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## Clues to Health in “Smartweeds”

Sonia Sultan and her colleagues say that plants may have something important to tell us about the environment and human health. **By Laura Perillo**

Sonia Sultan, a slim and dark-haired biologist, kicks off her sandals and begins to water one of the bushy green *Polygonum* plants growing in Wesleyan’s research greenhouse. She intends to compare it to its relatives growing in the wild on a bright Cape Cod beach.

By studying growth under different conditions, Sultan has shown that a plant’s development depends on environmental factors and not solely on its genetic makeup. The significance of this work extends far beyond the plants she studies, many of which are common weeds. Sultan’s insights are helping medical scientists understand how, even in the womb, environmental influences may play an unsuspected and detrimental role in human health, leading to serious diseases such as hypertension and diabetes.

Ever since Watson and Crick described the structure of DNA in 1953, scientists have focused primarily on the role of genes in determining traits of living things. The role of environment in development has taken a back seat. Sultan and her colleagues argue that environmental factors deserve a closer look. Surprisingly, environment can change development in ways that extend across generations.

“The general public is probably unaware how profoundly environmental influences shape development and physiology in both animals (including humans) and plants,” says Sultan. “Genes alone do not determine everything about us.”

She and a group of international colleagues recently published their ideas in the journal *Nature*. The article raises significant—and as yet unanswered—questions about public health.

The *Nature* paper had its origins in fields as diverse as evolutionary ecology, physical anthropology, and medical epidemiology. The key finding, according to the authors, is that many organisms show great adaptability in responding to environmental stresses, a phenomenon known as “plasticity.”

For example, the freshwater shrimp species *Daphnia* shows plasticity when a mother is exposed to chemical traces of a predator. Her offspring are born with a defensive “helmet” that protects them from that predator. If the predator has disappeared, however, this extra structure becomes a liability in competing to capture food. What is adaptive in one environment can actually reduce success if conditions change.

Sultan’s interest in plasticity dates

to her graduate work at Harvard in the mid-’80s. As she strolled by a vacant parking lot one day, she made an important connection when she stooped down to look at several weeds growing out of the cracked pavement. Some were in the shade and some were bathed in full sunlight. The weeds in the shade had developed broader leaves, which would catch more light, while the weeds in the sun had formed narrower leaves, which would conserve water. These adaptive differences were due to plasticity, since both plants belonged to the same species.

“I realized that if genetically similar plants could do well in the sun and shade simply by virtue of flexible responses, then flexibility is an important part of how species cope with different environments,” she says. “Organisms don’t have to have specific genes to survive in certain environments.”

Today, Sultan continues to study the adaptability of plants and how this affects their ecology and evolution.

“I prefer working with plants because you can clone them,” she says. “This produces much more convincing results since any differences between genetically identical plants must arise from environmental differences, and not from genetic ones.”

Much of Sultan’s experimental work takes place inside Wesleyan’s research greenhouse. A rooftop weather station feeds information to an elaborate comput-

er system that adjusts vents, shade curtains, and heating and cooling machinery to maintain optimal climatic conditions. One area Sultan and her students are studying is cross-generational plasticity—the way mother plants alter their offspring in response to environmental conditions.

In the weedy species called *Polygonum persicaria* (or “smartweed”), Sultan has found that mother plants grown in the shade make smaller fruits by building them with thinner outer walls, but the size of the embryonic plant’s nutrient reserves remain the same.

“Due to growing in low light, where they photosynthesize less, the mother plants economize on the outer covering of the seeds, but they maintain the more essential high level of nutrient supply to the new plant,” she explains. “The seedlings also make shorter roots, favoring shoot growth, which would maximize photosynthetic surface area under limited light. In this experiment, Sultan’s seedlings were particularly well suited to the shaded environment their mothers encountered.

“It used to be thought that the effects of environmental stress on a mother animal or plant would just result in smaller or weaker offspring,” she says. “In the past eight years or so, it’s been recognized that certain plant and animal species show specific, adaptive responses to these kinds of stresses in the way they make their offspring.”

Do humans respond in a similar way?

