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SACNAS Meeting Gives Minority Students a Lift

By Barry A. Cipra

The modern elevator is a uniquely safe conveyance. Elisha Otis's 1853 innovation of the gravity brake made it all but impossible for people inside an elevator car to perish in a fall. Nonetheless, the plummeting elevator is a convenient metaphor for the fragile status of small groups of people who have uncommon interests in common. Who hasn't boarded an elevator at a math meeting, heading to lunch with colleagues, and made a remark along the lines of "You know, if this elevator cable breaks, the world won't have a single expert on hyper-real methods in super-finite reduction theory"? To which the appropriate response is, "Would that be a bad thing?"

The elevator observation is usually treated as a joke, and often as a badge of honor, emphasizing membership in a self-selected elite. It can also be a call for action.

A Dramatically Changing Demographic

Richard Tapia, one of the approximately eight scientists who in 1973 founded the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS), recalls a colleague's comment at an early organizational meeting in Albuquerque: An elevator accident could wipe out the entire population of Mexican–American scientists. The group resolved to make such a fate impossible.

Today, it would take the collapse of an entire hotel to make even a dent in the demographic. While their presence in scientific circles still lags their portion of the population pie chart,* Latinos and Native Americans are pursuing careers in science—and gaining recognition for their accomplishments—in ever larger numbers. SACNAS today has approximately two thousand members. Amazingly, the same number attended the most recent annual meeting, October 10–14, in Kansas City.

Tapia was impressed not only by the quality of the students at the meeting, but also by their sheer numbers: "It's hard for me to believe what I saw in Kansas City," he says. SACNAS has been "a huge success," he continues. "It's sort of a dream come true."

SACNAS is a student-oriented organization. Its stated mission is "to encourage Chicano/Latino and Native American students to pursue graduate education and obtain the advanced degrees necessary for science research, leadership, and teaching careers at all levels." (In the early 70s, the Latino population in the U.S. was predominantly Mexican–American. The society, Tapia notes, periodically reconsiders the idea of making the "silent L" explicit.)

Focus on the Next Generation

Along with scientific sessions, the SACNAS annual meeting features professional development workshops on such topics as resume-writing and applying to graduate school. And with just about all meals included in the registration fee, the conference also fosters the kind of casual, chance encounters that often prove to be professionally pivotal. Senior members of SACNAS come to see one another, but they are there primarily to network with and mentor the next generation.

Mathematics was highly visible at the Kansas City gathering. Tapia gave a keynote address at the concluding banquet, before heading off to his own conference, a celebration of diversity in computing (http://www.richardtapia.org/2007/). Actually, two of his former students gave most of the SACNAS talk. Edward Gonzalez described the solution to a problem in lane assignments in motocross bike racing, one of Tapia's loves; Josef Sifuentes had used the Navier–Stokes equations to make the video animation he presented on another of Tapia's loves: his classic '57 Chevy show car. A workshop organized by the Berkeley-based Mathematical Sciences Research Institute highlighted upcoming programs in algebraic geometry and combinatorics.

Student posters—more than five hundred at the 2007 event—are the heart of a SACNAS meeting. Volunteers among the professional attendees formally judge the posters and also serve as mentors during the meeting. Awards for the best poster in each discipline are presented at the concluding banquet. In Kansas City, two dozen of the posters were in the mathematical sciences. Many of them originated in work done at summer programs for undergraduates.

A Sample of Impressive Posters:

Epidemiological/Population Models

The poster award in mathematics went to Brenda Jimenez-Gonzalez (Instituto Tec-nologico Autonomo de Mexico), for "The Cursed Duet: Dynamics of HIV/TB Co-Infection in South Africa." Jimenez-Gonzalez's poster presented research she had done with team members Diego Chowell-Puente (Universidad de Colima, in Mexico) and Adrian Nicholas Smith (University of Washington), graduate mentor Karen Rios-Soto (Cornell University), and faculty adviser Baojun Song (Montclair State University, in New Jersey), in the 2007 summer program run by the Mathematical and Theoretical Biology Institute at Arizona State University.

South Africa has been particularly hard hit by both HIV and TB: Approximately 5.3 million adults (age 15 and up) in a nation of 47.4 million are infected with the AIDS virus, some 300,000 have active (also called infectious) TB, and approximately 56,000 have both AIDS and active TB (the latter is taken as a sign that HIV has progressed to AIDS). Jimenez-Gonzalez's team studied the "deadly synergistic effect" of the viral–bacterial co-infection using a seven-compartment model for the intertwined epidemics (see Figure 1 on page 2).

