

BIRDS, BATS AND MINDS

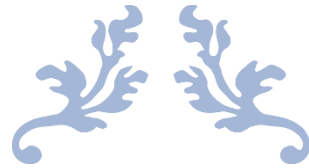
TALES OF A REVOLUTIONARY SCIENTIST

DONALD R. GRIFFIN



BY CAROLYN A. RISTAU

VOL. 2



***Birds, Bats and Minds:
Tales of a
Revolutionary Scientist,
Donald R. Griffin***

VOLUME TWO



Carolyn A. Ristau

Birds, Bats and Minds:

Tales of a Revolutionary Scientist, Donald R. Griffin

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[Previously titled *The Scientist Who Discovered Bat Sonar and the Minds of Animals –*

Donald R. Griffin: A Revolutionary]

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Cover

Front:

Design by Christopher W. Robbins

Top Left: *Elephants bonding* (by Nachiketha Sharma) Asian elephants (*Elephas maximus*)

Top Right: *Flying bat*, (by Nuwat) Adobe Stock File # **136172389** (Greater Short-nosed Fruit Bat, *Cynopterus sphinx*). Like most fruit bats, this species does not echolocate.

Bottom Left: *Migrating Canada Geese* (by Dennis Donohue) Adobe Stock File # 308035291

Bottom Right: *Close-up: Honey bees on a comb* (by Dmytro Smaglov) Adobe Stock File # 50392142

Back:

Carolyn A. Ristau, Churchill, Manitoba. Observation site, 1986. (by Anonymous)

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Don Griffin with a fishing bat at “Lake Slatell, Simla Trinidad” circa 1960. (by Alan D. Grinnell), winter

Fishing bat flying. Photo from Carolyn A. Ristau’s private collection of glass slides. Gift of Donald R. Griffin.

A Phyllostomus h. harem deep inside Tamana Cave. (by Julia Chase-Brand).

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Peter Marler in the field. (by Ingbert Grüttner). From Bardossi, Fulvio and Schwartz, Judith N. (1980). Birdman: [Dr. Peter Marler]. *Rockefeller University Research Profiles*. Book 1.

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Prof. Nottebohm presenting the first lecture in the New York Academy of Sciences series on Neuroscience (2000). (by Lisa Stillman) From Rockefeller University (2000). RU scientists featured at NYAS lecture series. *News and Notes* 2000, 10(18), 1.

Two Humpback Whales Swimming (by Wirestock) From Deposit Photos: 393767272_L.jpg

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The “Seasick Machine,” 1971. (by Ronald P. Larkin)

Jim Gould at Millbrook. (photographer unknown) From The Rockefeller University. (1975). Gould and 6,000 bees confirm a theory. *News and Notes*, 6(4), 3. http://digitalcommons.rockefeller.edu/news_and_notes_1975/7

Heading: A “Shack,” a “Witch,” a “Kytoon” and Puttering (Five Photographs)

Inside the Radar Shack (1977 version) (by Ronald P. Larkin)

“The Witch” (by Ronald P. Larkin)

Don Griffin “puttering,” 1970s. (by Ronald P. Larkin)

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Kytoon ready for launching, 1970s. (by Ronald P. Larkin)

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Jim Simmons, Philip Jen, Don Griffin in Chillagoe, Australia, 1980. (by M. Brock Fenton)

Don Griffin readying Kytoons (kite plus balloon), 1980. (by M. Brock Fenton)

CITATION PERMISSIONS

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Early Days

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Ruth Castle Griffin (1915-1998) (Griffin’s 1st Wife and Mother of Their Children)

[Ruth Castle’s background and early plans to be a biologist; includes the political times, family life and her role as an “inspiring teacher”]

Jocelyn Crane Griffin (1909-1998) (Marine Scientist and Griffin’s 2nd Wife)

[Jocelyn’s career with William Beebe and his research team, Beebe’s accomplishments, Jocelyn’s studies, particularly with fiddler crabs, her successes and trials as Director of the Simla Station, her meeting Griffin and their subsequent marriage and move to New York City, her life as a “role model” for women scientists]

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CHAPTER TWELVE

A TROPICAL PARADISE, A BUCOLIC FIELD STATION, AND EARLY YEARS AT ROCKEFELLER

[This File contains two Parts: Part Three - The “Rock,” The “Witch” and The Field Station and Part Four - The RU Animal Behavior Group: Their Research (Griffin, Marler and Nottebohm labs).]

PART THREE

THE “ROCK,” THE “WITCH” AND THE FIELD STATION

Overview

The chapter begins with “The New Guinea Voyage That Wasn’t,” though the more minimal expedition nevertheless spawns Jared Diamond’s later acclaimed book.

