

BORN

1941
Kansas City, Kansas

CURRENT ROLE

Eminent Scholar, and Davies, Fischer, and Eckes Professor Emerita of Biological Control, University of Florida

PAST POSITIONS OF NOTE

First female Ph.D. entomologist

Connecticut Agricultural Experiment Station (1973–1974)

First female Ph.D. entomologist

U.S. Forest Service, Northeast Forest Experiment Station (1974–1976)

First female faculty member Department of Entomology, University of California, Berkeley (1976–1992)

SPECIALTY

Biological control, agricultural acarology, and insect molecular genetics

STUDENTS & POSTDOCS

12 M.S., 15 Ph.D. students
20 postdocs

BOOKS

Insect Molecular Genetics
Agricultural Acarology: Introduction to Integrated Mite Management
Edited or co-edited 6 additional books

PUBLICATIONS

53 book chapters
159 peer-reviewed articles

Marjorie A. Hoy: Undaunted Pioneer, Eminent Scholar

Marlin E. Rice

Marjorie A. Hoy is internationally recognized for her groundbreaking research with the first laboratory-modified natural enemy deployed in a pest management program. The natural enemy had been genetically improved through selection to be resistant to three pesticide classes. Hoy is also highly regarded for the development of classical biological control of invasive pests of Florida citrus.

Hoy attended the University of Kansas as a National Merit Scholar and graduated Phi Beta Kappa with a B.A. (Zoology and Entomology, 1963). She earned her M.S. (Entomology, 1966) and Ph.D. (Entomology and Biological Control, 1972) from the University of California, Berkeley, under the guidance of Carl Huffaker. Her first professional position involved genetic improvement of a gypsy moth parasitoid at the Connecticut Agricultural Experiment Station (New Haven). She joined the faculty at University of California, Berkeley in 1976 and rapidly advanced from assistant professor to associate professor and professor within six years. Later, she joined the University of Florida in 1992 as Professor and Eminent Scholar, retiring in 2015.

Hoy has been awarded distinguished accolades including National Science Foundation Graduate Fellow, University of California, Berkeley (1963–1964); Fellow, Royal Entomological Society of London (1990); Fellow, Rockefeller Foundation (1990); Founders' Memorial Award (1992) and Fellow (1996), Entomological Society of America; Sigma Xi Senior Faculty Research Award, University of Florida (1996); Honor Award for outstanding research in biological control, U.S. Department of Agriculture (1997); Distinguished Scientist Award, International Organization for Biological Control (2004). She also served on the Governing Council, American Institute of Biological Sciences (1996–1998); Agricultural Biotechnology Advisory Committee, Sec-

retary of Agriculture, USDA (2000–2002); and Biological Threats to Agricultural Plants and Animals Committee, National Academy of Sciences (2001–2002).

Hoy is a highly respected scientist, and with expertise in biological control and acarology, she has served on the editorial boards for six scientific journals.

This interview occurred 13 November 2018 in Vancouver, British Columbia. Hoy was 77 years old.

Rice: What was your first experience with insects?

Hoy: Oh, I was an outdoor girl, but I was a biologist, and that's part of my thing, that I'm so interested in everything. We had pets of all sorts, and I loved to climb trees. I was a tomboy. But I was also a reader. I read *everything* I could get my hands on. During the summer, my brother and I would walk down to the public library and they let us check out four books at a time, so on the way home I would read them [laughs] and turn around and go back and get some more. Finally, they gave up and said, "Take as many as you want." I ended up working in the public library when I got to be 13.

Did you have a favorite book? Did you read the classics?

I read everything. One summer I read the Bible from front to back. Anything I could get. It was great when I had to take some standardized test because I had a lot of knowledge and vocabulary. It was one of my pleasures. I still read medical literature.

You read medical journals?

I do!

Do you read the *New England Journal of Medicine*?

Sometimes. I read *Cell*. I read *PNAS* [*Proceedings of the National Academy of Sciences*]. I read all of those molecular journals dealing with medical issues. It has been



Hoy in her almond research plot, San Joaquin Valley, California, 1982.

very helpful; I was able to diagnose my husband's brain tumor.

How do you diagnose a brain tumor?

