like creatures from outer space who alter the front of his house so that it opens out onto another planet. And the handy-man with his dog, Towser, goes exploring while the national guard is called out and the UN becomes involved. In another, "Huddling Place," he toys with the recurring worry of advanced technological societies being taken over by their creations.

But in the 1968 novel, *The Goblin Reservation,* Simak proves, at least science-fictively, that you can go home again. Its 25th century hero, Peter Maxwell, is on the faculty of the College of Supernatural Phenomena on Wisconsin Campus, even taking his breakfast in the Union built centuries before and gazing out over Lake Mendota. The conflict of the book involves banshees, colonists from a previous universe, and their successors, goblins, trolls, fairies—even a dragon who overlooks his river, the Wisconsin, from a craggy peak. The evil force of the universe is the Wheelers, which seem to owe something to Frederic Brown's 1944 short story, "Arena."

Simak's novel seems to be a blend of Tolkien and Asimov, and Weinbaum's longest story, a novelette called *The Black Flame,* is a similar blend, suggesting again that though the line between fantasy and science fiction can be generally distinguished, writers—in these cases, Wisconsin writers—leave such distinctions to the critics. Instead they allow their imaginations to lead them willynilly and their stories to pluck what awards they might. Whatever the strictures, stories within the two fields remain intriguing and fascinating, and the beauty is that boredom is hardly possible in either genre.

Richard Boudreau is professor of English at UW-La Crosse.

Wisconsin Science Fiction Writers—Past and Present

How much have Wisconsin writers shared in the development of science fiction?

Oddly enough, the biggest participation came in the 1930s and 1940s. The Milwaukee Fictioneers provided a spring board for several writers in this field. Many of them went on to make real names for themselves.

Robert Bloch (author of "Psycho"), a longtime Milwaukee resident, sold his first science fiction story to *Amazing Stories* (August 1938). Author of hundreds of stories, he has become the recognized successor to Poe and Lovecraft and Derleth in the field of fantasy. Currently he is living in Los Angeles.

In that same issue of*Amazing Stories* was a story by **Ralph Milne Farley.** His real name was Roger Sherman Hoar. He was an attorney for Bucyrus-Erie, South Milwaukee, until his death in 1963. He was author (in pre-TV days) of the enormously successful "Radio Man" series of books.

Raymond A. Palmer, also a Milwaukee Fictioneer, was a prolific writer of science fiction and became editor of *Amazing Stories* and *Fantastic Adventures.* He died in 1977 at the age of 67.

Few names rank higher in science fiction than **Stanley G. Weinbaum.** He wrote only 14 stories before his death in 1935, but his yarns are honored as classics.

Arthur Tofte, after selling a number of science fiction stories to *Amazing Stories* and *Fantastic Adventures* in the 1930s, left the field for a career in advertising. In 1973 he returned. Since then he has sold seven books and about 60 short stories. He is currently science fiction book reviewer for the Milwaukee Journal.

Clifford Simak, one of the truly great names in science fiction, is a former Wisconsinite. In 1977 he was awarded the Nebula Grand Master Award. In 40 years he has published more than 25 books and 200 short stories.

Frederic Brown was another successful writer in this field who lived for years in Milwaukee and was a member of the Allied Authors of Milwaukee.

Gene DeWeese, a Milwaukee author, won first prize in 1976 in the annual contest held by the Council for Wisconsin Writers with a science fiction novel. Nine of his published books are in this field.

Dave Haggberg (Cambridge, Wis.) has just signed a contract to do a series of six "Flash Gordon" novels.

P.C. Hodgell is a young woman living in Oshkosh who has made a promising start with the sale this year of a number of science fiction-fantasy yarns.

Larry Sternig, Wisconsin's premier literary agent, has written and sold a number of science fiction stories. His protege, **Ray Peekner,** also a literary agent, is author of several science fiction stories.

A SAND COUNTY ALMANAC
by Aldo Leopold; Oxford University Press, 1949. 226 pp. Numerous printings both hard cover and paper.

This collection of essays, a classic in both literature and ecology, has kindled and sustained an awareness of our natural world among several generations of students, teachers and concerned laymen. Aldo Leopold had no intent to move mountains with his pen, but he has, and therein perhaps is the strength of his simple yet eloquent poetic prose. He said in the Introduction that his essays would bespeak of:

1. What his family sees and does on a sand farm weekend refuge from too much modernity.
2. Some episodes in his life and what they taught him.
3. The rationale of one who dissents from the clamor to have the good life at the expense of our natural resources.

