

Born
1946
Malaysia

Current Position
Professor of the Graduate Division
University of California-Riverside
Distinguished Emeritus Professor
of Molecular, Cell and Systems
Biology, and Entomologist
University of California-Riverside

Publications & Book Chapters
180

Highly Cited Publication
Mode of Action of *Bacillus thuringiensis* Cry and Cytotoxins and Their Potential for Insect Control (with A. Bravo and M. Soberón)
1,492 citations

Mentoring
23 postdocs, 22 Ph.D. students,
6 master's students

Service
Editorial Board
Annual Review of Entomology
(1993-1998)

Editor
Insect Biochemistry and Molecular Biology
(2007-2020)

Honors
Gold Medal
McGill University
Fellow
American Association for the
Advancement of Science
Recognition Award in
Insect Physiology,
Biochemistry and Toxicology
Entomological Society
of America
Fellow
Entomological Society
of America



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Sarjeet Gill: Success over Discrimination

Marlin E. Rice

Facing both religious and racial discrimination in his native Malaysia, Sarjeet Gill vacated a tenured university position to attempt a risky and unemployed transition to the United States. Gill had earlier come to Canada on a commonwealth Colombo Plan scholarship, which earned him a B.S. (First Class Honors, 1969) in agriculture with an entomology emphasis. This degree was followed four years later with a Ph.D. (1973) in insect toxicology from John Casida's lab at the University of California-Berkeley. Honoring his government's obligation to return to Malaysia after completing his education, Gill accepted a lecturer position at Universiti Sains Malaysia in Penang, but six years later, he quit the university because of

discrimination, and in 1980 headed back to California. Gill called on his friend and former lab mate, Bruce Hammock, who offered him a place to live if he agreed to cook for the family in lieu of rent. Gill enthusiastically embraced the kindness, but he had to tone down the curry because it was giving Hammock's nursing newborn son stomachaches.

Gill found work as an assistant research toxicologist at UC-Riverside and UC-Davis for two years, and then he accepted an assistant professor position in the Department of Medical Physiology and Pharmacology at Southern Illinois University (SIU). Shortly thereafter, reorganization within the department at SIU complicated his new role, but an offer from UC-Riverside

as assistant professor of insect toxicology in the Department of Entomology was more in line with his research passion, so he left Illinois and returned to California. Gill's expertise and influence in toxicology grew significantly at UC-Riverside, and from 1990 to 1999, he was Director of the Environmental Toxicology Graduate Program, and then he served as Chair, Department of Cell Biology and Neuroscience (2002–2009). He was named Distinguished Professor—Entomologist, in the Department of Molecular, Cell and Systems Biology in 2016.

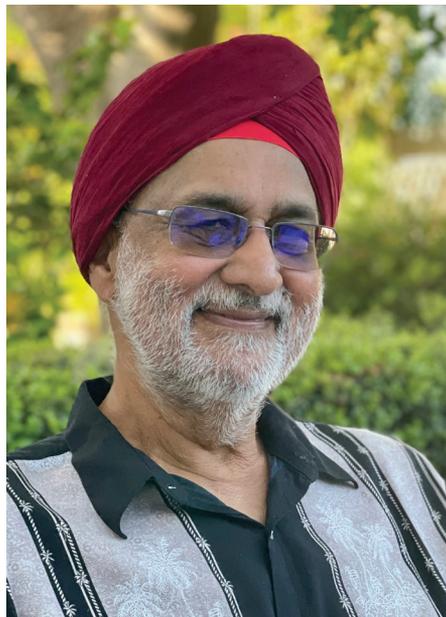
In 2021, Gill retired, freeing him from teaching and committee work, but his 41-year research in the University of California system continues. His laboratory has three principal research areas, all utilizing a cellular and molecular approach to elucidate the mechanisms of toxicity and cell membrane transport. The first area attempts to determine the mode of action of *Bacillus thuringiensis* insecticidal toxins, in particular those effective against *Aedes* mosquitoes. This research aims to gain a molecular understanding of how these toxins interact with cell membranes, resulting in disruption of ion regulation. The second area involves characterizing novel toxins produced in the bacterium *Paraclostridium bifermantans malaysia*, which is highly active against *Anopheles* mosquitoes. The third area focuses on understanding mosquito midgut and Malpighian tubule function in ion and nutrient transport, and changes that occur following blood feeding.

