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A Daylily Affair

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It was the summer of 1962 and I was participating in a National Science Foundation Summer Institute in Plant Evolution. The structure of the program, and the distinguished lecturers who had come to Vanderbilt University for those six weeks, provided plenty of information that could be carried back to undergraduate biology courses at Bridgewater. However, to a young faculty member only four years out of a PhD program, there was still something lacking from this total immersion in the academic role of a teacher. Every new PhD in the natural sciences is indoctrinated with the idea that their graduate degree is only the beginning. Research involving active laboratory or field investigations which contribute to scientific knowledge is the name of the game.

During the four years that had passed since leaving graduate school I had attempted to conduct active investigations in studies of plant structure, but this wasn't the same scene as my graduate research had been at Virginia Tech and the University of Maryland. In those places, there had been funds from the Agricultural Research Stations to support applied studies with peanuts and asparagus. There were other graduate students working day and night on intriguing small questions about the life of plants. There was a constant procession of classes and seminars led by well recognized botanists from large staffs. Equipment and supplies were available to do almost anything that was necessary to squeeze out the answers to all of those detailed questions that swirled around the laboratories. Above all, there was the pressure to produce a publishable thesis.

Suddenly, after five years of graduate school, I found myself with the skills, background and drive to conduct original studies, but with none of the encouraging atmosphere of graduate school. Norwich University in the late fifties had meager facilities for a plant cytologist and there were no other botanists upon whom one could try new ideas. There was little chance to solve problems at the cutting edge of botany, even though it was possible to find small questions that were relatively simple to solve, such as the unusual abscission patterns in English ivy leaves on the campus buildings. Unfortunately, I was just marking time, with no unified research goal developing. It was clear that an active research program, which would satisfy that overwhelming need of a new PhD in science to contribute new knowledge, could not long be sustained in this fashion.

Figure 1. 'Sturdy Son,' registered by Brennan in 1991 and introduced in 1993.

Bridgewater State College held out more promise, with three other botanists on the faculty and a new science building about to be constructed. The list of furnishings for the new building promised modern equipment. There would be up-to-date microscopes and associated paraphernalia which would allow me to plunge into substantial studies of plant cell structure. Why, there was even an x-ray unit listed; a tool that would allow experimental mutations and chromosomal aberrations to be induced!

In the process of looking for an overall goal that will bring unity to a research program in biology, it is usually necessary to concentrate on one major aspect of the life of a number of different organisms, or, even better, to concentrate on several different aspects of one experimental organism. If one is to develop expertise in scientific research, it is necessary to zero in on a concisely defined area.

Thus, it turned out that in that summer of 1962 in Nashville, I stumbled onto what has now become, at the end of my career, the center of my research interests. A diversionary weekend visit to the Tennessee Botanical Garden and Art Museum at Cheekwood led me to a flower exhibition featuring daylilies (*Hemerocallis*). There was a single table with not more than thirty or forty cut flower stalks (scapes), each bearing a single large blossom. I was intrigued by the form and color of these members of the lily family and I knew at first glance that there was great potential for this plant as the subject of a research program.

Daylilies are perennial plants which are most often propagated by dividing the plants every three or four years. Thus, each distinct variety, known as a "cultivar," represents a clone; all individuals in the cultivar are genetically identical. It is also possible to propagate daylilies by cross-pollinating different cultivars, thereby combining varying characteristics

into new hybrid cultivars. As more and more hybrids are created, some distinct characteristics become popular, creating a demand in the commercial market. Thousands of people throughout the country are actively crossing different cultivars and collecting seeds, in an effort to create new cultivars with what they think is the perfect combination of characteristics.

I returned to Bridgewater in the summer of 1962 and purchased my first three daylily plants. When we moved to another house two years later they went with us. Those original three cultivars are still in my garden someplace, and some of their genes are probably present in the breeding stock that I use to create new cultivars. How old fashioned and simple those first plants appear next to modern cultivars thirty years later! And how quaint and small that 1962 exhibition seems in comparison to the daylily shows of the nineties!

The research program that I envisioned centering around daylilies ran afoul of some roadblocks in the very beginning. As is often the case in state-funded projects, as the new science building neared completion, we found ourselves forced to cut about $300,000 from our equipment budget. The x-ray unit never arrived. This meant that I would be unable to create the gene mutations necessary to develop new characteristics. I tried for awhile to create mutations with ultraviolet irradiation of daylily pollen, but it was too slow. Without the more powerful x-irradiation, the prospects seemed dim. My research interests moved toward another plant named *Tradescantia*.