According to Sultan and her colleagues, humans evolved so that the mother would signal to her fetus what environment the child could expect, and that child would develop a body appropriate to that environment. If a mother has poor nutrition, for example, the fetus would develop the kind of metabolism and digestive system designed to conserve calories.

That’s the thrust of the *Nature* paper. David Barker, a leading epidemiologist who heads the Developmental Origins of Health and Disease faculty at England’s University of Southampton, says the study of developmental plasticity in people is just beginning.

Humans—just like the *Daphnia*

shrimp—may be adversely affected if the mother prepares the fetus for an environment that the child does not encounter. A pregnant woman in poor nutritional condition may unwittingly signal to her unborn baby that it is about to enter a harsh world. If so, this “weather forecast” from the mother’s body may result in her baby being born with characteristics such as a small body and a modified metabolism that help it to cope with a shortage of food. If the child later has lots to eat, this may trigger health problems such as obesity. Barker’s research shows that people with low birth weights who grow up in affluent environments are at increased risk of developing coronary heart disease, type 2 diabetes, and

hypertension. Those born as heavier babies and brought up in affluent environments enjoy a much-reduced risk.

The authors of the *Nature* paper say that a critical public health issue is whether measures exist that would help individuals whose characteristics were set early in life for an environment that subsequently changed. If so, physicians may be able to help some individuals avert chronic diseases. The group met in Italy last year to discuss ways that a mother’s nutritional health can affect the development of her child and his or her health as an adult.

Coauthor Patrick Bateson, former head of the Department of Zoology at the University of Cambridge and a fellow of Britain’s Royal Society, says

that people in developing countries where conditions are changing, such as India and China, are particularly susceptible to the problems caused by intergenerational plasticity. An essential public health measure, he suggests, is careful control of diet after birth, along with enhanced nutrition for young women.

He credits plant scientists, including Sultan, with leading the way toward a better understanding of plasticity and its implications for healthy or unhealthy development.

As with all of her research, Sultan’s ultimate goals remain the same. “I want to change the way people think about organisms,” she says. “I want them to question and challenge their ideas.”



Biologist Sonia Sultan and an international group of colleagues have published a provocative paper in *Nature*, arguing that as is the case with plants and other organisms, human health is influenced across generations by environmental effects.

**TIBETAN MONKS AT WORK  
A MANDALA TAKES SHAPE**

Tibetan monks from the Drepung Loseling Monastery in Southern India spent Sept. 8–11 on campus creating a mandala, or sand painting, in the lobby of Olin Library. A constant stream of visitors from on campus and off stopped by to watch the monks engaged in what the Wesleyan *Argus* called “a grand lesson in patience, delicacy, and precision.”

The monks worked from noon until 7 p.m. daily, painstakingly placing grains of

colored sand within an intricate design that acts as a symbolic representation of cosmic forces. The design, completed on the third anniversary of 9/11, was the same “Unshakable Buddha” that the Dalai Lama recommended for Washington, D.C., after the terrorist attacks.

The *Argus* might have added “humility” to its list of qualifiers, since, after the mandala was complete, the monks took the sand and led a procession to the Connecticut River to disperse their work, symbolizing the impermanence of existence. **W**

**NEW CHAIR HONORS**

**HENRY WRISTON ’11**

Henry Wriston ’11 was born in Laramie before Wyoming became a state. His mother had come west in a wagon train and survived a deadly clash with Indians. His father was a circuit preacher who taught himself Greek, Latin, and Hebrew so he could read scriptures in their original language.

In that rough country, Wriston somehow acquired the ambition to be

an academic, which he fulfilled as a history professor at Wesleyan and later as president of Lawrence College (now University) and then president of Brown University. His interest in public policy subsequently took him to several high positions during the Eisenhower administration.