We were on vacation, and suddenly he was having horrible, horrible headaches. We stopped at an emergency room, and I went in ahead of him, 'cause I knew he would laugh at me if I said what was wrong. I went into the emergency room and I told them that I think my husband has a brain tumor because ... and I listed the symptoms. They looked at him and did not see pressure on the optic nerve—that is often diagnostic—so they said, "Oh, you've got a migraine." And they gave him medication. Well, it didn't do a darn bit of good. We drove home, and he called me up at work and he said, "I'm really feeling awful. I just vomited." So I took him to the doctor and I said, "I think [laughs] my husband has a brain tumor." And they said, "Oh no, but let's send him into the hospital where they can give some medication for this migraine." At this point he couldn't stand bright lights, he couldn't stand noise. So I went out into the hallway and talked to

a doctor and said, "I think my husband has a brain tumor." [Laughs]. And sure enough, he did. They did a CAT scan and he had a brain tumor that was nonmalignant, thank goodness. But, they told me that if I hadn't alerted it to them then ... he had gotten to the point where it was pressing on the brain stem and affecting his breathing. They had to give him a week's worth of treatment to get the pressure down before they could do surgery.

It's good you read medical journals in your spare time.

In my spare time. Right.

Tell me about your parents.

My mom was a registered nurse, and my dad worked for the Santa Fe Railroad. And they were wonderful parents. My mother and father always said you could do anything you wanted to do if you're willing to work for it, and the other point was they always had the assumption that I would go to college.

Why did your parents assume college for you?

Because I was good at school and I loved it. I went to the University of Kansas [KU] as an undergrad [and] thought I was going into the pre-med program. Because I was in an honors program where you go until your junior year, and then directly into medical school. But then I took an entomology course. [Laughs.]

What made you change your direction?

I started a research project as an NSF [National Science Foundation] undergraduate researcher with Bob Beer on mites. My future husband and I got married when I was a junior, and he was finishing his Ph.D. It was going to be tricky to go to medical school and combine all of that with his program, so I was very, very happy with entomology. Actually, I was a zoology major and an entomology minor. I graduated, and I had an NSF fellowship and could have gone anywhere. My husband had an offer in Maryland and University of California, Berkeley. He said I'd get a better [entomology] degree at Berkeley, so let's go to Berkeley.

Did you meet your future husband at KU?

Yes. I was working one Sunday on my research project, and he came in [to the lab] with a snake he had collected, so that's how we met. And he took me out birdwatching for our first date.

After University of Kansas, you went to Berkeley?

That's right. I was there for a master's degree and Jim Oliver's first graduate student. In fact, he was the best man at our wedding. Yeah, it's a small world. And I took a really, really heavy load of coursework. I decided this is what I really wanted to do. [Then] I went to work in Robert Sokolof's *Tribolium* lab, and that was *profoundly* influential in my future career. He had *Tribolium* colonies from all over the world. We were doing mode of inheritance testing; I probably found 75 mutants. It was just intriguing and it really affected my perception of genetic variability. What we didn't realize at the time was the mutations were due to a transposable element, because when you cross the colonies the transposable element is not suppressed. It was really fun. So, I finished

my master's degree, and my husband and I moved to Fresno, California—he was working with the USDA. I started working at the University of California Research Center at Kearney on a pest management program in grapes.

I understand that you completed your Ph.D. in a year and a half?

Yes. My husband got transferred to Berkeley, and I went back to graduate school with Carl Huffaker as my major professor. At that point, we had a six-month old baby. That turned out to be interesting to try to do coursework, and pass my qualifying [exam] and my German exam. But it was okay because I had a babysitter two days a week, and when [the baby] was sleeping or napping, I studied at home. Then on the weekends and evenings, my husband took care of him. We made it work. I wrote up my thesis and turned it in a year and a half after starting, and that was a track record not too many people can talk about. [Laughs.]

This was when there was still a foreign language requirement.

Yeah. I took the GRE German exam. I had taken two years of German in college. I was surprised how well it came back, [but] I studied for a while. I did my Ph.D. in biological control, insect ecology, acarology, genetics, and evolution. I had five subject areas for examination. I did my research on the western orchard predatory mite. We knew it was an effective predator of spider mites. I did laboratory and field research to document that there was a diapause, and how they overwintered.