In these writings is the astute use of metaphor as religion, law, literature, mythology, history, art and philosophy are played against a backdrop of ecology to give meaning to the latter. In this unpretentious treatment no one escapes the meaning of his words. All strings of the harp of human values are plucked and the music creates both beauty and insight. Rarely will two persons agree on which essays are most moving. Indeed, there is no spectrum of quality or power in these offerings: the lower and middle ranges of such a spectrum are simply not there. It is as if he wrote the *Almanac* for everyone who is capable of reading and of reason. In his words are reflected our unexpressed thoughts in an articulate flow of language that gives each reader a rapport with things natural, wild and free that is unique and soul-satisfying.

Space does not permit an in-depth discussion of each essay or section of the book. My favorite essay is the one I reread last. However, a synopsis of a representative one from each section follows.

Part I. A Sand County Almanac: "If I Were the Wind."

This 24-line essay describes the action of the wind on a November day. Wind can be identified only by what it does, and the author pictures a landscape confronted by this invisible force as if it had a sense of mission. He says, "A tree tries to argue, bare limbs waving, but there is no detaining the wind." I doubt whether there has ever been a more apt or lucid description of the interaction between a tree and the wind. Almost predictably he brings animate objects into this word portrait of the unseeable when he sits on a driftwood log and describes a flock of geese moving south against a headwind. When the geese can no longer be seen or heard, he writes, "It is warm behind the driftwood now, for the wind has gone with the geese. So would I if I were the wind."

Part II. Sketches Here and There: "On a Monument to the Pigeon."

At a time when ill health plagued him, Aldo Leopold accepted an invitation to write an article for a brochure on the dedication of a memorial to the passenger pigeon in Wyalusing State Park. I saw this essay develop from a routine obligation to a superb assessment of man's avarice and greed that destroyed an evolutionary masterpiece and a natural resource of great beauty. In his lament he wrote, "There will always be [passenger] pigeons in books and in museums but these are effigies and images, dead to all hardships and all delights." About these book pigeons he goes on to say, "They know no urge of seasons; they feel no kiss of sun, no lash of wind and weather. They live forever by not living at all." Each line of this outstanding piece is pungent with the essence of man's relationship to the natural environment. No writing before or since presents so persuasive a case for the moral obligation we hold toward endangered species.

Part III. The Upshot: "The Land Ethic."

This essay is long and subdivided into several sections. It contains the basic message concerning the man-land relationship distilled from a lifetime of experience by a man whose perception is unsurpassed. The entire Part III could have been one long essay. Although written prior to 1950, the basic principles and the fundamental concepts are just as important and relevant, if not more so, for the 1980s. Mark these words: "To promote perception is the only truly creative part of recreational engineering." "Conservation is a state of harmony between men and land." "The evolution of a land ethic is an intellectual as well as an emotional process." And, "A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise."

This last part is philosophical, gently reprimanding, prophetic and provocative. The strands of the ecological fabric woven by these essays are as bright and as strong today as when written. We have only to see ourselves as Leopold saw others to realize how much or how little progress we have made in the intervening years in developing an ecological conscience.

Leopold could examine a handful of soil and as it slid through his fingers he comprehended its geological origin, its organic history, its potential for life support, and thus, its future. His eyes grasped a landscape, and age, composition and vital statistics became elementary. From this gift of insight and understanding, he wrote of a social and biological evolution for the betterment of man and land. It is all in *A Sand County Almanac.*

Reviewer's Note: Technically these comments cannot be regarded as a book review in the classical sense. To attempt such an exercise would be akin to reviewing love letters written by one's parents. I admit to overwhelming bias, but not to inaccuracy.

—*Robert A. McCabe*

Robert A. McCabe, a professor of wildlife ecology, was a student of Aldo Leopold's.

THE VEGETATION OF WISCONSIN by John T. Curtis; The University of Wisconsin Press, Madison, 1959. 657 pp. $17.50.

It has been 20 years since this book was published, and in that time it has become a classic. It is not often that a 20-year-old book can be used as a text, but Curtis's book is still widely used. In fact, it seems to enjoy the timelessness of great literature. It is on the shelves of most active plant ecologists and in addition is read with interest and pleasure by many non-professionals. About 9000 copies have been distributed and the book is in its fourth printing.