Now his son, Walter Wriston ’41, former chair and chief executive officer of Citicorp, has commemorated his father’s distinguished career by establishing the Henry Merritt Wriston

**Pick of the Syllabus**



**SUZANNE O'CONNELL, ASSOCIATE PROFESSOR OF EARTH AND ENVIRONMENTAL SCIENCES**  
**Selects**  
*Noah's Flood: The New Scientific Discoveries About the Event That Changed History*  
by William Ryan and Walter Pitman

Growing up in a Catholic Irish household, I learned early the story of Noah and the flood. It is one of the most powerful stories in the Judeo-Christian tradition, one guaranteed to capture the imagination of a child. What I hadn't realized though, until reading William Ryan and Walter Pitman's fascinating book, was how widespread this story is, how many cultures and traditions possess a similar myth. For example, the Epic of Gilgamesh, a legend from ancient Mesopotamia that was recorded 4,000 years ago, also includes a vivid description of a world-devastating flood. As an earth scientist, I find that intriguing. Could the myth be more than a myth? Ryan and Pittman make a convincing case that it is.

They are far from the first scientists to raise this issue. In my sedimentology class, students learn to describe sediment deposits as recorders of the earth's history. In doing so, I tell them, they are following the example of Leonardo da Vinci, who was, among his countless achievements, an excellent sedimentologist. He sketched studies of sedimentary

**NOAH'S FLOOD: MYTH VS. REALITY**

rocks and landscapes, often to develop them later into backgrounds for his paintings. These sketches reveal considerable detail and understanding of sedimentary processes. In his notes, he wondered why all of these rocks, deposited by Noah's floodwaters, were standing on edge. He also noticed a marine fossil included in the sediments and wondered how this creature could have made its way from the ocean depths to a mountain top in 40 days. Clearly some of the great minds of science have puzzled over aspects of the flood myth.

Ryan and Pitman belong in this category of scientific great minds. Among Pitman's claims to fame are the magnetic time scale, the series of polarity reversals recorded in sediments and rocks that allow us to determine their ages. Ryan's research has uncovered data indicating that about five million years ago, water could no longer flow between the Atlantic Ocean and the Mediterranean Sea, and as a result, the Mediterranean dried up. During that time, it should have been possible to walk from Casablanca to Rome.

Ryan and Pitman's flood studies, which they share in the book, provide strong geologic, biologic, and linguistic evidence that a gigantic flood occurred some 7,600 years ago in the Black Sea. Prior to the flood, the Black Sea was a freshwater lake. As the ice sheets melted and sea level rose, water in the Mediterranean rose and flowed over the Bosphorus Sill, rapidly filling the Black Sea. They, Ryan and Pitman, calculate that the salt water rose half a foot a day. The human inhabitants who lived on the sea's shores had to find new places to go. Thus began a diaspora, which would carry Black Sea inhabitants and their sophisticated agricultural techniques to the areas near the confluence of the Tigris and Euphrates rivers and around

the world. These inhabitants would also carry the story of a disastrous, roaring flood where “the waters swelled so mightily that all the high mountains under heaven were covered.”

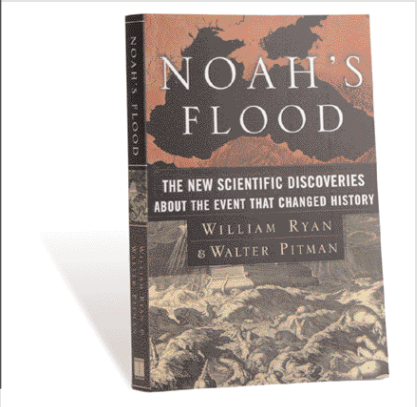
I like *Noah's Flood* on so many different levels and have used it in my general education science courses. In these courses, my goal is to prepare students to continue to learn about science after they complete the class. This type of book can be an excellent source of information. I rely on general science volumes myself to learn what is going on in other areas of science. Many, if not most, of my students have never read a general science book. After reading one for a class assignment, most report having enjoyed it and claim that it increases their likelihood of reading another such publication in the future.

*Noah's Flood* is a particular favorite of mine because it gives students a sense of how science is done, the creativity and detective work involved. Da Vinci didn't have access to cores from the Black Sea that show the sharp boundary between the fresh water lake organisms and Mediterranean marine organisms, and to carbon dates to show that these changes were geologically continuous; nor did he have seismic reflection profiles that show scouring and erosion near the mouth of the Black Sea. But Ryan and Pitman did and used the information to develop a theory about the actual events that led to Noah's flood.