Tell me about your first professional position.

I had given this seminar about the possibility of genetic improvement of biological control agents. Robert van den Bosch knew I had training in genetics and biocontrol. He sent me an advertisement for the job at the Connecticut Experiment Station in New Haven to do genetic improvement of parasitoids of gypsy moth. I got the interview, and I stayed there about a year and a half. Then the Hamden Experiment Station, just down the road, offered me a job, so I went there and stayed another year and a half.

Then you were hired as a faculty member at Berkeley, right?



Marjorie and Jim Hoy, 1964.

Then an acarology position at Berkeley came open. I interviewed and got the position. I was delighted to go back, because the two jobs in Connecticut didn't have any interaction with graduate students. I couldn't teach. And I really, really liked [students and teaching], so I was thrilled to go back to Berkeley. When I got to Berkeley, it was interesting. I was the first tenure-track woman in the Entomology Department. It was a big, big, big department. At that time, it was considered the best entomology department in the country.

Did you experience any challenges that you thought were unique to you as a woman?

At the time I was there, it was published that women faculty on the campus earned 60 percent of what equivalent males did. I decided that was unacceptable. The system was you could put up a [promotion] package every year, but for sure you went up at six years for associate professor, but you could go up sooner if you wanted. So, I did. After three years, I went up from assistant to associate, then I asked to go up from associate to full in three more years. At that time, I had a department chair that will remain nameless. He said, "Why are you pushing?" [I said,] "Because I'm not going to be one of those women earning 60 percent, and if I qualified and the commit-

tee agrees, then I want to be promoted." He said, "You're just going to have to pay more income tax." [Laughs.] I said, "That's good!" I went home and told my husband, and he just about had a heart attack.

When you were promoted to associate professor, did you get a salary that was equal to other associates?

Oh yeah!

Going back to undergraduate school, was there ever another area that you considered other than medicine or entomology?

Not really. I had no other role model. I was astounded that I even became a faculty member. It just evolved, and I had wonderful support from my husband. When we moved to Connecticut, he left his USDA position, which was permanent, and he ended up at the State University of New York. Then we went back to Berkeley, and he would write grants, and he was absolutely wonderful in encouraging me in what I loved to do.

This is unusual for the husband to defer to the wife for her to follow her career path.

Oh yeah, for that era! And it happened, and we had friends that said, "You're just going to get divorced!"

They told you that?

Oh yeah. But my husband is a very

strong man, and self-confident, and he has much broader interests than I do, so he does all kinds of things. His career was important, but not in the same way as mine. He has a Ph.D. in entomology, and he has worked on a variety of things. He has written publications, and worked for USDA, and then started his own business. He has many talents.

What do you say when people ask what you do?

I'm an entomologist. I'm a geneticist. And I *love* solving problems in applied entomology using genetics tools. And I like teaching, and that is why I have written so many books.

You just published your fourth edition of *Insect Molecular Genetics*.

That is one of those things I'm very proud of because it was very, very difficult. I was not trained in molecular biology, but in 1982 I was at Berkeley, and I had been doing genetic improvement, and realized that artificial selection would work if you had adequate genetic variability. I had been reading *Science* all my career, and I encouraged graduate students to read *Science* and *Nature* every week because if you're going to be a good entomologist, you've got to be a good biologist. And so there was this [article on] genetic modification of *Drosophila* using the P element, and I said, "Oh! I can clone a gene." Then, using transposable elements, perhaps [I might] be able to put it in a whole array of natural enemies instead of worrying if there is sufficient genetic variability to use artificial selection. So I decided that's what I wanted to learn. I was a full professor, and I went to the graduate-level biochemistry and molecular biology instructor and sat in on courses. Then I applied to Cold Spring Harbor to their summer gene cloning course—it was six weeks, I think. They only took 16 people, so I had to have letters of recommendation.

As a professor at Berkeley, you had to have recommendation letters?