There are a number of reasons why this book continues to enjoy such a fine reputation. Probably the most important reason is that it was far ahead of its time when it was published, and it is taking the rest of ecology a long time to catch up. To this date there is still no comparable treatment for any other state in the United States, and to the best of my knowledge nothing comparable in any other country. Another reason is that Curtis presented a unique way of organizing his material and used techniques which, while not solely invented by him, had never been used on such a large scale. His methods were extremely controversial, and the publication of the book elicited a number of fairly critical reviews. Many reviewers commented on Curtis's crisp style and the readability of the book, but differed with him on his concepts of organization. Curtis first presented his "continuum concept" in 1950, and extended this concept to a multidimensional approach, called ordination, in 1957. These two concepts form the backbone of Curtis's system, and it is these that aroused the controversy. The controversy is largely over now, and the more sophisticated of these two ideas, ordination, is now one of the standard techniques used by most ecologists, regardless of their philosophy. In fact, a major direction of research in ecology is the refinement of techniques for the ordination of data. The sophistication of the approach has increased considerably since Curtis's first efforts, but the basic ideas remain largely unchanged.

Other reasons for the success of *The Vegetation of Wisconsin* are attributable to Curtis's ability as an organizer and a thinker. A massive data base was used for the book—data from more than 1400 individual stands of vegetation. From 1946 to 1958 a succession of students devoted their efforts to working on the major forest communities of the state, while Curtis, in collaboration with Dr. Henry Greene, studied the grasslands and most of the lesser communities. All of this work was organized and directed by Curtis. He had an active, inquiring mind, a great ability to synthesize data, and a thorough and highly critical knowledge of the literature. He spent many hours discussing his ideas with his students and colleagues. The work is not just a compilation of data, it is a synthesis of ideas. In the final analysis, the success of the book is attributable to the genius that was J. T. Curtis.

—*Grant Cottam*

Grant Cottam is chairman of the botany department at UW-Madison and was one of J.T. Curtis's first ecology PhD graduate students.

A RIVER SURVEY OF THE UNIONID MUSSELS OF WISCONSIN 1973-1977 by Harold A. Mathiak, Sand Shell Press, P.O. Box 44, Horicon, 1979. 76 pp. Paper $15.00.

Harold Mathiak, research associate at the University of Wisconsin-Stevens Point, biologist, naturalist, wildlife specialist, ornithologist and sought-after public speaker, retired as research scientist from the Wisconsin Department of Natural Resources in 1972 and immediately launched into an intensive study of the mollusks of Wisconsin. He did this at a time when federal and state funds for such a study were not readily available. At his own expense he drove over 25,000 miles and sampled at 641 sites on 251 rivers to collect live specimens of 42 species. He deposited 7000 carefully prepared voucher specimens in museums over the country. After completion of collections in 1977, he wrote the text and with its publication finished a labor of love.

The need for the present work is aptly expressed in the foreword by Paul Parmalee, author of *The Fresh-Water Mussels of Illinois:*

> At a time when so many species of America's endemic plants and animals and the natural habitat in which they occur are being drastically reduced or entirely eliminated by ever-increasing land development and water control projects, an immediate accounting of these resources is essential if we are to preserve what still remains.

In the past, man tapped this resource for food and pearl button manufacture. In recent years mollusks have been harvested from the Mississippi River for making mother-of-pearl novelties and blanks for the Japanese pearl-culture industry. Mollusks are still an important food source for a number of Wisconsin animals, and treasure seekers of all ages still search inside shells for that rare pearl.

In the present survey each species is treated on a separate page. Given are scientific and common names, a range map, a short description of shell color and physical characters, and ecological notes.

Especially useful to the potential mollusk collector are the many suggestions regarding water conditions, aids to visibility and favorable collecting sites. A detailed description is given for the construction of a simple collecting tool invented by the author. It was most useful in murky waters where hand-grubbing was not practical. Care of mollusks after collecting, and tempering to prevent cracking are explained in detail.

The brilliant color plates and descriptions should enable the reader to identify many specimens in hand. Several additional plates, all in color, depict good collecting sites and other pertinent molluscan features.