Griffin continues his avian navigation studies via the “Witch,” an Army surplus tracking radar from the Korean War. Griffin was proud of this “shoe-string” budget equipment, with its capacities enhanced by computer programs and various “contraptions.”

The search for an optimal field site for the RU Field Station includes “entertaining” the landed gentry in hopes of donated land. That strategy worked and an area in Millbrook, N. Y. became the station’s home, allowing the RU Animal Behavior group to settle into its new country residence and new research opportunities.

Continuing and Beginning: Griffin’s Studies with Bats and Birds

The Challenge Continues: How Birds Navigate and Bats and *Birds* Echolocate

Much Griffin lab research continued at The Rockefeller University (aka “The Rock”) and field sites. With the aid of “The Witch” (not the one said to inhabit his early Kent Island research site), Don and colleagues were using radar to track avian navigation during migration. “The Witch” was the tracking radar, but much more on “her” and these endeavors later.

Griffin conducted bat studies at Simla, where Jocelyn remained Director, even after her marriage to Don and residence in New York City. Griffin was officially her “boss,” since he was the Director of IRAB, the joint venture between RU and the NY Zoological Society of which Simla was a part (renamed the William Beebe Tropical Research Station). But with severe logistical and financial problems and national sociopolitical difficulties, the NY Zoological Society’s association with the Tropical Research Station was terminated (1971).¹ August 1969 was Griffin’s last research journey to that station. (These matters are discussed more fully in Chapter 14.²)

The New Guinea Voyage That Wasn’t

Late in the summer of 1969, a trip to New Guinea! A splendid opportunity ... or so it seemed. Don and Jocelyn planned to join a team of scientists from the University of California, Los Angeles (UCLA) and other institutions on a four-month expedition aboard the Woods Hole ship R/V Alpha Helix. Griffin would extend his comparative studies of echolocation in bats. These included another species of puzzling fishing bats (*Myotis moluccarum*), known to exist in Asia and possibly New

Guinea as well, and several species of echolocating Asian cave swiftlets (Genus *collocalia*). Jocelyn planned to continue her comparative studies of communication behavior and social systems of fiddler crabs (genus *Uca*).³

Especially intriguing was the fact that not all cave-dwelling swiftlet species penetrated deep into the dark caves; some nest in the dim light nearer the entrance. The best echolocators were the darker-dwelling species. Probably not accidentally, the very best echolocator was the species that had been taken by the thousands over the centuries for birds' nest soup. The preferred soup was made of "white nests," those constructed almost entirely of the bird's spittle, while the "black nests" had more mud and twigs mixed in. Griffin surmised that the preferred "white nest" species had moved further into the caves to escape human predation, developing echolocation to navigate the darker environments. He had, in 1958, already suggested this possibility in "*Listening ...*"⁴, a treasure trove of suggestions for bat research, even to contemporary times. For the Alpha Helix project, he proposed that a comparative study might shed light on the likely evolution of the birds' echolocation over a few thousand generations, driven by human predation.

And most impressive scientific companions for the voyage: From UCLA, George A. Bartholomew, the team head, as well as Jared Diamond and Alan Grinnell.⁵ Grinnell was Don's former student, long-time "bat" colleague and close friend; Alan's many significant research contributions have already been discussed.⁶ George A. Bartholomew ("Bart" to almost all) was a physiological ecologist, but stressed the essential interrelatedness of the natural disciplines, a unified and inclusive view of biology, recognizing the significance of different levels of biological mechanisms and explanations. He is considered to have laid the foundations for the field of evolutionary biology.⁷ Jared Diamond, having begun his career in physiology, was expanding to evolutionary biology and biogeography. It was this trip in 1969, his first to New Guinea, that provoked many more studies over 50 years, and stimulated his Pulitzer Prize-winning book, *Guns, Germs and Steel*.⁸ In Diamond's words, it began when Yali, an indigenous New Guinean had asked him, "Why is it that you white people developed so much cargo [i.e., steel tools and other products of civilization] and brought it to New Guinea, but we black people had little cargo of our own?"⁹ Over 25 years later, in his book of 1997, Diamond examined the development of the world's societies sufficiently to attempt an answer to that question.