That's right. I got accepted, and it was a wonderful, wonderful experience. It was lectures and labs from 8:00 in the morning until midnight every day. I went there not even knowing how to accurately pipette. I was not trained in biochemistry. I remember wanting to learn this so much. I was fortunate to have a lab partner who was a biochemist who could tell me things

I needed to know, and I struggled through that course. Then I came back, and Jerry Rubin, who was the discoverer of transposable P elements in *Drosophila*, was teaching a lab course. I asked if I could come and sit in on the lab and he said yes. I took that course, too, and then I realized that none of the entomology students were getting any molecular biology, and I knew this was going to be the future. I organized a course for entomologists, focusing on insects, but giving the basic concepts and principles. I put together a reader and contacted Academic Press. They said, "[We] don't do readers; you've got to write your own book." [I said,] "Okay, maybe I can try." Do you know the Bellagio Center of the Rockefeller Foundation?



"I REALIZED THAT NONE OF THE ENTOMOLOGY STUDENTS WERE GETTING ANY MOLECULAR BIOLOGY, AND I KNEW THIS WAS GOING TO BE THE FUTURE."

Yes, in Italy.

I got a scholarship to go there for six weeks.

Did you take your husband?

Yeah. And it was fabulous. I took a suitcase full of papers and a laptop, and I worked like a dog.

Wait a minute. You're on this beautiful Italian lake, and you're spending all your time working?

Well, not all the time. We did a lot of eating and drinking great wines. And it was a very creative time. I got 10 of the 14 chapters written.

You wrote 10 chapters in six weeks?

Yeah, I like to write. Then I got home and I finished it. I was writing it for people with no background. I gave it to my darling husband, and if he didn't understand something, then I would rewrite it. I had a colleague in biochemistry at Berkeley read edition one to make sure I hadn't made any really egregious mistakes. Then I did the second edition [*laughs*], then the third, and then the fourth, and already it's slightly out of date.

Because it's a rapidly advancing field.

It's so exciting. I've gotten good reviews. There's not another text quite like it. It works well with people with no background in molecular biology.

After 16 years at Berkeley, you were hired by the University of Florida as a professor with the title of Eminent Scholar. Why leave California?

First, they were in the process of disintegrating the Berkeley entomology department, and it broke my heart. I did my master's and Ph.D. there and was on the faculty. I started looking at other opportunities because I just couldn't bear the dissolution. [Second,] it was interesting to meet new people and new challenges. I was supposed to work on citrus biocontrol, and it turned out citrus IPM was biocontrol-based. In '92, it was common for there to be two oil sprays and one copper spray, and that would control almost everything. There were natural enemies for scales and mealybugs and whiteflies. It was just very good biological control. However, shortly after I got there, the citrus leafminer arrived. I said, "I'll take on classical biological control, and do exploration, and find out what kind of natural enemies we can safely bring in and release." So, I did that. We got two parasitoids that were quite effective.

Where did you find these parasitoids?

Australia, then to Thailand and Taiwan. That was [for] the brown citrus aphid, which is a vector of citrus tristeza virus. Most of the citrus was on susceptible rootstock, and we had to do something. So, I brought in a parasitoid of that aphid and released it. Then the next one was citrus psyllid. I did bring in two parasitoids, but it was a real challenge because I was not allowed to bring host material in for fear of introducing greening [disease in citrus]. I had to bring in adult parasitoids and estab-



ADVICE FROM A LEGEND



Did you have any special encouragement for your female students?

“You can do it, you have to want to do it. You have to get up and love to go to work in the morning, and if you *don't*, there are options other than academia. [But] you are going to be very well trained for a lot of other opportunities. I'm going to help you develop very good writing skills. You're going to have good analytical skills. You're going to be a problem solver.” I tried to encourage them. We would have weekly lab group meetings where we would discuss results. Before we went to conferences, everyone would practice their presentation and critique each other. I told them, “If you go to a meeting, these are things you need to think of in advance. If you want to meet someone, or postdoc with someone, or explore ideas within industry or USDA, [then] arrange to meet them ahead of time, or go to their talk and ask to meet them afterwards. You're not just going to party; this is a professional opportunity.”