Sensitivity analyses and numerical simulations indicate that HIV exacerbates the TB epidemic. "We expect in about 12 years the HIV–TB co-infection prevalence to be the same as the active TB prevalence," the researchers write. "This can be avoided by introducing treatment and management

*A 2007 report on under-represented min-orities in science and engineering, by chemist Donna Nelson of the University of Oklahoma, is available on Nelson's homepage: http://cheminfo.ou.edu/~djn/djn.html.

protocols that focus efforts to increase the successful treatment rate of HIV-positive individuals who are latently infected with TB."

In another poster from the MTBI summer program, James Gambino (Columbia University), Marco Martinez (Pontificia Universidad Javeriana, in Bogota, Colombia), Kehinde Salau (Arizona State), and Edme Soho (Montclair State), with graduate mentor David Murillo (Arizona State) and faculty advisers David Hiebeler (University of Maine at Orono) and Fabio Sanchez (Cornell), developed a spatially based model to study the "mesopredator release hypothesis" (MRH), an explanation of the decline or extinction of certain prey species. MRH is concerned with "predator–predator–prey" situations in which an underlying species, such as songbirds, is preyed upon by two predator species, say rats and cats, one of which (the cats) also preys upon the other (the rats). The hypothesis is that suppressing the "superpredator" (cat) population can, in certain circumstances, lead to an explosion of the "mesopredator" (rat) population, to the detriment of the prey species.

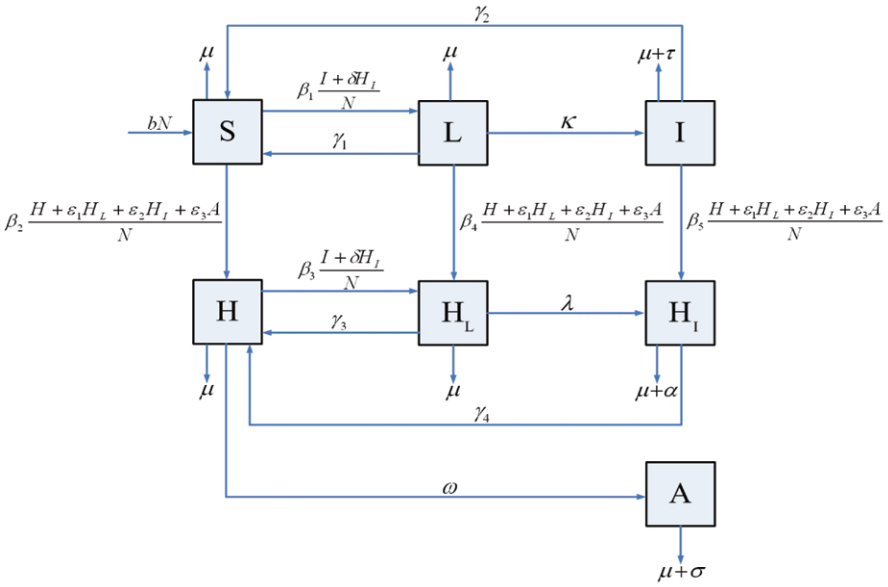

Figure 1. *The Cursed Duet. Latent and infectious TB can pair with HIV to exacerbate the AIDS epidemic, which is otherwise describable by a simple three-compartment model, S→H→A. Figure courtesy of Jimenez-Gonzalez et al., "The Cursed Duet: Dynamics of HIV–TB Co-infection in South Africa," Mathematical and Theoretical Biology Institute research archives, Summer 2007, http://mtbi.asu.edu/Summer_2007.html.*

The devil, of course, is in the details, one of which is the spatial distribution of the competing populations. The MTBI student group put space into the equation by sprinkling cats, rats, and birds onto toroidal grids of various sizes, from 75 × 75 up to 300 × 300, and then playing a stochastic Game of Life, with locally determined births, deaths, and predations. To test the mesopredator release hypothesis, the group allowed the system to reach an equilibrium and then disrupted things by suddenly turning up the cats' (un)natural death rate. Doing so, they found, can produce simulations in accord with MRH (see Figure 2).

A subtler form of predation was studied by a student group from the Applied Mathematical Sciences Summer Institute (AMSSI), hosted jointly by the California State Polytechnic University in Pomona and Loyola Marymount University. Jennifer Jones (Colorado State University), Carol Ambrose (Illinois Wesleyan University), Kurt Larson (Cal Poly Pomona), and Lucy Orozco (Loyola Marymount), with graduate research assistant David Uminsky (Boston University) and adviser Steve Wirkus (Cal Poly Pomona) set up an ODE model of political affiliation and fanaticism, with the goal of understanding red/blue mood swings in the U.S. in the last century and a half.