Mathiak's contribution is the first since Baker published his monumental work on mollusks over 50 years ago. The present effort details for the first time the Wisconsin distribution of each species and it will be a benchmark for future distributional studies. Hopefully it will promote a resurgence in study of this important group, which over the years has been sadly neglected.

This colorful book, appealing to the general reader as well as the professional, is printed on high grade glossy stock and should become an important and long-lasting adjunct to every natural history library.

—George Becker

George Becker, professor of biology and curator of fishes at the University of Wisconsin-Stevens Point, is a published author and a former AIBS visiting biologist.

PODS: WILDFLOWERS AND WEEDS IN THEIR FINAL BEAUTY by Jane Embertson, with photography by Jay M. Conrader; Charles Scribner's Sons, New York, 1979. 186 pp. $14.95.

Appropriate to both the sciences and arts, this unique book has an exploratory subtitle: "A visual guide—from flower . . . to pot . . . to dried arrangement." On each page three professional color photographs depict a wild plant in flower (in the field), in fruit (against a uniform black background) and as used in a table or wall arrangement (alone or with other material). Concise notes help the reader identify the flower and prepare the pods. "Pod" is adapted to include all kinds of fruits, stalks, capsules, seeds, associated leaves and their arrangements on the stem.

This is by no means a complete "Peterson" field guide, for it treats barely seven percent of the flora of its range—the Great Lakes and northeastern states and adjacent Canada. (Neither is Lauren Brown's *Weeds in Winter*, Houghton-Mifflin, 1977, paperback, with almost the same number, about 200, of species illustrated by pen sketches.) But in its three habitat sections—open sun (field and prairie), woodland and wetland—one must think hard to find significant omissions. From motherwort and four milkweeds to marsh aster and meadowsweet, they cover all structural types. The sections devoted to grass and sedge silhouettes are representative, too, although very brief. I did miss certain favorites such as draba, wild yam, phlox, yellow pond lily, lotus, cocklebur, vetch, alfalfa and ostrich fern. And while including certain woody fruits, such as wild roses, the book omits some distinctive ones like bladderbush, waahoo, alder, ash, buttonbush and water-willow. For the amateur's protection, the forbidden fruit of poison ivy, sumac and oak are described (but not illustrated).

By not saying too much, this book entices you to discover on your own the delightful designs and subtle colors that follow the more conspicuous flowers. You look over the shoulder of three experts (Mrs. Embertson and two colleagues, Ruth Weber and Colleen Weiler) as they go about their business. The sequence involves locating specimens in flower, returning periodically to select pods at the right stage for color and durability, curing them (usually by simply hanging them upside down to dry), and finally creating original arrangements. The examples chosen for illustration often reveal exciting possibilities in what may at first seem unpromising material such as plantain, lopseed, burdock and sow thistle.

Some of the simpler and most striking arrangements are swamp milkweed in an asymmetric jade green vase; purple loosestrife in an upside-down door spray with red Japanese lanterns (a cultivated ground cherry); teasels with honey locust pods; and campion capsules with pheasant tailfeathers.

Especially appropriate is a brief but well-balanced introductory section, in lay language, on the ecology and conservation of wild plants. One is advised to appreciate the several values of our lowly weeds, and to perpetuate all of the species used: let seeds fall, protect habitats, avoid over-collecting, never uproot nor transplant and spare all unidentified species and known rarities.

My main criticism is that keeping the book's size small (15 x 21 cm.) for field use causes some of the creative arrangements to suffer from over-reduction; one loses the effect and sometimes even the species in question. Arranging the species by time of ripening is logical, but confusing because of a broad overlap in maturing dates. But a thorough Latin and English index and the marginal location of titles and photographs make retrieval easy.

The collaborating Wisconsin artists, Embertson and Conrader, are to be commended for conceiving and executing a work describable as "neat as a pin." The relatively few errors are lost in the overall excellence of production including a sturdy binding, hard covers and tough, flexible pages. The high price is justified; even Japan, where one must now go for fine color work, is no longer cheap. This book is a must if you haven't known the joys of going outdoors to select and create from nature's treasures, and it will give you some new ideas if you already have.

—James H. Zimmerman

James H. Zimmerman is a naturalist-writer, environmental consultant and lecturer at the UW-Madison department of landscape architecture.

WORLD SPACE-ECONOMY by Anthony R. de Souza and J. Brady Foust; Charles E. Merrill Publishing Company, Columbus, Ohio, 1979. 637 pp. $16.95.