Pictured: Marjorie Hoy, Professor and Eminent Scholar, University of Florida, 1992.

lish a colony in quarantine. We developed a very sensitive, high-fidelity PCR technique for the greening genes, and I showed that we could detect one bacterium in 100 billion parts. At the same time, I also discovered from sampling citrus leaves from the field that [greening] was already here. I told John Capinera we were going to have greening in five years, and he [later] said “Marjorie, you were right.” I was not happy I was right, but as a result, we went from what I called a biological control treadmill where we would bring in new natural enemies as the invaders came, and it got switched over to a pesticide treadmill.

That's an interesting term—biological control treadmill.

I invented it. Van den Bosch talked about the pesticide treadmill all the time. I'm doing this first with leafminer, then brown citrus aphid, then psyllid, and I'm on a biocontrol treadmill if we're going to maintain this program, and unfortunately we couldn't do it. After the psyllid arrived, as many as 18 sprays were going on with really nasty stuff. If you go into a citrus grove now, it's hard to find anything alive. Now the entire state is infested with greening.

Have you ever gotten into a tight spot during your international travels?

When we went to Thailand to make collections for parasitoids of leafminers, I was going to get help from the local department of agriculture folks. They said to bring my husband, and they really insisted on it. We were going out and do field work in what they called the Golden Triangle, where there were a lot of drugs. Our driver had a gun, and we were guarded while we were doing field work. We stopped at one site, and they had ditches between the rows of citrus, and a little board [laughs] between them, and I was walking across and fell in. I was up to [my chest] in muck! It was sewage.

Ew!

[Laughs.]

Was this human sewage?

I don't know! We're just assuming. But they had me wash and change clothes right away.

When you joined the Department of Entomology at University of Florida—with

the title of Eminent Scholar—you were only the second female faculty member. Did this create any challenges for you?

Not really. I've had women graduate students talk to me in the past, and [ask] “How do you tolerate things?”

Do you mean tolerate attitudes?

Attitudes. You know, I mostly ignore it because I'm focused, and I'm enjoying what I do. [Laughs.] Sometimes I would go home, and gnash my teeth, and grumble to my husband. I just didn't let it get to me too much. Our department now probably has slightly more women than men in the graduate program. When I was at Berkeley working on my master's, there were a hundred graduate students and there were three women, including me. And when I would go to the entomology society national meetings, initially people assumed I was somebody's wife or technician. They wouldn't want to talk to me, necessarily. It took a while to establish my credibility. In the same way, when I applied for the job at Berkeley, I said, “I want to work in agriculture.” They said, “Oh, we've never had women work with farmers.” I wanted to try it, and they thought I was joking. I was located next to Bill Allen, and some other very applied people, and they were wonderful mentors. The department chair was just shocked that I wanted to stay there, and do research up and down the San Joaquin Valley. I didn't want to move to the main campus because I had my greenhouses and research there. It was fun. I would go out in the fields and talk to the growers and extension agents and ask, “If I could do this, would it be useful?” I called it “kicking the dirt clods.”

You mentioned the word fun. There is a legend that the department head at Florida asked you to dress up like an elf for a Christmas party.

[Laughs.] It's true. I did. And it was interesting. I was sort of terribly embarrassed, but when we got there the little kids were coming up to Santa, and I was supposed to help, and I had fun with the little kids. So, I just forgot that I looked like an idiot, because the kids were so cute.

Did you ever have a favorite insect that you liked to research?

Well, I worked on the western orchard predatory mite for many, many, many years. We selected it for resistance to pes-

ticides, and developed a carbaryl-organo-phosphate-sulfur resistant strain. We found sulfur resistance in vineyards, and organophosphate resistance in orchards. We combined them, mass-reared them, and showed that there was no detectable fitness cost. And they provided very good biological control of spider mites in almond orchards. An ag economist estimated the value of the program, and it saved the growers \$20 million a year.

Was this savings just in almonds?

Just in almonds. It reduced acaricide rates dramatically from three times a season to one-tenth the label rate and mostly spot treating. Commercial people took the colonies, mass-reared them, and sold them. I think it was the first time anyone had done lab selection for a trait, then taken it to the field, and showed it to be a very effective program. The dogma at the time was [that] you can't select in the lab [without] major fitness costs. We showed that, in this case, we could do it. And that was very satisfying. I give lots of credit to the Cooperative Extension folks in California; they would help me find cooperative growers. And I had some wonderful graduate students: Rick Roush was my first graduate student.