In addition to a large body of refereed publications, Gill has co-edited with L. I. Gilbert and K. Iatrou several major works published by Elsevier: *Molecular Insect Science* (a seven-volume series), *Insect Control*, and *Insect Pharmacology*. His most recent book, co-edited with T. S. Dhadialla, is *Insect Midgut and Insecticidal Proteins: Advances in Insect Physiology*.

This interview occurred 19 May 2022 at Gill's home in Riverside, California. Gill, age 76, complemented the interview with California red wine and brie. The interview is edited for clarity and length.

Rice: You were born and grew up in Malaysia. Tell me about your family.

Gill: I've got five siblings, all alive: two brothers, two sisters. I'm the middle.



Sarjeet Gill, Distinguished Emeritus Professor, University of California–Riverside, 2022. (Photo by Marlin E. Rice.)

▼
“I WAS SURPRISED. I GOT A SCHOLARSHIP TO PURSUE ENTOMOLOGY.”

So you're not the special child: not the firstborn and not the baby.

I was the naughty one—real naughty one. I did a lot of things which my other brothers did not do. I was a sportsman, which none of them were, and I was very hot tempered. I used to get into fights because my older brother was not very aggressive, and I would fight to defend him. Because I'm a Leo, you see that trait quite often. But I've calmed down quite a lot since I was a teenager.

Did you ever get into trouble with the law?

No, no! I've never been in trouble with the law outside of a speeding ticket. I would say I love to play practical jokes.

I heard a legend about a rat at university.

John Casida's lab was crowded. Bruce Hammock and I used to share half an office desk; basically, half him and half me. And after about nearly a year and a half, Casida finally gave us some bench space. I was cleaning up the new bench space, and there was a plastic mouse. I took that mouse and casually threw it on the desk of the secretary, and she screamed and all the headsets went flying. John Casida, whose office was next door, didn't say anything to us, but he was pissed. He took the rodent, packaged it nicely, and threw it in the garbage bin. That night, the janitor, seeing it packaged and nicely wrapped, opened it up and he got a scare. Bruce saw this and kept the mouse and sent it to me a number of years later. We exchanged this rodent, between him and me, until it disintegrated. Then he got some other rat and we used to ship them to each other from different parts of the world. I'll see a package coming and usually I can tell if it's the rat, although we usually use other people's names [to mail the package].

Tell me about your parents.

My mom was a homemaker. She finished elementary school in Punjabi, which is my mother tongue. My dad was a financial clerk in the government during the Japanese occupation of Malaysia [during World War II]. And all the years after that, he was very anti-Japanese. Treatment was bad because my father lost a couple of close friends, who were also Sikhs. The Japanese would take them away and they would never come back. Life was tough because you never knew when you would be affected.

You finished secondary school, and then decided to pursue university?

Right. In Malaysia, they are called A-levels. Then I wanted to do engineering, and I got admitted to the University of Christchurch in New Zealand. My father said, “Yes, I will support you, but it will be tough,” because my elder brother and sister were overseas at that time in India and Australia, respectively. I decided, “I will apply for scholarships,” and got one

under the Colombo Plan. It's a commonwealth plan where they give scholarships to less developed commonwealth countries. I chose a field which I think had a better chance because in those days entomology was not well known. When they called me for an interview, I was surprised. I got a scholarship to pursue entomology at McGill University.

Entomology is quite a radical change from engineering. Had you checked the entomology box?

I did. I checked entomology, microbiology, molecular biology.

After earning your bachelor's degree at McGill, how did you decide where to pursue an advanced degree?