This scholarly work is exhaustive in its treatment of the plethora of models, analytic approaches and concepts which have evolved in the discipline of the geography of space-economy since about 1900, the date of publication of Ellen Semple's *Economic Geography*. De Souza and Foust, who are professors at the University of Wisconsin-Eau Claire, have authored an impressive introduction to the body of thought created by economists and geographers, from Adam Smith (1723-1790), Malthus (1766-1834) and Thunen (1783-1850) to current writers of the 1970s. The declared purpose of the book is to enable the reader to get a "deeper understanding of what is going on in the world" in terms of economic landscapes. Human beings do not live on Wall Street graphs, but rather on three-dimensional landscapes, a fact that these two Wisconsin geographers document well, with the aid of photographs, excellent charts and diagrams. Conservative and liberal ideas, as well as radical critiques are presented. Yet the emphasis is on "the world's capitalist system." There are glints of humor and evidences of compassion, which endear the writers to the reader. On many pages, succinct biographical summaries and explanations of key concepts are set off in boxes. These comprise a sequential abstract of the volume. A smaller companion book by the same authors, entitled, *The Economic Landscape* (Merrill, 1978; 344 pp.) may serve as an additional aid in exploring the subject.

The scope of the book is indicated by the following headings that are taken from the table of contents: ideas of economists, competing mindsets, economic problems, macroeconomics and microeconomics, fundamental geographic concepts, perspectives in economic geography; population distribution, composition, migration and growth; resources and their limits, food resources, nonrenewable mineral resources, energy, factors affecting rural land use, location of land use inside cities, central places and their hinterlands; spatial forces influencing manufacturing, social consequences of changes in the location of manufacturing, network analysis, transport costs, the behavioral matrix; sociological theories of underdevelopment, the geographer's perspective on underdevelopment and modernization, the conventional case for trade, center-periphery relations, the proto-proletariat (peasants in the urban environment), and ecological and political features of urban Third World masses.

This reviewer appreciates the way in which the book shows, principally through maps, the place of Wisconsin in universal settings, with respect to such topics as population distribution and annual growth rate, speed of urbanization, geography of hunger, location of nuclear power reactors, land use patterns, average value of cropland, wholesale trade areas, average hourly wages of production workers, distribution of manufacturing enterprises, percentage of families below low income level, extent of commuting fields and tourism at home and abroad. *World Space-Economy* permits the reader to see the economic landscapes of the world, and Wisconsin's place among them, through the eyes of leading past and present thinkers and observers, but also through the eyes of two able Wisconsin geographers.

—*Francis D. Hole*

Francis D. Hole, professor of soil science and geography at the University of Wisconsin-Madison, teaches a course in geography of Wisconsin and is on the staff of the Geological and Natural History Survey, University of Wisconsin-Extension.

MAP USE: READING, ANALYSIS, AND INTERPRETATION by Phillip C. Muehrcke, with the assistance of Juliana O. Muehrcke; JP Publications, P.O. Box 4173, Madison, WI 53711, 1978. 469 pp. $14.95. Paperback.

If you are intrigued by maps—reading or making them—you'll find this book a gold mine of information and enjoyment. Its purpose is to enlighten **users** of maps, but, of course, map interpretation and appreciation cannot be discussed without telling something of how maps are mentally designed and physically produced. So an added reward is that you are taken into the mind and drafting room of the cartographer and thus learn much about making maps as the experts do.

While you read *Map Use* you'll feel an excitement about maps. You'll be introduced to mapping innovations, new gadgetry, the latest terminology, and you'll be brought up to date on satellite photography, remote sensing and sophisticated portrayal of statistical data. The old, well-known basics are there too. As you discover what maps can do for you, you'll note that the book is not only educational, but entertaining. One reason is that it is styled, in large part, for the general lay reader. Another reason is the enthusiasm of the people who created it.

Although *Map Use* has become a popular cartography textbook across the country (and is organized for such use), it is nonacademic in tone, and addresses itself to the outdoor, as well as indoor, map-user. It is a mixture of the serious, the stimulating and the humorous. One never has to read long in a studious vein before happening on a sprightly quotation, anecdote or drawing.

Who says you can't mix science and levity? And who says you can't mix sections of technical and popular writing in the same book? Here those are blended and alternated in a lively, interest-sustaining manner.