Roush is now at Penn State and a dean.

Yeah. He was outstanding, and my very first, but I had a lot of outstanding students. [But] if they weren't hard-working and good, then they didn't come to my lab. I didn't go seek anybody out; they came to me. The first day I was there, I was painting my office in Berkeley, and Rick came in and said, "I want to work in your lab." [Laughs.]

He arrived unannounced?

Yes! And I said, "This is what I'm wanting to do." And he said, "Sign me up." He did his undergraduate entomology degree at Davis. He was very knowledgeable, and he had NSF graduate fellowship funding for three years.

Why did he pick you as an advisor?

[Pause.] I don't know. [Maybe] I might be doing something new and different. I was working with resistance, trying to develop pesticide-resistant strains, and he has maintained his interest in pesticide resistance. I was challenged because he had been a debate champion in high school, and our conversations sometimes were

rather demanding, but he was fun to work with and a wonderful student.

Do you have any advice for young women studying entomology or science broadly?

When my graduate students came in the first week they were there, I asked what they wanted to be when they grew up. I tried to tailor a program to fit what they thought they wanted to do; whether it was teach at a four-year school, academic research university, industry, extension, government. And then I said, "By the way, there aren't very many jobs in entomology. You only need to do this if you really, really love it." In some areas of science—genetics is one—women have a pretty good route. Right now, we have a lot of women in our entomology department. [But] there's still this big gap between getting the Ph.D., getting a tenure-track position, having a family, and having a spouse that can move with you. I told some students, "Please marry a doctor or a lawyer or a schoolteacher or somebody that can do their job anywhere." Because jobs on faculty in entomology are very limited and site-specific. You have to really love [entomology].

The career opportunities are very competitive.

It's very competitive. For women 30 years ago, I used to say that they had to be better than the average man to make it—just to be blunt—because there were real discriminations. I don't think that's the same now; things have gotten somewhat better, but they're still not perfect. I noticed at the ESA [annual] meeting there was all this discussion about harassment and behavior, and we've got rules about it [laughs], which were not there earlier.

Do you think the harassment code of behavior is unnecessary?

No. I certainly had one or two experiences where there was inappropriate behavior, and unfortunately, the power situation is still such that students are in a difficult situation with regard to the power structure. Typically, it's males interacting with graduate student women. I suppose sometimes it's the other way around, but less common. But the power structure is such that women are at a disadvantage still. Of all the students I've had, and almost without exception, they were all very bright, hard-working people, the *only ones*

who ever came to me and said, "I don't know if I can be good enough,"—it was always women. Of all the students I ever had, women were the only ones who indicated doubts about their competency. The guys [said,] "I can do this, I'm going to be fine."

What do you hope to leave as a legacy?

I was very much impressed with the importance of genetics in entomology, and I have used genetics as a tool to solve problems, [for] diagnoses, and [for] risk assessments. Insect molecular genetics is, I hope, a contribution. I taught the course, and people have gone out and worked in industry or extension, or government agencies. They're not all going to do molecular genetics, but they learn the terminology, they learn what can be done, the issues and potential applications. They've learned a vocabulary and an understanding of the basic techniques. They don't necessarily know how to do it, but they have an appreciation to read the literature and know what PCR is, and what cloning is, and know what sequencing involves. I hope I helped contribute to some degree to that [understanding]. As you may have figured out, I really enjoyed my career and the students and the postdocs.

There is a legend that you required your students to attend presentations outside their area of research.

Oh, that's another thing I did, [and] I tried to get them to subscribe to *Nature*, [but] even if you're only reading the titles and the abstracts—do it consistently. I still read *PNAS*, *Science*, *Nature*, and *Cell* every week.

This is amazing. Even after retirement and 77 years of age, you are still reading heavyweight scientific journals.

But it's so much fun!

Marlin E. Rice is a past president of the *Entomological Society of America*, and a technical lead for *Africa-Middle East with Corteva Agriscience in Johnston, Iowa*.

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