The scholarship to Canada was a five-year program. But when they saw my grades in the A-level subjects I took, I skipped the first year and finished in three years. So I wrote to the Malaysian government and said, "I finished in three years. I need to do graduate scholarship." They said, "Yes, do a master's in Canada and come back." This scholarship had a requirement to go back to Malaysia. They wanted me to do economic entomology, but I really did not want to do it. I liked physiology, toxicology type of things. So I applied for scholarships in the U.S. and got two: one from Cornell [University] and the other was [University of California] Berkeley. Because I had spent three years in a cold area, Cornell was not the place to go. [Laughs.] So I went straight for a Ph.D. at Berkeley. That's how I ended up in John Casida's lab, although they didn't assign me to Casida.

How did you maneuver into Casida's lab if he wasn't your advisor?

The college assigned me to Harold T. Gordon. He had no students at that time, and I was working with very little guidance. After one quarter, I looked across at Casida's lab, and that lab was so active. I talked to my graduate advisor and said, "I can't do this anymore. This is going to be tough because (Gordon) doesn't have any intellectual stimulation. I would like to work with John Casida." He said, "Okay, you can try to talk to him, but he doesn't take students." So I went to Casida and said, "I want to work with you." The first thing he said: "How are you going to fund yourself?" I said, "I have a scholarship." He



Sarjeet Gill, McGill University graduate, 1969.

▼
**"I BURNED
THAT BRIDGE.
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THAT
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said, "Okay." Then he gave me a project, and I did a project for a month, and after a month, he said, "What are the results?" I shared the results; then he pulls out from his drawer a paper and said, "Yeah, that's correct." What I was doing is what people have done already. It's basically a test to see if I could repeat it.

After that, he said I can work, but he didn't assign me any space. At the same time, Bruce Hammock had his own scholarship, and he also had to basically

tell Casida he wanted to work with him. Casida put us near a fly-rearing and mouse room, and just a desk. He said, "Sarjeet, take this half; Bruce, take that half." But it was fine because we worked mostly late hours. Bruce and I used the bench space at night when nobody was there. It actually was quite stimulating, in a way; in the sense you know how tough space can be. But we had a lot of fun at that time, really. And I was in Berkeley during the student riot days in 1969.

Did you throw rocks during the riots?

No, I didn't throw rocks. I was very quiet, calm person, but I played a lot of jokes. But after the rodent incident, I was walking one day down the street from work at maybe six o'clock. I used to stay in the international house, back in the hills of the campus. Suddenly I see five or six sheriffs chasing somebody. I look around—there's nobody except me! [Laughs.] All the smoke was coming and gas they were throwing, and they were chasing me up the hill.

The cops were chasing you?

Yeah! What the hell!? I didn't do anything, but this guy was carrying a baton. He was hitting any damn student he could find.

Did they catch you?

No. At that age, I could run quite fast. Those are fat pigs, as they were called then; they couldn't run. [Laughs.] Berkeley was very interesting. I would say an amazing place, but you have to find your niche. If you don't find, you get lost.

Ronald Reagan was governor of California at the time of the riots, and he sent in the National Guard to put down the unrest.

I know. My Ph.D. certificate is signed by Ronald Reagan. It's a very good signature. [Laughs.] But he was mild compared to what you see now in the U.S.

You finished your Ph.D. and returned to Malaysia as a lecturer at university.

I had a very comfortable life there and with quite a good salary. I've always had a link to the past; it's very easy to get pulled back. But I realized after a year that going back was the wrong choice I made. After three years, I decided to come back and spend a sabbatical with Bruce at Riverside. I said, "Bruce, I need to move

out of Malaysia.” He says, “Okay, you can come back and work with me.” It was very difficult to find a job from Malaysia in an academic situation. Then I resigned my position in Malaysia, I gave a 24-hour notice, and I said, “I’m gone!”

By resigning from the university, would you say you burned that bridge?

I burned that bridge. [Laughs.] I never regretted that decision. I got fed up because if I don’t make a move, I’ll be stuck.

Why were you fed up with your teaching position in Malaysia?

There were two things: one was religious discrimination, and then there was racial discrimination. Both of these because I’m not a Muslim. Malaysia is a Muslim country. The first time I went back, I was teaching an undergraduate student. By the time I decided to leave, that student had completed his Ph.D. and now was being appointed a dean on top of me in a short time.