I like the way the two writers describe how science is done. People often have the mistaken impression that scientists work in isolation, spending time dressed in their white coats in a lab, puzzling over data and experiments. Although that is certainly a part of science, it's not the whole story. For the most part, science is very collaborative.

How many single-author papers are published? Very few. One of the real pleasures of being a scientist is the collaborative nature of our work, sharing ideas, discussing data, planning for future experiments or expeditions. I think this aspect of the scientific process comes through clearly in the book.

I also have personal connections to the work, which makes it especially appealing. Ryan was my Ph.D. adviser, Pitman a good friend, and many of the people mentioned in the book are friends and colleagues. I especially like the connection with Wesleyan graduate Candace Major '94 (pictured in the book on page 130). As a rising senior, she accompanied Ryan and Pitman and the other scientists on the Russian vessel *Aquanaut* to collect cores and seismic profiles. It is a kind of project that can take hold of a person, and Candace continued on to Columbia University for her Ph.D. Now, after a post-doc in France, she's working at the Woods Hole Oceanographic Institution. She did not plan to major in earth science when she arrived at Wesleyan, and I hope other students in my classes will follow in her footsteps. Of course, her work has added changes to the Ryan and Pitman story. That's what science is about.





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Professorship, which will be devoted to public policy. His gift has helped Wesleyan exceed its \$250-million campaign goal.

“Dad’s influence on us was large,” Wriston said. “We used to argue about so many things around the dinner table with books spread all around us.”

Henry Wriston was a prolific author who wrote more than 20 books. Among them was *The Nature of a Liberal College*, and to this day every graduating senior at Lawrence receives a copy.

While at Lawrence College, Wriston displayed a knack for hiring people of enormous talent, including Victor Butterfield, later Wesleyan’s president, and Nathan Pusey, who subsequently taught at Wesleyan before becoming president of Harvard.

Under Wriston’s leadership extending over two decades, Brown University was transformed from a small Baptist school to one of America’s noted universities.

“Dad was always a teacher,” Wriston said. At Lawrence he taught a course in public policy in which the only text was the *New York Times*, which arrived two days late in Wisconsin.

During the Great Depression, when 18 million Americans were out of work from 1933–39, the elder Wriston wrote *Challenge to Freedom* as an argument against socialism. During World War II, he wrote *Prepare for Peace*, in which he laid out a prescient program for the post-war era.

Eisenhower tapped him to handle a major reorganization of the State Department. At Eisenhower’s request, Wriston became president of the American Assembly, devoted to furtherance of public policy. He also headed the Council on Foreign Relations.

Walter Wriston, who this past summer received the U.S. Presidential

Medal of Freedom for his own distinguished career, said he hoped the new faculty chair would help promote the study of how public policy is made  the era of Internet communication.

**OUTREACH TO PUBLIC SCHOOLS**

**PIMMS MARKS ITS 25TH**

In 1979 a group of Connecticut citizens concerned about math education got together on the Wesleyan campus.

