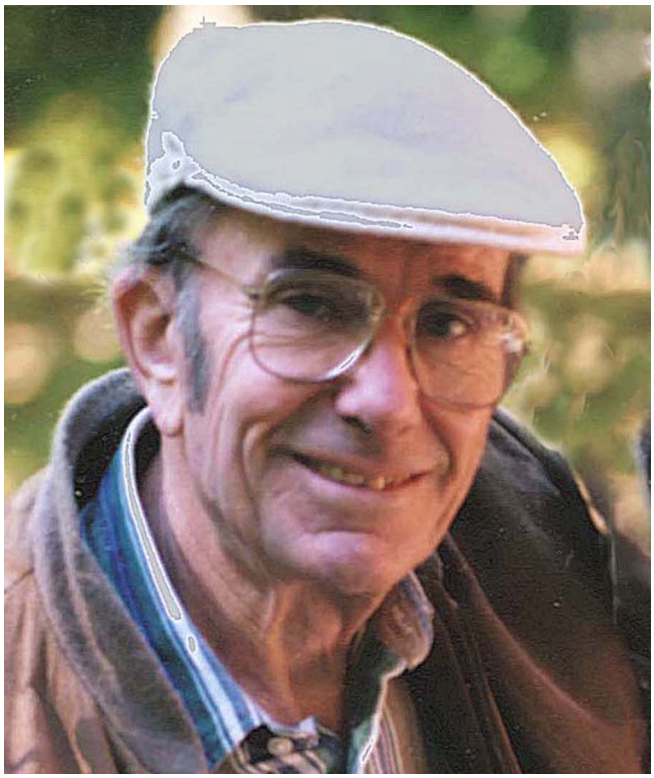
Resolution of Respect



Thomas Eisner
1929–2012

Thomas Eisner, Jacob Gould Schurman Professor Emeritus of Chemical Ecology at Cornell University, died on 25 March 2011, exactly three months before what would have been his 82nd birthday. He is widely acknowledged to be among the founding fathers of the field of chemical ecology, an interdisciplinary field to which his broad-ranging interests were ideally suited. He probably would have objected to being called a Renaissance man, but few other terms are quite as apt to capture his extraordinary facility with languages, his absolute command of history, his encyclopedic grasp of music, and his remarkable artistic eye, all of which combined to contribute to and inform his manifold scientific achievements.

Tom was born in Charlottenburg, in Berlin, Germany, on 25 June 1929, the son of the chemist Hans E. Eisner and his wife Margarete, an accomplished artist and painter. As the Nazi Party began to exercise its power and anti-Semitism started to influence political policies, the entire family left for Barcelona, Spain in 1933, where his father found work as a chemist in a private company. The Spanish Civil War soon drove them to pack up and leave again, initially to France and soon thereafter to Uruguay, where the chemical company had a branch office. Tom spent a decade in Uruguay, graduating from high school

in Montevideo, having achieved, in the course of his travels, fluency in German, Spanish, and French. He also mastered the piano during this time period, continuing to play throughout his life, having a particular interest in pieces for four hands, played initially with his father during his childhood and with musically inclined colleagues (including, among others, Gottfried Fraenkel) later in his career. He also had the time and opportunity in this relatively stable period to grow intimately familiar with the natural history of the region. By 1947, the Eisners had moved again, this time to the United States, enabling Tom to attend college. He was accepted into Champlain College in Plattsburg, New York (after being rejected by Cornell University) and began his academic studies.

After two years, he succeeded in transferring to Harvard University, where he took his first formal course in entomology. He continued his studies in entomology, eventually earning a B.A. in 1951. That same year, he met Maria Loebell, an exchange student at the Graduate School of Social Work at Simmons College in Boston; they married in 1952 and she became both a life partner and research partner for Tom, accompanying Tom on field trips and assisting him with laboratory studies for more than a half-century. Tom remained at Harvard for his doctoral degree in 1955, working with, among others, famed ant systematist William L. Brown and fellow student Edward O. Wilson, who became a lifelong friend. With them, he published several papers on insect morphology, including a series of studies on the ant proventriculus and the function of its morphology in social feeding. He continued as a postdoctoral fellow until 1957, when he was hired as an assistant professor at Cornell. He remained at Cornell for his entire faculty career (and kept the rejection letter he had received in 1947 framed and hanging on his office wall).