It seemed truly ideal, a well-equipped laboratory on board the ship, while situated close to the animals and natural environments under study. And intellectually stimulating, good-spirited companionship as well! But the expedition was a disappointment and frustration scientifically. The ship was extraordinarily expensive, had difficulty filling with sufficient numbers of scientists, and the voyage to New Guinea seems to have been canceled, then reinstated, relatively late, leaving little time for advance preparations. Some of the scientists' equipment either didn't arrive or was late. With limited time available to him and other responsibilities at Rockefeller, Griffin had set up a laboratory onshore, while awaiting the delayed ship. In his view, it would have been foolish to attempt re-establishing his experiments on board. His visits to the ship were few, talking with the scientists setting up their work. He advised future use of the ship only for projects that critically required such a vessel.¹⁰ Given all the funding by the National Science Foundation (NSF) for the expedition, Griffin's appraisal must have been received with some dismay, but Don's honest opinion had been sought and was given.¹¹ And, at that time, Jared Diamond's significant book, to be published decades later, was merely a minor buzzing in Diamond's brain. Considering both Don's

and, especially, Jocelyn's love of the tropics, I cannot but think that this immersion in New Guinea's flora and fauna, whatever the scientific dissatisfactions, must also have held many delights.

Time to Establish a New Field Station with a Home for the "Witch"?¹²

[NOTE: Griffin's writings (italicized and preceded by DRG) are from his unpublished memoirs. Unless otherwise referenced, the excerpts in this section are from a manuscript titled "Millbrook," begun January 2, 2003.]

DRG: *In 1970 it became clear that our symbiosis between The Rockefeller University and the New York Zoological Society was showing signs of strain. Fairfield Osborn had died, and Bill Conway was displaying less enthusiasm for scientific research in comparison with zoo affairs and worldwide conservation efforts.¹³ I and my immediate colleagues, including Larry Eisenberg, Mike Rosetto and Rich Penney had our radar (The Witch) functioning reasonably well.*

[CR: These colleagues were most accomplished persons in their own right. As the Co-Chair, with Dr. Robert Schoenfeld, of the Rockefeller University (RU) Electronics laboratory, Dr. Larry Eisenberg helped many a Rockefeller scientist to develop the particular practical or esoteric instrument/gadget needed for his research. Together, they both gave a fairly advanced electronics course for the students who wished to participate.¹⁴ As noted in the Text Box, Michelangelo (Mike) Rosetto was an engineer with other creative talents as well, and Dr. Richard (Rich) Penny had studied the social behavior of Adélie penguins and had conducted extensive tracking work with them.]

Griffin himself had worked on radar during WW II when he had interrupted his Harvard Junior Fellowship to assist the war efforts scientifically. In short, Griffin and his colleagues seemed exceptionally qualified to deal with the challenges of coping with complicated radar instrumentation and tracking migrating birds.

But back to "The Witch." "She" was an old, surplus 1953 tracking radar from the Korean War, purchased from the army for \$6,000 of Griffin's NSF grant.¹⁵ The "Witch" was so-named for the logo of a witch on a broomstick painted by its previous owners. That witch was sweeping aircraft from the sky, as would be the military purpose of using the radar to spot enemy planes, then destroying them. Possibly, the name "stuck" due to the radar's often unpredictable "witchy" behavior, sometimes working well, sometimes not. With the collaboration of Larry Eisenberg, it was adapted to tracking individual birds ... and, to their surprise, insects. Sometimes, even bats were "captured" by the radar. The Witch did her tracking even at ranges of a few miles. This was accomplished via an enormous conglomeration of vacuum tubes and, in Griffin's view, "elegant" machinery." Such tracking capacity would allow Griffin to test the idea that birds could fly long distances and maintain height above ground at night without visual cues. As we shall see, during the Atlantis II voyages, she also allowed the researchers to determine whether the birds could migrate enormously long distances over oceans without visible ground cues. Ron Larkin created the computer program behind all these calculations.

DRG: *... The "Witch" was by now mounted on a trailer and a second much smaller trailer carried the kytoon and helium tank. [The kytoon in its various manifestations was a balloon and a kite which was sent aloft with various instruments as needed for a particular bird migration tracking experiment.] All was based in a small shed on the IRAB area adjacent to the Bronx Zoo, and a third trailer was necessary to house and transport the specialized gasoline engine powered generator*

needed to supply 115-volt 4 phase power. This had been purchased as war surplus, and was a fine piece of machinery except that it used military parts that were almost impossible to obtain in the commercial market. The curator of reptiles who lived in an apartment adjacent to the buildings we were using as laboratories objected to the esthetics of war surplus radar, generator, trailers and the like, and this was one of several symptoms of a growing feeling that we scientists didn't belong in the zoo culture.

Short Bios of Griffin's Colleagues

Larry Eisenberg

In the 1960's, Dr. Eisenberg and Dr. Alexander Mauro had improved the cardiac pacemaker, creating a battery-operated, transistorized version that also reduced the risk of infection. An accomplished science fiction writer as well, Eisenberg published numerous stories, including a particularly popular "What Happened to Auguste Clarot?" (Eisenberg, 1972). His 13,000 limericks to the New York Times online comments section, earned him a reputation as a "poet-in-residence." More relevant to Griffin's tasks at hand, Larry Eisenberg had served as an Army radar operator (Eisenberg, 2019).