The abundant illustrations provide excellent examples of well-executed maps and diagrams that demonstrate different techniques and uses of symbols. Many are done in distinctive shadings of black through grays to white. What is impressive is not just the skillful design of these illustrations, done by the author, but also their crispness, legibility and right size after having gone through the printing process, the ultimate sign of craftsmanship and foresight.

Among the illustrations are many photographs, including air and space photos and even appropriate cartoons and comic strips.

While some parts of the book are technical, like those dealing with cartometrics and advanced mathematics, most are of general interest. The wide range of subjects includes topics such as interpreting the natural environment, portrayal of landforms, route-finding techniques, maps as propaganda tools, land-partitioning systems, and sources of different kinds of maps and air-space photos and how to order them.

Suggested readings follow each section, and a bibliography of quotations appears at the rear.

In the appendices one finds methods of changing map scale, analysis of map projections and tables of mathematical data. There, also, is good advice on how to care for and mount your maps and how to orient yourself and survive if ever you are lost.

The personality and talents of the author and his wife pervade the book. The author, Phil Muehrcke, is professor of geography at the University of Wisconsin-Madison where he teaches cartography and map use. His manuscript was "illuminated," as he says, by his wife, Juliana, who is a professional writer of educational and other works. She edited or rewrote much of her husband's prose, revising it into language suitable for the average reader, at early college level. Escapes from academic tedium are felt throughout and many of them must be her doing. A poem of hers introduces the book.

One can sense that years of effort went into assembling the material for this encyclopedic paperback volume, and that no amount of thought or energy was spared to make it as special as possible. It is indeed encouraging to growing ventures in self-publishing that, independently, a book of this subject and size, with its richness of illustration, could be so successfully produced, so eagerly received and so widely marketed.

—*Gwen Schultz*

Gwen Schultz is a geography professor, currently with the Wisconsin Geological and Natural History Survey. Cartography is one of her specialties.

PHYSICS FOR POETS (Second Ed.) by Robert H. March; McGraw-Hill, Inc., New York, 1978. 287 pp. $13.95.

I am not a physicist; I'm a poet. So, naturally I was attracted to a book specifically addressed to me. I must admit that I approached Robert H. March's text, *Physics for Poets*, with as much reservation as one might approach a book entitled *A History of Beef for Vegetarians*. However, March explains this uncommon title for a college physics text in his introduction. He states that poets and physicists share a pursuit for truth. In addition, both use creativity and a desire for beauty in their pursuit of truth. March, a professor of physics at UW-Madison, argues that although scientific objectivity must be maintained in the testing of ideas, creativity and subjectivity are important in the initial ideation. This notion contradicts current impressions of physical science as a totally impersonal, objective and empirical study.

Physics for Poets is an introductory text which provides a historical overview of the field. From Galileo to quarks, March focuses on classical mechanics, relativity and the quantum theory. This is not exactly typical leisure reading. However, it is written in an engaging style that provides delineation of scientific concepts within the perspective of history. In addition to the historical development of scientific ideas, March includes brief personal histories of the authors of these ideas. For example, readers learn that Isaac Newton was painfully sensitive to the slightest criticism of his work and it was only through the persuasive powers of Edmund Halley (of Halley's comet fame) that his most significant work was published.

Obviously, I'm in no position to critique the validity of the book's content. That I'll leave for Dr. March's colleagues. However, as a learner and poet, let me point out some things that I believe are important. As a student, I had typically found texts to be written in either of two extreme styles. Some textbook writers unknowingly (and some, I suspect, knowingly) write in a way that mystifies the reader. Others, in an attempt to avoid mystification, write in so elementary and explicit a manner that the result is condescending. March is an exceptional writer. His competent and personal style makes the content easy to grasp. He demonstrates a respect for the reader. One gets the impression that he is addressing an audience of intellectual peers—perhaps uninformed about physics but yet no less able to grasp and understand it.

In addition to being clear and accessible, March's writing shares a characteristic of good poetry. Good poetry invites readers to participate in the experience of the poem. Readers provide their own experiences and emotions to complement, and perhaps complete, the poem. March's style reflects a similar invitation to participate. Through his animated and informative writing, readers participate in the learning.