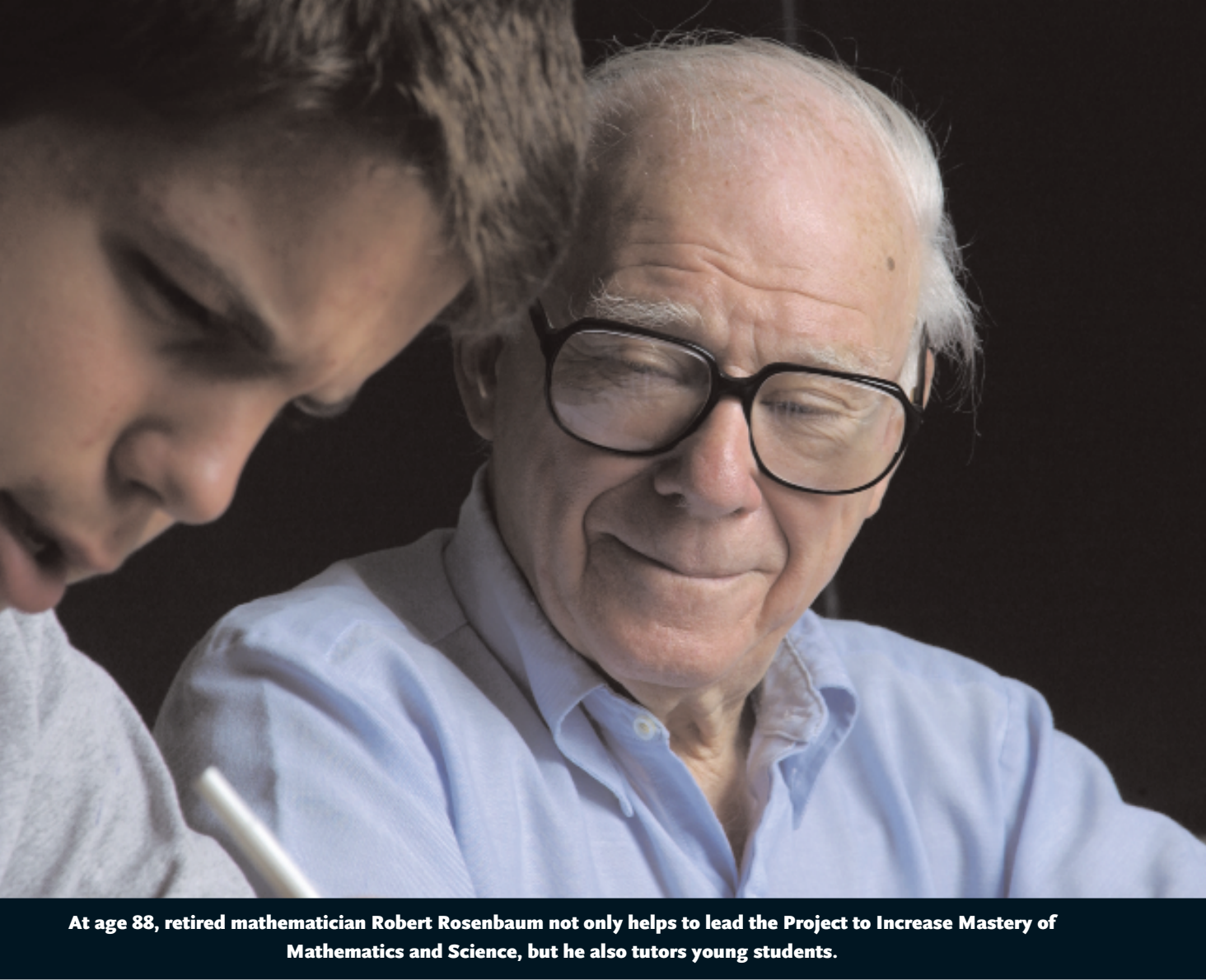
Their worries ranged from declining student performance in math to the small number of women choosing math-related careers to high school students’ lack of preparation for college.

Robert Rosenbaum, who was nearing retirement from a long career in Wesleyan’s mathematics department, led an effort to do something about the problem. Eventually, that response took shape as PIMMS, the Project to

Increase Mastery of Mathematics and Science, headquartered at Wesleyan.

PIMMS is celebrating its 25th anniversary this year. Rosenbaum, at age 88, has logged roughly 40,000 hours of volunteer service to the organization, and no one is more closely identified with the program.

“I have been pleased, and to some extent astonished, that PIMMS has continued as it has,” he says. “That pleasure



At age 88, retired mathematician Robert Rosenbaum not only helps to lead the Project to Increase Mastery of Mathematics and Science, but he also tutors young students.

BILL BURKHART

is attenuated by the realization of how much still needs to be done for the whole educational system. You can’t just stop and assume you’ve done your part.”

The first corporate backers of PIMMS were not thinking that way when the program began.

“At the very start, some of the people in business and industry whom we approached for funding had the notion that if they supported PIMMS for a couple of summers, that ought to be all that Connecticut needed,” Rosenbaum says. “Now there is greater realization that such professional development is an ongoing activity, as it is for doctors, lawyers, and other professionals. In the process, PIMMS has become much better known as part of Connecticut’s top-notch educational landscape.”