Mike Rosetto

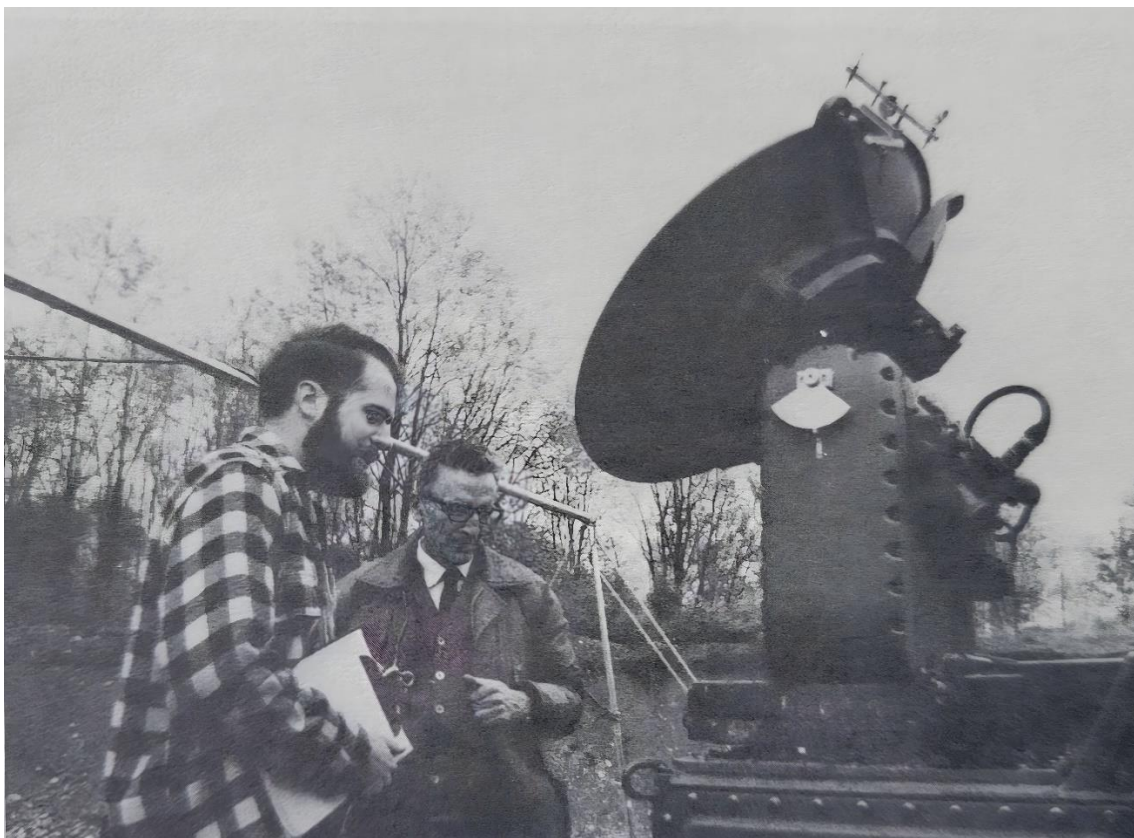
Another engineer, Michelangelo (Mike) Rosetto, was creative in both his electronic work and the arts. He was a photographer, and, like his namesake, also sculpted. Usually, his medium was found tree pieces and other wood. Being quite modest, and overloaded with sculpted wood in his small Manhattan apartment, he took a certain pleasure in placing his wooden sculptures out on the sidewalk. From his unnoticed, upper-floor window, he could watch if someone "rescued" it or if the piece found its demise in the Sanitation Truck pickup. He worked with marble also, traveling to Italy to sculpt the fine marble there. One of his large works was installed in an Italian piazza and another in Red Hook, Brooklyn, New York, where it stayed until a development project apparently led to its disappearance. He managed "The Witch's" radar tracking on a Griffin sea voyage project. Larry Eisenberg had been the radar engineer for the first RU-Woods Hole Atlantis II expedition to Bermuda, while Mike fulfilled that role on the second trip. The "Witch" followed the migrating birds with the engineer repairing the "lady" as needed en route.

Richard (Rich) L. Penney

Dr. Richard Penney provided further tracking experience to the research group. He had tracked a very different sort of bird, Adélie penguins, in Antarctica. Off fishing for themselves and their single offspring, the penguins were displaced from their rookery inland somewhere on the vast snowfields. They must "home" from these natural displacements or those created when Penney dislocated the penguins during his experiments. Typically, the penguins set off in a generally correct direction, with sun position as part of their navigation data, but the mechanisms required further explanation. Deploying a specialized radio transmitter, he had created and attached to a flipper, Penney could track individual Adélie paths. The expeditions were challenging; on one trip, he spent 16 months (1957-58) at the frozen South Pole without mail and with no outside food. But fascinating, of course, as published in his research articles and his charming children's science book, *The Penguins are Coming!* (1969), a tale of Adélie lives in the Antarctic.