Tradescantia is a member of a plant family closely related to lilies, and is often used as a houseplant. The small flowers of *Tradescantia* last for only one day, just as daylilies do, but, unlike daylilies, some of the flower parts are covered with tiny hairs. These hairs are composed of columns of the most beautiful small cells that I have ever seen. By treating these cells with various chemicals, it was possible to learn some fundamental factors inherent to the development of plant cell shape.

Not long after my interests had shifted away from daylilies, Bridgewater State College obtained the funds to purchase an electron microscope. The high resolution and magnification of that instrument held out the promise of research into the mysterious fine structural microcosm of such things as *Tradescantia* hair cells. My colleague in the Biology Department, Walter Morin, had a grant from the National Institutes of Health and I had a grant from the National Science Foundation. The funds from these grants supplied the equipment necessary to prepare biological material for electron microscope studies, and we immersed ourselves in intense fine structural studies.

Figure 2. 'Grandma Jean,' registered by Brennan in 1991 and introduced in 1993.

We were able to demonstrate the involvement of submicroscopic structures in various cellular functions. Walter followed the tiny structures involved in transmission of nerve impulses, while I observed the function of extremely small microtubules in plant cell elongation.

Because of my preoccupation with investigations of *Tradescantia,* I did not return to daylily studies until the early eighties. As a part of the return to what I consider the most attractive member of the plant kingdom, I became a member of the American Hemerocallis Society. I was mildly surprised to find so many people interested in a single plant, for so many different reasons. During the year of the fiftieth anniversary of A.H.S. in 1996, the society had over 10,000 members. A New England chapter meets monthly and there is an annual national convention. The practical knowledge among the membership astonished me and there was always a helping hand available. The influence of the society and its members had a profound influence on the emphasis in my research program.

The American Hemerocallis Society has been named the International Registration Authority for *Hemerocallis*, by the International Council on the Naming of Cultivated Plants. Nearly 40,000 different cultivars have been registered and their descriptions published in Check Lists.

I was not prepared for what had happened to daylilies since I first saw them twenty years earlier. I couldn't believe the great advances in floral features that had been accomplished. The old timers let me know that x-rays and ultraviolet light weren't needed to develop new characteristics, since the plants already possessed immense variability.

In some ways, this ideal research organism puts roadblocks in the way of solving basic problems. The very nature of the plant itself calls out to anyone familiar with it to get involved with hybridizing and creating new cultivars, and this activity eats into time that might be de-

voted to fundamental research. I have registered seven new cultivars. Three have been introduced into commerce, with another one due for introduction in Fall 1997 (Figs 1-4).

In spite of some commonly accepted views, I still don't accept the idea that all of that variation was there in the rather plain early plants. There are so many people producing so many seeds from so many crosses, that spontaneous mutations are certain to be the basis for many of the new forms, patterns and colors. What I had originally planned to do with x-rays is probably occurring naturally. With so many new combinations being created, many new characteristics are bound to appear.

While great leaps in the development of new forms have taken place, not enough fundamental work has been done with the anatomy, physiology and cytology of daylilies. My investigations went in several directions, as I tried to learn as much fundamental information as possible about *Hemerocallis*. There are a few centers of activity, such as the State University of New York at Stony Brook (tissue culture), University of California at Davis (genes controlling floral senescence), and several Universities in Japan and Korea (chromosomes and taxonomy). There is still a need for studies of almost all aspects of daylily basic botany.

Hemerocallis provides a veritable cafeteria of problems calling out to be studied. Before we can even begin to connect characteristics to genes in chromosomes, we must have an unambiguous description of the chromosome complement. It is well known that daylilies have eleven different chromosomes, but they are somewhat similar in shape and size. In order to understand the hereditary basis of the many cultivars, we need a clearly stained preparation to make the chromosomes of a single cell visible with a microscope. I have spent hours on the preparation techniques for this process, but it is obvious that the technique with *Hemerocallis* is more difficult than we hoped that it would be. Great progress has been made with similar studies of human chromosomes, but a satisfactory solution in daylilies remains elusive.