The group's model distills the political spectrum down to five compartments: undecideds (aka susceptibles, a group that includes the constitutionally apathetic), "moderates" of each party, and "fanatics" of each. The definitional difference between moderates and fanatics is that moderates simply favor their chosen party (e.g., plan to vote for whoever the Dems nominate next summer) but don't bring the subject up in polite company, while fanatics actively try to browbeat others into seeing the political light. (For all practical purposes, third-party enthusiasts, by not casting meaningful votes, can be classified as apathetic.) The AMSSI group assumed that fanatics within a party can move to and from only the moderate group of the same party, while moderates can switch party allegiances.

The transition rates in the model are a mix of linear and quadratic terms. For example, dF_R/dt, the rate at which the ranks of fanatical Republicans swell or subside, has the form $aM_R - bF_R + M_R(cF_R + dM_D + eF_D) - F_R(gM_D + hF_D)$. The linear terms can be thought of as representing responses to current events and/or mass-media advertising (especially attack ads); the nonlinear terms represent effects of interpersonal exchanges—i.e., the tendency of people to be galvanized to action (or inaction) by those around them. After setting certain parameters equal and others to zero, the AMSSI group analyzed the stability of equilibria in several scenarios. In some settings, they find, it's counterproductive for a party to have too many fanatics—a big tent of moderates can be more attractive than a brash band of true believers.

And a Few Controversial Subjects

AMSSI students Lizette Ortega (Univer-sity of Arizona), Megan Armentrout (Whitworth University, in Spokane, Washington), Jennifer Nguyen (Cal Poly Pomona), and Amber Goodrich (Central Washington University, in Ellensburg, Washington), with graduate research assistant Laura Smith (UCLA) and adviser Lily Khadjavi (Loyola Marymount), analyzed racial disparities in traffic stops. Their data was from the Los Angeles Police Department, which has been under a consent decree to record information on each stop, including race, age, and gender of the detainee and details of the stop, such as whether a search was conducted or a citation issued. In all, the students analyzed data from 638,732 stops in LA's 18 reporting districts between July 2004 and June 2005.

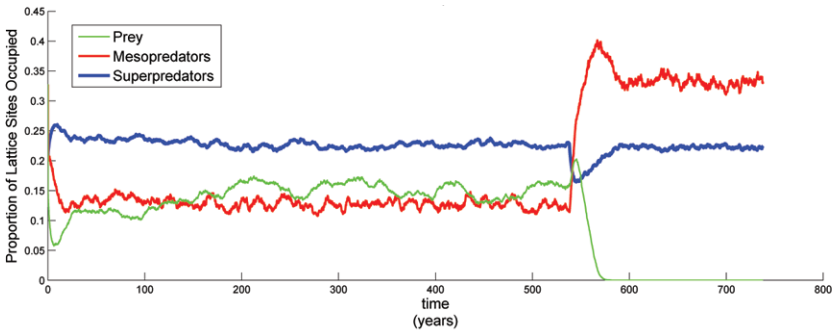

Figure 2. *Rats! Suppressing a population of "superpredators" can create a surge of "mesopredators," leading to the extinction of a species of common prey. Figure courtesy of Gambino et al., "Cats Protecting Birds Revisited with a Spatial Approach," Mathematical and Theoretical Biology Institute research archives, Summer 2007, http://mtbi.asu.edu/Summer_2007.html.*

The data show strong correlations with race. Search rates, for example, are approximately four times higher for African–Americans and Hispanics than for

Whites (see Figure 3). A logistic regression indicates that your best chance of being pulled over in LA is by driving while black, brown, or young. None of which proves discrimination, the students note—plenty of other demographic and socioeconomic correlations are not accounted for—but their results, they write, "give sufficient evidence to support the possibility that racial profiling is indeed occurring."

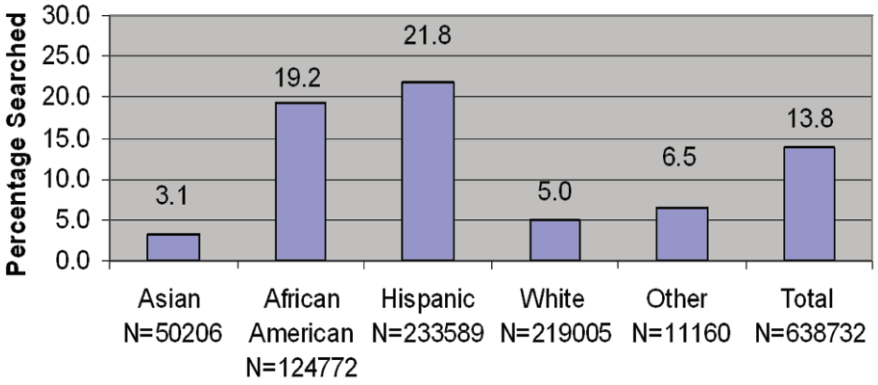

Figure 3. *Over-represented minorities. Los Angeles police conduct searches in nearly one of seven traffic stops, but the percentages vary widely by racial category. Figure courtesy of Ortega et al., "Cops and Stops: Racial Profiling and a Preliminary Statistical Analysis of Los Angeles Police Department Traffic Stops and Searches," Applied Mathematical Sciences Summer Institute technical reports, http://www.amssi.org/.*