At a more conventional academic level, it was also becoming very clear that Fernando Nottebohm was gaining an outstanding reputation for his research on the [neuro]physiology of song control in songbirds, and as an assistant professor was sure to be sought by other universities. [Nottebohm and his research are discussed later in this chapter.¹⁶] I also knew that he and Marta were dissatisfied with their living arrangements in an apartment on City Island. After all, they came from Argentina and grew up riding their horses over enormous estates. I tried to emphasize that Rockefeller faculty often lived in pleasant suburbs, and that Fernando's prospects were excellent.

But they complained that there was nothing but asphalt jungle for hundreds of miles in all directions. It was clearly important to convince them that they could find a pleasant place to live within commuting distance of Manhattan.



Don Griffin with Ron Larkin and the “Witch” at Millbrook (RUCFR), 1974

(From RU, Winter 1985/1986, p. 4)

(Additional photos of the “Witch” and the Radar “Shack” may be found in Chapter 12, Part 5¹⁷)

Searching for a Research Site in Millbrook, New York ... Alas, Too Many Trees

At this time, I was actively seeking better locations to use the Witch. Its range for tracking single birds was somewhat less than we had hoped, and to extend its reach I was trying to find hilltops where it could be operated effectively. I had heard that the Audubon Society had some sort of a sanctuary in Millbrook, New York, a few miles east of Poughkeepsie where there was a hill with a roadway to the top. So, I arranged a drive with the Nottebohms with two objectives, first to show them that there was nice country within driving distance and second to look at what I thought of as an

Audubon hilltop. On a pleasant late spring or early summer day, we drove north on the Taconic and other parkways, with a side trip to Bear Mountain Park, carefully avoiding all cities. I found in Millbrook that the Audubon Society was only overseeing the estate of the late Mrs. Cary, although they hoped that they might be allowed to establish it as an Audubon sanctuary. Canoe Hill turned out to be suitable for our radar except for one fatal flaw. The road to its top ended in a dense woodland, and to operate our radar we would need to clear a few acres of mature trees. Since Mrs. Cary had been intensely interested in her trees, this was obviously out of the question. So, we drove back to New York, I again choosing the most scenic roads, and I thought this had been merely a minor effort to acquaint my esteemed colleagues with the attractive parts of Westchester, Putnam and Dutchess counties while inspecting a possible radar site.

A very few days later, sitting in my office overlooking the East River I received a phone call from Frank Stubbs, who explained that he was one of the four trustees of the Mary Flagler Cary Trust and was distressed that he had not known of my recent visit to the Cary lands in Millbrook. Wouldn't I like to come back and let him show me around? I explained that my interest had been in the possibility of bringing our mobile radar to Canoe Hill, but that it had turned out to be unsuitable, because the radar needed an unobstructed view in all directions, and that I would not think of cutting the beautiful trees. He persisted, however, mentioning, I think in this first conversation, that they also owned another hill that might be suitable. This was all a pleasant surprise, but at his next sentence, I almost dropped the phone. Wouldn't Rockefeller University like to have a field station in Millbrook?

Of course, I said that was an interesting possibility, and asked how could we look into it further. This was the beginning of a long series of visits and meetings in Millbrook in which I explored the possibilities. Peter Marler was away, in Norway studying a particular species of songbird that was of special interest to him. I immediately informed the president's office of this development, and Vice-President Rodney Nichols took a special interest and immediately had his staff look up the Mary Flagler Cary Trust, which turned out to own about two square miles of farmland and woods in Millbrook and also have an endowment on the order of \$50 million. As I recall, writing this in 2003, I had learned this before my next trip to Millbrook to meet Frank Stubbs and begin to explore the possibilities. Frank was enthusiastic about our program of research in animal behavior, and it turned out that he had been acquainted with some of the medical research at Rockefeller many years earlier, I think in the 1920s. I cannot now recall the exact sequence of our early meetings, but Frank's good friend Kent Leavitt was an active participant from the start. Because my initial interest had been in Canoe Hill as a radar site, they told me about another tract of hilly land several miles east of Millbrook also owned by the Cary Trust which they thought might be suitable. It was not exactly what I was seeking, not quite a hilltop, but a high steep series of pastures up which cars could be driven, at least under favorable conditions. So, partly to encourage the idea of a Rockefeller Millbrook Field station, we did use the radar, generator, kytoon and all on that hill in the fall of 1970.