Was this student a native Malaysian?

He was a Malay. I’m a native Malaysian because I’m born there, but that didn’t count at all, as I am of Indian origin. My father was born in Malaysia; that didn’t count.

Was the discrimination because of your Indian heritage?

Because of my race, but actually religion is more important. If I converted to Islam and changed my name, I would have been able to go a bit further, but still I would be considered second-class Muslim.

Are you Sikh?

I’m Sikh. It’s very obvious; I’m glad you noticed. [Laughs.]

You left Malaysia because of racial and religious discrimination. Have you experienced any discrimination in California?

Yes, interestingly enough, when I first came into this department here, but it was subtle. But I’m also a very resilient person, so if you discriminate [against] me, I just work harder. Simple as that. When I joined the university, professor Roy Fukuto—a very famous insecticide toxicologist—says, “What you do is make sure you publish, have good grant support, and teach such that it doesn’t hurt you.” The advice

he gave—it was very good. He said, “The University of California expects you to be a good teacher. If you are a bad teacher, it hurts you. But if you’re good teacher, which you would expect, then it doesn’t hurt your evaluation, but it doesn’t significantly help you.”

So you must teach, but without it being a priority.

What helps is actually good research productivity with grant support. Good teaching is expected. That’s what he told me, and that’s what I focused on.

You’ve been in the U.S. a long time. Did you become a naturalized citizen?

Yes, I did. This was facilitated by getting a job that could enable a resident visa application. When I was in Bruce’s lab, I got a job at Southern Illinois University.

Southern Illinois is a small public university.

Yeah. They worked my visa out, and while that process was going on, I got an offer from UC–Riverside, so I was in the dilemma. I went to Carbondale, but they suddenly rearranged the department, and I was now left stranded, in a way. I asked the department chair there what should I do about the job at Riverside. He said, “Take

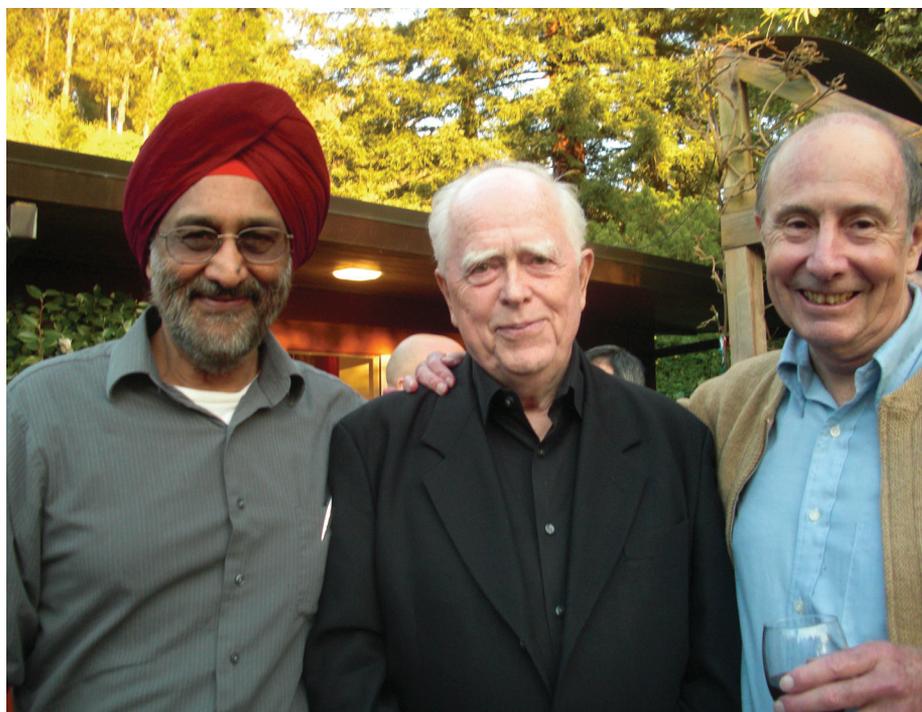
that one; you’ve got a good offer.” I was startled, but that was good advice.