Eisner rose through the faculty ranks, promoted to associate professor in 1962, to full professor in 1966, to Jacob Gould Schurman Professor of Chemical Ecology in 1976. Cornell proved to be a fertile place for advancing his interests. In addition to attracting superb students, he began what became a legendary collaboration with chemistry professor Jerrold Meinwald. Together Eisner and Meinwald determined the structure and function of a dazzling diversity of arthropod semiochemicals, including, among many others, defensive secretions, pheromones, aphrodisiacs, pigments, and glues. Chemical classes subjected to their scrutiny ranged from the relatively simple cyanogenic glycoside in the oozing secretions of millipedes, to the macrocyclic polyamines produced in the sticky trichomes of Mexican bean beetles, among the largest nonprotein natural products ever reported. Most famously, Tom worked out the mechanism by which the aptly named bombardier beetle explosively discharges its defensive secretion of quinones at boiling-hot temperatures (and developed novel photographic techniques to capture the behavior memorably on film).

Collectively, Eisner and his collaborators provided fascinating explanations for bizarre and mystifying things in nature: why catnip smells the way it does, what makes stinkpot turtles stink, why seemingly defenseless and immobile eggs and pupae are left alone by predators, and why fireflies can glow at night without being caught and eaten. Eisner excelled at elucidating the functions of strange organs and peculiar protuberances on a variety of organisms that were of interest only to a handful of taxonomists seeking out minute differences in order to classify species: the long stalks of lacewing eggs (which contain droplets of a glue to deter egg predators), the grooved edges of ground beetles (which serve as a launching pad for acrid defense secretions), the grappling hooks on the backs of lacewing nymphs (which provide an anchor for waxy secretions expropriated from their aphid prey), the enormous hairpencil glands of male bella

moths (which contain aphrodisiac substances used in courtship), the whip of the whip-scorpion (which propels at great force an acidic secretion directly at a predator), the osmeteria of swallowtail caterpillars (which pop out when needed and release repugnatorial substances that repel would-be predators), and the spongy feet of the palmetto beetle (which contain a powerful oil that stymies erstwhile consumers trying to pluck the beetles off the plants), just to name a few. The collaborative work of Meinwald and Eisner, in solving these mysteries of the natural world, has yielded remarkable new chemical structures, analytical approaches, and biosynthetic pathways (including the first demonstration of combinatorial chemistry practiced by an insect). That chemical analysis can provide extraordinary insights into the process of evolution, however, proves the power of this remarkable collaboration. Over four decades of astonishingly productive and ingenious work, Eisner and Meinwald merged two apparently disparate disciplines—evolutionary biology and chemistry—into productive harmony. The fact that any decent introductory biology textbook contains at least one Eisner story means that chemical ecology has gained the attention and interest of a vastly broader audience than could ever have been imagined.

Tom actively promoted the growth of the new discipline of chemical ecology. In 1970, with former mentor William L. Brown and Cornell colleague Robert H. Whittaker, he published a paper in *Science* expanding the vocabulary of the discipline, coining the terms "allomone" and "kairomone" to provide a vocabulary for describing interspecific chemical signals that could parallel the vocabulary for describing pheromones, the intraspecific chemical signals. That same year, he contributed a chapter on arthropod chemical defense to the edited volume of E. Sondheimer and J. B. Simeone, entitled *Chemical Ecology*, for years the only book available on the subject. He was also instrumental in designing and offering at Cornell one of the first classes taught in the subject. He was in attendance at the first Gordon Conference on Plant–Herbivore Interactions in 1980, organized by his Cornell colleague Paul Feeny along with University of Kentucky faculty member Gerald Rosenthal. With Meinwald in 1990, he founded the Cornell Institute for Research in Chemical Ecology (CIRCE), dedicated to exploring chemical interactions among organisms to expand basic knowledge, conserve biodiversity, and find innovative solutions to environmental and health challenges. CIRCE was the first academic institute dedicated to chemical ecology, anticipating by six years the founding of the Max Planck Institute for Chemical Ecology in Jena, Germany. Eisner and Meinwald partnered three years later to organize a symposium, the proceedings of which were published in Proceedings of the National Academy of Sciences and subsequently made available as a separate volume, published in 1995 http://www.nap.edu/openbook.php?isbn=0309052815. In 2008, Meinwald and Eisner published a second series of papers on chemical ecology in *PNAS*, illustrating how the field had diversified in the intervening 13 years http://www.pnas.org/cgi/collection/chemical_ecology.

Over decades of productive work, Tom succeeded in cracking the chemical code with which the vast majority of organisms, humans excepted, communicate. In the process of doing so, he did more than found a new discipline—he demonstrated the importance of understanding natural history to gain leads to chemical diversity, the value of bioassay in tracking activity, and the enormous benefit of characterizing chemical components in an ecological and behavioral context. Moreover, he was a powerful and articulate advocate on behalf of nature and a persuasive proponent of biodiversity conservation in the context of chemical prospecting. The rich and rigorous scientific legacy of Eisner provides those advocating to protect the earth's biotic resources, because of their untapped potential value to humans, with clear and undeniably compelling chemical arguments to bolster their case. The biotic diversity of the world houses

unimaginable chemical riches, and Eisner led the way in revealing those riches and providing insight into their potential utility. He was active in promoting the passage of the Endangered Species Act and in garnering support for preservation of natural areas in the Florida Keys and in the Big Thicket in east Texas.