The Urges to Expand and to Restrain

The Rockefeller administration "smelled blood." Fred Seitz had just taken over the presidency from Det Bronk, and I think for the first time Rockefeller was looking for outside support, rather than relying entirely on their own endowment, as I believe was the case when Bronk was expanding the Rockefeller Institute into what he hoped would become a graduate university in the sciences. Marler and I, together with the behavioral scientists recruited by Carl Pfaffman were the final wave of that

expansion. So, an ambitious proposal was generated, contemplating a major center for research in ecology (which was what we wanted) and also ecology thrown in (which was not exactly what we would have said if the matter was left entirely to our inclination). [CR: Griffin presumably meant to write 'center for research in ethology,' the natural behavior of animals in their environments as his and Marler's inclination, in contrast to "ecology," or "environmental biology" which includes animals' interactions with their environments, but lays more emphasis on the physical environment.] Rockefeller was ready to tell the Cary Trustees what good use we could make of much if not all of their two square miles of Dutchess county and a significant portion of their endowment.

Of course, they received other proposals, and one was from the New York Botanical Garden. The upshot was a series of meetings and discussions in which Frank and Kent were our enthusiastic advocates. Kent had no official role, but he was a well-established gentleman farmer in Millbrook, a minor baronet perhaps, since his farm had only 400 acres, but one whose opinion was clearly given some weight. Kent literally took me in tow, and on many visits to Millbrook he drove me around pointing out numerous large estates whose owners he said came to them only a few weeks out of the year, and "Maybe we could get them given to Rockefeller." Kent's enthusiasm was obviously not shared by all these landed gentry, and I doubt that he even mentioned these wild possibilities to any of them. I remember Kent saying on one of these excursions, "Kent, you have to do something, or the next thing you know you will wake up some morning and see a whole bunch of little houses on these hills." One of the estates Kent showed me was the large farm owned by Jimmy Cagney, and I was introduced to him on our brief tour of inspection. The other estate that was especially impressive was that of Chauncey Stillman. It was on a fine hilltop with huge brick stables in the valley which housed, Kent told me, a fine collection of carriages that were kept in perfect condition because Chauncey admired them. It was winter and Chauncey was away, perhaps in Florida, and Kent secured permission to drive us up the hill and around the main brick edifice. Construction was obviously underway, and Kent muttered with annoyance something approximating "Damn it, Chauncey has fallen into the clutches of the Catholic Church. He's having Italian masons build a chapel as a wing on his grandfather's house, and I'm afraid we'll never get him interested." I will come back to Chauncey Stillman and his house later. [CR: Such writing was not found.]

Unfortunately for us, the other three trustees did not share Frank's and Kent's enthusiasm for a research station devoted to the study of animal behavior. Several meetings ensued, including fine dinners, some at the Cottonwood, a local inn, in which the four Cary trustees and numerous other members of the Millbrook gentry all discussed the various possibilities for use of the Cary estate...

[CR: The process of "courting" the potential donors also involved the "brilliant" RU grad students. As Jim Gould, then a Griffin graduate student, describes it, the wealthy landowners had to be convinced that the students were not just "a bunch of pot-smoking hippies," which the gentry seemed to assume. The Goulds were recruited to the effort, for they were the "only presentable graduate students." He was clean-shaven with a "proper" haircut, not that generation's East or West coast '60s-'70s look; Carol wore "proper" length skirts. "Maybe, because we both came from Oklahoma, we knew how to dress." The students learned from the encounters as well; it was at a dinner in Kent Levitt's home that Jim had his first quiche.^{18]}

[CR: Presumably at yet another dinner, likely "schmoozing" the same or possibly a different land-holding potential "donor," several grad students were in attendance, notwithstanding whatever hair or beard length they sported. José Torre Bueno, another Griffin grad student, and his

wife, Susi, recalled a formal dinner invitation to a home. The table was laid with silver service and a maid served the meal. Not a fancy meal, as José recalls, possibly even hash. Someone asked for ketchup. The would-be “donor’s” wife rang a small bell; the maid reappeared and at least 15 minutes later, the maid brought a silver tray with a dollop of ketchup on it. Neither José nor Susi had ever been at such a dinner. José vaguely recalled that this potential “donor” passed away and never left any funds for Rockefeller University.¹⁹ Kent Levitt (possibly the same individual) signed his property over to a conservation trust, ensuring that the land would never be developed.]