Students in Connecticut’s more affluent school districts consistently rank near the top of the nation in standardized math tests. Although it’s not possible to disentangle the effect of PIMMS from other measures taken to improve student performance, PIMMS has brought large numbers of teachers into its fold. About 750 PIMMS Fellows have at least two years’ experience with the program, another 1,500 have shorter experiences, and thousands of teachers have participated in workshops or other activities led by PIMMS Fellows.

Connecticut is also home to some of the poorest cities in the nation with struggling schools. PIMMS has worked closely with a number of these, including Simpson-Waverly Elementary in Hartford. Over time, the performance level of students at Simpson-Waverly increased so much that their Connecticut Mastery Test results now consistently exceed those of schools in much more affluent neighborhoods. Simpson-Waverly earned federal Blue Ribbon status, accorded to high-achieving schools in poverty-

stricken areas. Of course, engagement with PIMMS was only one element of a program fashioned by a strong and celebrated principal.

Although some PIMMS programs have targeted students, the organization has focused primarily on helping teachers acquire new knowledge and skills to help make science and math vibrant subjects. In response to the changing needs of Connecticut’s schools, PIMMS has shifted its focus in recent years from secondary-level education to elementary and even preschool efforts. In a recent *Hartford Courant* op-ed, PIMMS Director Mike Zebarth argued that Connecticut must reach students as early in the educational process as possible to address the huge achievement gap between rich and poor districts.

“Evidence is increasing,” he says, “that Connecticut’s high quality school readiness programs can decrease the numbers of children held back in kindergarten and first grade, decrease the need for elementary school special-education designations, and reduce early reading performance gaps.”

In Bridgeport, PIMMS is working with a grant from General Electric to help elementary teachers in the impoverished inner city. Zebarth says the preliminary results show distinct improvement on the Connecticut Mastery Test.

Test scores don’t directly measure something that Zebarth says he has observed personally in classrooms: the infectious enthusiasm that teachers who’ve worked with PIMMS bring to their students. The guiding philosophy of PIMMS is to work with teachers as colleagues, and the leaders of the program believe that this approach has helped many teachers rediscover enthusiasm for tackling the many trials and frustrations of contemporary public school teaching.

There are other untestable aspects


of teaching that PIMMS seeks to cultivate, such as sensitivity to the role of math and technology in our culture.

“This is not just a matter of aesthetics,” says Rosenbaum. “It’s important for the future of a technologically oriented society.”

The Bridgeport project also reflects the changing nature of corporate funding, which now tends to be focused on specific problems rather than general program support.

PIMMS has always relied heavily on corporate and foundation support, which waxes and wanes with the economy or changing corporate priorities. To provide ongoing stability, Wesleyan is helping PIMMS raise a \$2-million endowment.

Rosenbaum sees this collaborative fundraising project as indicative of the strong ties between Wesleyan and PIMMS.

“When I came to Wesleyan, it’s fair to say that there wasn’t much interest in pre-collegiate education on the part of the science division,” he relates. “Undergraduates were not encouraged to think of teaching as a career. This has changed. Now there are lots of faculty who have a concern for pre-collegiate education and a feeling of collegiality with those who work in that field. s a much healthier environment.”

**A PHOTOGRAPHER’S VIEW**

**IMAGES OF BUDDHIST LIFE**

The trip across Japan last summer visiting ancient shrines actually began in Wyoming in the early 1970s. That’s when a high school student named William Johnston came across a book called *Essays in Zen Buddhism*.

“I was interested in philosophy, in how other cultures in the world answer the big questions we all confront,” says Johnston, now a professor of history.

The search for those answers took

Johnston to Japan, where as a young man he began studying Zen. It has since taken him back to that country dozens of times to live or visit there. One of his most recent trips resulted in *Zen Pilgrimage of a Photo Thief*, a distinctive photography exhibit on display until December 10 at the gallery in Wesleyan’s Mansfield Freeman Center for East Asian Studies.

The exhibit is the marriage of the religion, which Johnston now practices daily, with photography, another of his great loves. The crisp and often stark photographs also illustrate the simple beauty that drew him to Zen.