MTBI summer students Susan Seal (Arizona State), William Rayfield (University of Maryland Baltimore County), Carl Ballard (Alabama State University), and Holden Tran (Northwestern University), with graduate mentor Edgar Diaz (Arizona State) and faculty adviser Christopher Kribs-Zaleta (University of Texas at Arlington), took a mathematical look at the "three-strikes" law, famously adopted by California in the mid-1990s in an effort to deter crime by imposing harsh prison terms on repeat offenders. The theory is that three-strikes cuts crime in three ways: by dissuading criminals on parole from committing additional "strikable" offences, by preventing the fourth, fifth, and further offenses an incarcerated third-striker would presumably commit, and by limiting the ability of career criminals to "recruit" new criminals—a side benefit of removing them from the general population. The question is, how well does the theory work in practice?

Seal's team constructed a dynamic model for the three-strikes law, tailored to the inner-city communities of Los Angeles County, and compared it with a corresponding model of the traditional "infinite-strikes" approach, which does not base sentencing on a convicted criminal's prior record. They also analyzed a "one-strike" model, also known as "lock 'em up and throw away the key." (The arbitrary choice of three—in fact, the name "three-strikes"—obviously comes from baseball, which is part of the law's appeal.) The basic compartments are "susceptibles" (think impressionable youth), uncaught criminals, prisoners, ex-cons who have not committed additional crimes but are susceptible to doing so, and "immunes," which includes both reformed criminals and simple law-abiding citizens. The three-strikes model splits the criminal, prisoner, and ex-con compartments into subcells according to the number of strikes, while the streamlined one-strike model drops the ex-con compartment (because prisoners never get out of jail).

The students found that their three-strikes model does better at controlling crime than the infinite-strikes approach, at least in the high-density population setting of LA County. Comparing the models with parameters for sparsely settled regions typical of New Mexico and Montana, they found the reverse. In both settings, the students found, the one-strike model is highly effective at deterring crime, "but at the cost of sending almost everyone in the population to prison." There's no obvious, uncontroversial balance of costs and benefits (if your sole goal is to prevent crime, then a "no-strike" policy looks awfully appealing), but it's likely that an optimal solution would involve some strikeout number other than three. Society might have been better off if baseball had frozen its rulebook in 1887, when the umps' cry was "strike four, yer out!"

Analysis of another controversial topic—the vaccination of teenage and preteen girls against the human papillomavirus (HPV)—was undertaken by MTBI students Yeni Nieves (Purdue University), Alison Green (Canisius College, in Buffalo, New York), and Cindy Enrigue (University of California, Berkeley), with graduate advisers Dori Luli (Arizona State) and Britnee Crawford (University of Texas at Arlington) and faculty adviser Kribs-Zaleta. HPV is an endemic sexually transmitted virus, estimated by the Food and Drug Administration to infect more than half of all sexually active people. It accounts for approximately 70% of cases of cervical cancer, or about 7800 new cases each year; treatment costs are estimated at around $21,000 per case. Because cervical cancer is fatal in about a third of all cases, eradication of HPV would save an estimated 2600 lives per year.

In 2006, the FDA approved Gardasil, a vaccine for females that is nearly 100% effective in preventing HPV infection. Some states have considered making the vaccination mandatory for girls entering sixth grade. Critics object that such programs tacitly encourage sexual activity among young people, and that Gardasil does not guard against other sexually transmitted diseases. Furthermore, at $360 for a three-shot regimen, Gardasil is a relatively expensive and complicated vaccine to deliver, which means that even a mandatory program will miss some fraction of the population.

The students did a cost analysis of two models of HPV eradication: a mandatory vaccination program reaching 95% of females between the ages of 11 and 26, and a mass-media education program aimed toward reducing sexual activity and encouraging voluntary vaccinations. (Eradication was defined as reducing the number of infections in the model to less than one. Because HPV has a high transmission rate, eradication requires generous estimates for parameters that reduce the reproductive number.) The students found the two approaches roughly comparable, but only when the "effectiveness" of the mass-media program was set to 50%. Otherwise, their results support the conclusion of a recent study in Finland that HPV's high transmission rate will maintain a sizable infective population even in the presence of a vaccine.

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