You have described yourself as a molecular biologist, physiologist, and entomologist. Let’s focus on the entomological aspect. When did you decide to pursue entomology?

I was not very clear what I wanted to do at McGill. I was thinking of becoming a physiology or toxicology type of person, but the seminal time was in the graduate program at Berkeley. Those were formative years because Casida would challenge you, but also give you freedom to work. Since our project was not the main line of work of Casida’s lab, he left Bruce and me to do our own work. He gave us a long lease, and we actually did quite good work on epoxide hydrolase action on juvenile hormone. No complaints.

Your primary research at Riverside was elucidation of mode of action of the *Bacillus thuringiensis* toxins, plus *Clostridium*, which kills mosquitoes. In your long career, what research has been the highlight or has delivered the most satisfaction?

Basically, focusing on mosquito toxin mechanism of action studies, because they are very difficult. I’ve worked with



Sarjeet Gill (left) with his mentor, John Casida (center), and good friend and colleague Bruce Hammock, 2010.

multiple toxins and tried to elucidate the mechanism. I successfully identified the mosquitocidal toxins in *Paraclostridium*, and identified the molecular mechanism of action of the toxin active on *Anopheles*. Although this took us more than seven years, this was very satisfying.

With *Bacillus thuringiensis* toxicity, part of this work was done with very good collaborators from Mexico. I bring this up because it shows how good work can be done collaboratively. I was giving a lecture in Colombia on phased display, a very unique methodology of mapping a protein at that time. This young gal, Alejandra Bravo, from University of Mexico saw what I was trying to do; she talked to her husband, Mario Soberón, and he said, “That’s very creative,” and he was using a similar approach. Then we were in a meeting in Spain. They were just starting their careers, and they asked to have dinner

together. They said, “Can you provide some clones to do this work?” I came from a field of toxicology where I shared reagents very freely, but the rest of the field was not doing that at that time. They would not provide clones so easily, since there were commercial applications. I provided clones and reagents, and they were very grateful, and we started collaborating.

Are you giving away your research ideas?

Not really—it just saves some time with collaborations. And since that time, we have a very long collaboration for nearly thirty years on all different things, except for *Paraclostridium*, which is basically my work. As a consequence of that, I use the word “we” because they couldn’t do some of the work without me and I cannot do some of the work without them. But I think I benefited more from this collaboration.

It was good synergy, then.

Yeah, it was very important synergy. We looked at the mechanism of how the Bt toxin inserts, the role of multiple receptors, and how, together, they are actually necessary for the ultimate mode of action of the toxin. And in the case of the mosquito proteases, where they have multiple toxins, we also showed that you need two receptors for the toxins to work. It is still a hallmark of the field, and an important one, that you need more than one protein for full toxicity.

When your neighbors, who are not scientists, ask what you do and why is it important, what do you tell them?

My explanations have to be simple. It is important for them to understand *Bacillus thuringiensis israeliensis* (Bti) can be used in the field for controlling insects, such as blackfly, which causes river blindness. It



ADVICE FROM A LEGEND

You’ve had 23 postdocs, 22 Ph.D. students, and a handful of master’s students. What do you look for in a postdoc or graduate student?

I like independence, actually. That’s the first thing. One of my students says, “You just take the student and throw them into the pool and see if they can survive by swimming out.” [Laughs.] Which is not a bad description because if they cannot swim, I do go jump in the pool. But ultimately, I find that most students can swim, and they will be able to succeed. Some take longer than others, but they will learn a bit more critical thinking. It’s not that I don’t provide guidance. I do. They design the experiment, then let’s talk about it. I rarely provide day-to-day guidance or weekly guidance; I provide more long-term guidance.

What about soft skills, such as communication or social chemistry?

That is one of the more important things: how they interact with people, how they communicate with people. It’s easier in some and more difficult in others. It depends on their upbringing, actually, more than anything else. The ability to communicate is very important, irrespective of what job you get. How you’re able to communicate, what you’re going to do, why you are doing it, what are the results, what

are the implications? Out of all my students, there have been a couple that have not been particularly successful communicating.