Throughout his life, Tom remained a citizen of the world. Among his visiting appointments were stints at Wageningen, The Netherlands; the Smithsonian Tropical Research Laboratory, Barro Colorado Island, Canal Zone; the Max Planck Institut für Verhaltensphysiologie in Seewiesen, Germany; the Division of Entomology, CSIRO, Canberra, Australia; and the University of Zürich, Switzerland. Closer to home, he conducted research at the Marine Biological Laboratories, Woods Hole, Massachusetts; University of Florida, Gainesville; and Hopkins Marine Laboratory, Stanford University, California. During his first summer as an assistant professor, he discovered the Archbold Biological Station in Lake Placid, Florida, on a field trip; he visited Archbold on a regular basis for the rest of his career, where its remarkable flora and fauna (including, among countless others, millipedes, golden silk and ladderweb spiders, walking sticks, tortoise beetles, queen butterflies, pipevine swallowtails, carrion beetles, ant lions, bella moths, and bombardier beetles along with such plant oddities as sensitive plants and carnivorous sundews) inspired many of his best-known studies. He described several of these studies in an article for *BioScience* in 1982, passionately advocating for incorporating field experiences and exposure to natural history into biology education, a theme to which he hewed throughout his career. Among the last courses he taught at Cornell was a wildly popular course on natural history. As a citizen of the world, Tom also never forgot how governments and politics can jeopardize science and scientists—he was a tireless advocate for scientific integrity and human rights, serving with distinction on the National Academy of Sciences Committee on Human Rights, and on the AAAS Committee on Scientific Freedom and Responsibility, chairing its Subcommitee on Science and Human Rights for eight years. He never shied away from political controversies relating to science policy, and was outspoken on such diverse subjects as the biological effects of nuclear war, population control, and global climate change.

But beyond the scientific contribution, Tom has made a lasting aesthetic contribution today that is every bit as worthy of recognition. The images that have accompanied his publications for the entire duration of his career are technical marvels in and of themselves. Understanding the power of the image, Tom has partnered with professionals, including engineers, to capture and preserve images that are now iconic, not only because of the scientific principles they illustrate but because of their inherent beauty. To capture the millisecond bursts of bombardier beetle defensive spray, for example, required inventing entirely new equipment; that image is now familiar to generations of students (and even inspired some creationist web). To illustrate the power and range of the whipscorpion's whip, Tom posed the whipscorpion on indicator paper, so that the footprint of every droplet of acidic secretion was brilliantly visible. Always a masterful photographer, Tom found new forms of artistic expression when Parkinson's disease robbed him of the incredible control that he needed for image capture—his work with a color photocopier made the Science Times section of the *New York Times*. Parkinson's disease did not prevent him from teaching classes and writing books; three of his nine books were written in the last decade of his life.

Tom's work was been recognized by virtually every kind of academic award—election as a fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of

Science, the Entomological Society of America, the Animal Behavior Society and the Explorers Club, as well as a member of the National Academy of Sciences, the American Philosophical Society, and the Deutsche Akademie der Naturforscher Leopoldina; he was elected as a foreign member of The Royal Society of London and the Academia Europaea. He won awards from practically every scientific society he belonged to: the Founder's Award from the Entomological Society of America, the Silver Medal from the International Society of Chemical Ecology. In 1990 he received the Tyler Prize for Environmental Achievement, and in 1994, he was awarded the National Medal of Science. His honorary degrees spanned four nations on two continents (University of Würzburg, University of Zürich, University of Gothenburg, and Drexel University). Beyond the scientific community, he also won recognition for his outreach and public engagement efforts. Of six films by or about him, "Secret Weapons," for example, produced with the BBC, won the Grand Award in the Science Category of the New York Film Festival. His book *For Love of Insects* was recognized as the Best Book in Biological Sciences for 2003 by the Professional and Scholarly Publishing Division of the American Association of Publishers, and in 2005 he won the Lewis Thomas Prize for Writing about Science from Rockefeller University.

He is survived by his wife of 58 years, Maria Loebell; three daughters, Yvonne, Vivian, and Christina, six grandchildren, and a sister, Beatriz Gil Zorrilla. In his memory, a fund has been started to create an endowment at Archbold Biological Station. Despite his extraordinary creativity, astonishing insight, and unflagging enthusiasm, his almost-82 years were not sufficient to allow him to explain all of the mysteries in this rare pocket of biodiversity, and the endowment will ensure that natural history will continue to inspire and motivate lovers of insects (and every other kind of organism) for years to come.

Acknowledgments

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