That attraction began in earnest when Johnston decided to spend his junior year of undergraduate study in Japan. It was a complete immersion experience. His host family spoke no English and Johnston’s Japanese was minimal. The first few weeks were interesting at best.

Johnston was able to communicate, however, that he would like to study Zen. As luck (or was it destiny?) would have it, the mother of Johnston’s host family had a cousin who was married to a Zen priest. A few days later, Johnston stood face to face with Niwa Kensho, a priest in the Soto sect of Zen. He was not quite what Johnston expected.

“He smiled a lot and laughed easily,” Johnston says. “He was small in stature and worked as a Japanese literature teacher at a local school. Not intimidating at all.”

But Johnston soon discovered that the smiling little man’s attitude toward Zen was extremely serious.

“I quickly learned how badly my legs could hurt.”

The Soto sect believes enlightenment comes through sitting—specifically sitting cross-legged, or for some, in the near-kneeling position of *seiza*. The idea is to sit and keep the body and mind completely still, usually for ses-



sions of 40 minutes at least. To do this in itself is enlightenment. But it's also much easier aspired to than performed.

"Sitting completely still is difficult enough," Johnston says. "The leg muscles, the back, the whole body gets tired, especially in the early stages. And even though I might keep the body still, the mind continues to move."

Johnston would do his sitting on a small pillow known as a *zafu* under the watchful eye of his teacher. Kensho would note any time his student's focus would waver. Sometimes he would address Johnston's distraction with a word or two. But as Johnston's sitting increased, Kensho would often make his point with the traditional *kyosaku*.

"It was a long piece of wood that he'd hit me with," Johnston says. "It was usually a pretty good strike. It does get you to refocus, that's for sure. And in an odd way, if the strike is done correctly, it actually has the effect of a good massage."

After practicing for several months, Johnston asked Kensho for an introduction to the monks at the famous Eihei-ji (literally, the "Temple of Eternal Peace") in the mountains of the Fukui Prefecture. It was uncommon for a Westerner to sit in such a shrine, but Johnston was eager to go. Kensho said he would think about it. A few months later, Johnston got his introduction.

"I thought my legs hurt before. The experience at Eihei-ji was incredible."

At Eihei-ji, people sat in silence for eight hours a day, including through meals. Even when they did have a brief time to talk later, there was little or no discussion of Zen or sitting technique.

"It was a special experience," Johnston says with a slight smile on his lips. "Physically exhausting, spiritually cleansing."

His smile widens.

"They served the best vegetarian food I have ever had. And you could eat as much as you liked."

Since then Johnston has lived in Japan a total of seven years and visited many of the well-known as well as the not-so-well-known Zen temples. He has continued with his daily Zen sitting. In 2003, he visited several Zen shrines with an old reconditioned Rolleiflex in hand.

He took all the shots in the exhibit with the camera held at *hara*—that is, a position in the center of the body a few inches below the navel. In Zen, this is believed to be a person's center where the *ki* (also known as *chi*) energy flows in and out.

"I thought shooting from there would offer a unique perspective that would both fit the subject matter and the spirit of the journey," Johnston says.

The result is a series of black and white photos that offer opportunity for contemplation and observation of what few people in this part of the world have seen.

The exhibit has drawn interest beyond the campus. On Nov. 18, renowned photographer Philip Trager '56 was scheduled to lead a special presentation in the gallery, discussing Johnston's work.

As for the title, it is borrowed from an old fable that has a thief breaking into a Zen monastery. The thief encounters the abbot, who smiles and tells him to take whatever he wants, even more than he needs.

"Taking photos is also a theft of sorts," Johnston says. "There is a sense of transgression, of literally taking something away from the site. At the same time, displaying the photos shows us that beautiful places, spiritual places, are all around us. That's the real beauty of it all." 🍵

*Zen Pilgrimage of a Photo Thief will run at the Mansfield Freeman Center Gallery until December 10. Hours are Tuesday to Sunday, noon to 4 p.m. (closed Nov. 23–29).*



Framed by his photos of Buddhist shrines in Japan, Professor of History William Johnston demonstrates the Zen sitting position while holding his Rolleiflex.