DRG: *I learned from [all]these meetings that Mrs. Cary had been enthusiastically devoted to trees. For example, she had ancient and decaying white pines wired together when their time had clearly passed. Thus, it was just as well I had never mentioned the possibility of clearing the top of Canoe Hill for our radar. When we studied the wording of her will setting up the Cary Trust, it was clear that our aspirations could be fitted into the area of endeavor specified for the Trust, but only barely so. The Botanical Garden, however, came much closer to what she evidently had in mind, and it is not surprising that their proposal prevailed and led to establishing the Cary Arboretum.*

The Consolation Prize: Innisfree

Yet our efforts were far from being in vain. We were offered and gladly accepted a generous consolation prize. The Cary Trust purchased, from a near bankrupt trust for the Innisfree Gardens, most of their land, and the service buildings of a fine estate that had been built in the 1930s. After the couple who had built it and surrounded the main house by a Japanese garden at the north end of Innisfree Lake, the mansion had stood unoccupied for about 40 years.

[CR: The couple who had the house built were Walter Beck, a painter, and his wife Marion. As the daughter of a 19th-century iron baron, Wellington R. Burt, Marion’s family money permitted the acquisition of the bucolic countryside and its continued landscaping into the inviting Innisfree Gardens. Modeled after meandering Chinese gardens, they were the conception of the landscape designer Lester Collins and Walter Beck, whose own paintings were said to “reflect Asian design principles.” To Collins, the gardens were his life’s “Masterpiece.” “Steeped in Chinese and Japanese gardens,” Collins bulldozed and molded the land into little hills and a lake, carved a stream, and created a waterfall controlled by an electric switch. Giant boulders, carved by nature, were settled into the meadows, affording places to pause and reflect. Truly a beautiful and serene creation.²⁰]

DRG: *The endowment for the Innisfree Foundation had unfortunately been invested in stock based on the Masabairon mines. When these were exhausted during WWII, there was little or no income.* [CR: These mines, aka Mesabi, Mesaba, and Missabe, are in the range of iron ore in northern Minnesota, known to local Ojibwe Indians as Misaabewajiw (“Giant Mountain”). Within that range is the world’s largest open-pit mine, in Hibbing, still functioning. Finally, the easily processed high-grade ore gave way to a lower grade, requiring extensive processing, and hence the decline of many mines.²¹]

DRG: *But the sale to the Cary Trust of the 900 acres of hilly land provided enough so that the gardens could be maintained, under the management of Lester Collins, an architect from Washington DC who had a small house on one corner of the lake, where he and his family summered for many years.* [CR: Collins had worked at Innisfree for almost 40 years, devotedly continuing to landscape and maintain the magnificent property.]

DRG: *At one point during the negotiations Peter, Fernando and I looked over the mansion with the thought of converting it to a Field station. Very little had been changed or removed since the death of the original owners, and the tour was a combination of poignant admiration for their ambitious creation and realization that to use it for a research station would require modifications more costly than building something from scratch. But it had a marvelous view over the lawns stretching down to the lake, and I suspect that Peter imagined himself presiding in an office in the former master bedroom with a view of the lake. When we inspected the heating system with a local plumber and his assistant, it turned out that there were three separate furnaces supplying different parts of the building, but none had been in use for forty years. The plumber said to his colleague “Joe, what do you think would happen if we tried to turn this thing on?”*

The end result was that the Cary Trust gave us the 800 acres²² and the service buildings, and later supported the Rockefeller University Center for Research in Ethology and Ecology (abbreviated RUCFR) quite generously for several years – even providing funds to purchase a considerable amount of adjacent land. The main service building had been designed as housing for a number of servants and grounds workers, so that the rooms were small, but it was not too difficult to adapt them for laboratories to study birdsong, including soundproof chambers to study the effects of raising young songbirds in various acoustical environments. In later years, Marler and Nottebohm obtained funds, partly from the Cary Trust and partly from Rockefeller, to build additional small buildings. There was a sizeable barn which I spoke for, and adapted in various down-to-earth ways to house our radar and related gadgetry. A hot air heating system was installed, and a good workshop set up. The latter suffered the usual fate of communal shop facilities, and although I tried to keep it shipshape, I was not there enough to prevail in all respects. [CR: These few sentences reveal again Griffin’s modest and most practical sensibilities; functionality is prime, aesthetics is secondary and considerations of luxury are simply absent. Jocelyn, his second wife, did minister to the aesthetic aspects of their living spaces. And of the many words in the English language to indicate order, ‘tis rather amusing and in accordance with Don’s lifelong nautical interests that his concerns were for a “shipshape” workshop.]