For poets who open March's book with the intent of finding ideas for lines or titles for their poems—they will not be disappointed. The section headings within the chapters reveal some well-crafted and clever wording. Some of my favorites include: "The Tao of Space Time," "A Cosmic Vacuum Cleaner," "The Mangy Dog and the Man With the Golden Nose" and "The Loneliness of Deep Space." Considering the titles of many recent poetry chapbooks, I suspect that poets will feel comfortable delving into sections with headings like that.

—*Jeffrey Winke*

Jeffrey Winke is a poet living in Milwaukee.

INSIDE THE ACADEMY

Challenge and opportunity

by Walter E. Scott

"Great fleas have little fleas
upon their backs to bite 'em,
And little fleas have lesser fleas,
And so *ad infinitum*"

Over a century ago Augustus DeMorgan wrote the above rhyme in his "A Budget of Paradoxes," in a sense stealing the idea from Jonathan Swift's "On Poetry, A Rhapsody" written more than a hundred years earlier. Poets, too, long have understood that the interrelationships among animals are indeed very complex!

It was into this world that scientists such as Thomas C. Chamberlin, Philo R. Hoy and Increase A. Lapham were born. All of them signed the "Call for a meeting to organize" a comprehensive state Academy of Sciences, Arts and Letters 110 years ago in Wisconsin. Their reasons were very clear: much more was **unknown** than **known** so far as the fledgling state's resources were concerned.

In 1851, Lapham sent to UW Chancellor J. H. Lathrop "A Systematic Catalogue of the Animals of Wisconsin" which he had prepared, and this appeared in January 1852 as part of the Board of Regent's Fourth Annual Report. Later that year, in Volume 2 of the Wisconsin Agricultural Society's TRANSACTIONS, Lapham published an article on the "Fauna and Flora of Wisconsin" that contained a section revised and annotated by Dr. P.R. Hoy entitled "Notes on the Ornithology of Wisconsin." These scientists already were working conscientiously.

Former Academy President A.W. Schorger's 1947 article on "The Wisconsin Natural History Association" listed several abortive attempts by Lapham and his colleagues to organize such a group in 1848, and when that failed, to reorganize it in 1855. Still not succeeding, four years later Lapham tried to incorporate a natural history survey into the proposed Geological and Agricultural Survey—and that faded away in 1863. Then in 1867 Lapham attended a meeting in Madison which adopted the constitution of a "Wisconsin Academy of Sciences," but this also did not survive. Dr. Schorger closes his article: "but finally, in 1870, the Wisconsin Academy of Sciences, Arts and Letters was founded. Though the academy has enjoyed continuous existence and has done some fine work, it has yet to rear a monument to natural history such as Lapham envisaged when he founded the old association."

Four years after WASAL was chartered in 1870, Chamberlin (representing the Wisconsin Geological Survey) talked to those attending the State Agricultural Society Convention. He had recently given the survey's instructions to Franklin H. King, professor of natural science at River Falls State Normal School, on research procedures for a study of the "Economic Relations of Wisconsin Birds." Chamberlin's text in the Society's TRANSACTIONS (Vol. 12) on relation of the Geological Survey's work to agricultural interests used an example of biological complexity in trying to find out whether a bird was good or bad for the farmer. He explained the difficulty of determining if insects eaten by birds were detrimental or helpful, depending on what they attack, and also what was eaten or killed by the ones which in

Edgar L. Obma

turn were eaten by them. His thesis was that, "We have cats and dogs to prey upon troublesome mammals. Why not have cats and dogs among the insects for a similar purpose in their order of the animal kingdom?" Biological scientists still are searching for these answers in spite of (and because of) modern pesticides.

According to J. W. Hoyt's letter of January 28, 1870 to prospective members, the proposed Wisconsin Academy should be supported by "all those who are zealous for the advancement of science, art and literature." He became first president of a successful organization that prospered because of its broad base—not in spite of it. In the ever more complex future, the challenge for scientific research and its interpretation through the arts and letters will progressively become greater than before. This also is our mutual opportunity.

Walter E. Scott has been a member of the Academy for 38 years. Assisted by his wife Trudi he served as editor of the **Wisconsin Academy Review** *from its first issue in 1954 until its 40th issue ten years later.*

WISCONSIN ACADEMY REVIEW

1922 UNIVERSITY AVENUE
MADISON, WISCONSIN 53705
RETURN POSTAGE GUARANTEED

Second-class Postage
Paid at Madison, WI