To what do you attribute challenges in communication?

Some of it’s really cultural because, for example, some Chinese students don’t like to speak out; they are very quiet. It is in the culture: they’re not told to do that. If you look at some Indian students, they are very communicative, but some of them tend to be a bit more subdued, especially among the women. You have to really ask them to do that, and then, when you bring it out, then they become a bit more assertive.

What is one book you would recommend graduate students read?

Depends. For my current students in toxicology, I find they don’t know the morphology of an insect. They really don’t know what they’re doing. They know how to clone, they know where the genes are, they know how to do this, but they don’t know at times which part of the mosquito they are working on.

was used in Africa for 30 years, and no resistance has developed because of the duality of the toxicity that's required. You need two toxins and two different receptors to cause full toxicity. Resistance is thus difficult. For mosquito control in California, it is used for many years and is very effective.

What research are you most proud of, looking back on a four-decade career?

I'm proud that I never gave up the tough work that was required. You know, it was very slow slogging. A lot of times people say, "Why don't you do something else? It will be much better." That's why, a lot of times, I did side projects to keep me active because this was very slow going. And yes, I'm still doing it because it's slow going.

And this is with respect to the mode of action research?

Yes, mode of action studies are very *sloooow*. Ultimately, you'll find one target, which is mapped to a single very small locus in the genome.

What research questions are you attempting to resolve today?

One project is on Bti. For one of the toxins, we have mapped the resistance allele to a very narrow region by whole genome mapping. So we are trying to actually identify the gene. The other project is on *Paraclostridium*; we are looking at the receptor for the toxin. It's very difficult in mosquitoes to identify the receptor, and thus we are knocking out certain genes in *Drosophila*. And I just retired last year and went into what the University of California calls "professor in the graduate division." I can write grants, I can have students, I can do all the research. But I don't have to do

committee work, and I don't have to teach.

That's a sweet way to finish a career. What do you think about at the end of the day?

Time for a beer, time for wine. [Laughs.] But to me, there is no real precise end of the day. When I was younger, I used to go back to the lab at night as an assistant professor. I was doing that consistently, but those days were aggressive days. I don't do that now.

Acknowledgment

Thanks to Bruce Hammock for insights into the life and career of Sarjeet Gill.

Marlin E. Rice is a Fellow, Honorary Member, and past president of the Entomological Society of America.

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Maybe they don't know a coxa from a femur?

Yeah, sometimes they don't know the anterior and posterior [Laughs.] They can do the molecular biology, like to grind up the whole insect, but that doesn't make sense. You need to dissect the tissue. So they need to basically understand good morphology. For that, there's a good series of three books by Alan Clements on mosquito biology.

Can you recommend any general science books?

A good book to read and see the issues is *The Double Helix* by James Watson. It tells how many things they had to go through, the problems that they fought, and of other people competing with them. That was a very good book. But most of my reading is generally towards primary papers.

How critical is the scientific literature?

This is something I always tell my students. They will come with this paper, and I say, "Who did it?" They say, "I don't know." That's important because if you don't know who did it, it's not gone into your mind yet. You need to know who did it, why they did it, and when they did it. All of those things are simple things but are very important in life. That's one of the weaknesses with students nowadays. They tend to understand that the literature only exists on the internet. Some good papers precede the internet. I'm sorry they only cite more recent papers, and in fields like insect physiology, some of the old works, even like Wigglesworth, are still current, so you have to know all the literature. Some of the old texts and principles of morphology are still very important.

One of my favorite graduate textbooks was *The Insects: Structure and Function* by R. D. Chapman.

That is another classic.

When a postdoc or student departs your lab, do you have any final advice?

Usually that doesn't come as one piece, but generally, be very truthful in what you do. If you try to lie, you'll get caught, so just be truthful to the last word. And be truthful to your objective; analyze all the data—don't analyze *some* of the data, but analyze *all*—because it's different aspects you can see.