My classes in Biological Electron Microscopy have utilized the increased magnification and definition of our electron microscopes to study the structure of daylily leaf and root cells. While the results have not revealed anything really unusual, there are some noteworthy features of chloroplast structure and development which we have noted. The anatomical structure of the leaves is distinctive and may explain some things about the plants' well-known adaptability.

Figure 3. 'Bee Gee,' registered by Brennan in 1991. This cultivar will be introduced in the Fall of 1997. Six inch flowers, 34 inches tall.

Zihang Zheng, while a Bridgewater graduate student in 1993, discovered the minute organelles that carry the yellow and orange pigments in flower petals. His electron microscope study developed from observations which we had made on the general location of colored substances in the petal cells. We had found that the water-soluble red, lavender and purple pigments were located only in a single layer of surface cells, while the fat-soluble yellow and orange pigments were seated more deeply in the tissues.

We have begun to take light microscopic photos in my lab of the minute details of both male and female reproductive cell development. None of these details have yet been published, but it is clear that some new information can be added to botanical knowledge.

Some daylilies have brown colored blossoms, a most unusual feature in flowering plants. I think that there is beauty in a chocolate brown flower, but it is sometimes difficult to find agreement on this. Brown pigment was difficult to explain, but I speculated that the overlay of lavender on orange would produce this effect. It could be shown with transparent watercolors or colored cellophane. In my confidence about this idea, based on our observations of pigment location, I wasn't prepared for the discovery of the real reason.

Hand cut sections of brown petals revealed something microscopically that had not been seen before in flower petals. I was shocked to see a large spherical, dark "glob" in each cell in the single layer of cells that normally possessed the red and purple pigments. In broken cells, the globs deteriorated into water soluble lavender pigment. It was apparent that the purple pigments were somehow concentrated and held in a brown, crystalline glob in each cell.

It proved unusually difficult to prepare these fragile features for electron microscopy. Last year, I managed to preserve some globs intact and I am only beginning to think about their fine structure and chemistry.

Time grows short, as in all aspects of life, and there are scientific questions about daylilies for which I will never see answers. But there are other distractions in the daylily world. Believe it or not, it is also possible to get involved administratively, to the extent that such activity interferes with basic and applied research.

In 1992 I was elected as a member of the Board of Directors of the American Hemerocallis Society from New England and New York. Since then, the time that I can spend thinking about daylilies has been overwhelmingly dominated by administrative work.

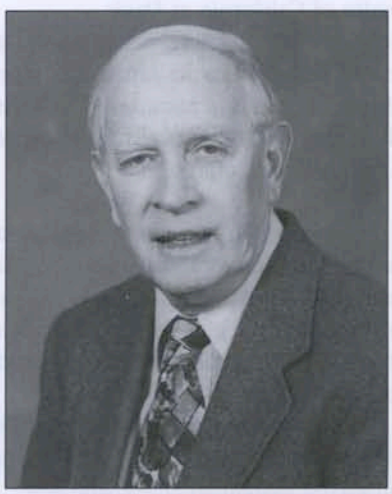
During the past year, I have chaired two national committees, Registrations and Scientific Studies. With about 1000 new cultivars being registered each year, it is clear that the oversight and decisions of a strong committee on registrations is necessary in matters of policies and procedures. The Registrations Committee constantly faces unexpected problems that require attention. The selection of new names and the rules governing their approval can be contentious subjects.

Figure 4. 'Bear's Lair,' registered by Brennan in 1996. Over six inch flowers, 30 inches tall.

The goal of the society is "to promote, encourage and foster the development of the genus *Hemerocallis*." Thus, the Scientific Studies Committee is essential to the overall purpose of A. H. S. Among the functions of the committee are the administration of funds for scientific research. Papers for the *Daylily Journal* are solicited and refereed. There is always mail to be answered from the membership on scientific questions.

It is hard to imagine that one plant could be the focus of scientific research, a highly rewarding hobby and the source of so much time-consuming administrative work. Over and above all of these aspects, and possibly the biggest surprise, is that I have developed a very large number of lifelong friendships, on the basis of a common interest in a single plant.

While the discovery of daylilies as the focus of a research program has turned out to be a rewarding adjunct to my professional life, from my present perspective I see another great advantage. The promise of a pleasant and colorful garden is guaranteed during my retirement years.



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