Let the Wind Tunnel Blow

One of my research dreams on establishing the Rockefeller/NYZS symbiosis (which we called the Institute for Research in Animal Behavior, abbreviated IRAB) was to set up a wind tunnel designed for bats and small birds in the hope of studying their behavior in reasonably normal flight. This was only partly successful in its early stages, initially on the 6th floor of Smith Hall [at Rockefeller University in Manhattan] and later in the modified building we used adjacent to the Bronx Zoo when that became available. I will describe its features and potential elsewhere (THIS MEANS A SECTION ON WIND TUNNEL)][CR- I have not found such writings] but its final use was in the thesis research of José Torre-Bueno on the upper floor of the barn at RUCFR. He induced starlings to fly continuously for a few hours, long enough to measure body temperatures at a range of air temperatures generated by connecting the hot air ducts from the barn’s furnace for high temperatures and opening the hayloft door in winter for the low end of the temperature range. He later worked with Vance Tucker at Duke and there modified one of Tucker’s wind tunnels into a respirometer with which he could measure oxygen consumption. This led to the surprising discovery that, unlike budgerigars which Tucker had studied, starlings could fly at a wide range of air speeds with only minimal changes in metabolic rate.

Apparently, they modify their wing shape to attain efficient flight over a considerable range of flight speeds. This general conclusion has been confirmed with other species in recent years. While our wind tunnel could not suffice for such measurements, Torre-Bueno's work can reasonably be said to have started in the RUCFR barn. [The RUCFR Wind Tunnel and José's work are further discussed in this chapter.]

Adapting to Country Living – The Marlers, Nottebohms and Griffins

Back to the general story of the Millbrook Field station. Both the Marlers and the Nottebohms moved to Dutchess county. Marta joined the Millbrook Hunt, and my basic objective of that summer excursion was abundantly attained. Peter moved most of his work there, but Fernando kept an active technical lab on the Rockefeller campus. Jocelyn and I did not want to move to Millbrook, so we used various motels for stays of a few days at a time, while I continued working on radar observations with the Witch. (NEED A WHOLE SECTION ON THE WITCH). [CR: I have not found such writing.] The La Grange motel, a bit south just off the Taconic Parkway was the one we used most, and Jocelyn would read and work on her books while I used the radar. We found that it worked best in a gravel pit on the Field station property created by road building, as the walls reduced the ground clutter, and after about 1972, most of our radar work was there

[CR: Expanding a bit about Griffin's successful cajoling of faculty to move to the Millbrook area: Nottebohm's wife, Marta, was quite the envy of every male faculty or grad student. She was a striking, tall, dark-haired Argentinian beauty, with flair and grace ... and even a certain regal demeanor. In joining the Millbrook Hunt, Marta was becoming a member of "one of the premier equestrian organizations in North America," according to the Millbrook Hunt's website description.²³ Founded in the 1890s, its mission was to "support and enhance the character and atmosphere of our area" ... maintaining the traditions of "our region." Whatever quite all that means is unclear, but they did seek to limit development in the countryside. There was probably no concern about excluding people of color or even Jews, because, at that time, such folk were a rarity in the area. Besides "hound and puppy" shows, the Hunt also maintained riding trails and sponsored "equestrian-related events," such as competitive obstacle trials and speed races over woodland trails. The quintessential "fox hunt with dogs" was not mentioned on the 2018 website, but the "sport" remains legal in New York state, even in 2020, although it is banned in its archetypical home of England.²⁴

The Marlers and their children settled into a very traditional and beautiful Colonial-style home in the midst of a small forest of trees. Seeming to adapt quickly to country living, the family grew flowers and vegetables and even established a bee colony. Occasionally, they held large parties for all the Field station students, postdocs and faculty, typically including the families as well. Judith, Peter's wife, would serve her excellent cooking, enhanced by enticing offerings from their garden and those brought by the guests (i.e., usually the wives). At Christmas time, the Marlers held a particularly special gathering, including a visit from Santa Claus, who presented gifts to each child. Although extra padding and pillows helped produce the friendly, plump figure, it helped to start with a strapping physique; this was often Robert (Bob) Dooling (RU:1977-81). (He was then a Marler post-doc, later becoming an RU Assistant Professor. When not playing Santa, over the years, he studied comparative psychoacoustics and acoustic communication and established his career as a prolific and genial faculty member at the University of Maryland.)

The Decline of a Finishing School

DRG: *Some time later, too late unfortunately for us to benefit, a “condo” was added to the Field station, with several rooms and a commons area for students and others who did not reside in the Millbrook area. There was also an intermediate housing arrangement, the infirmary of Bennett College. Bennett had been a girls’ finishing school, but by 1972, when we moved from the quarters adjacent to the Bronx Zoo to the Field station in Millbrook, it had become a two-year college. The campus was adjacent to the village of Millbrook. And its original building named “Halcyon Hall” was a large Victorian era wooden college building with gables and even, as I recall, some gingerbread. But the college had added several modern buildings, including a science building named for the physicist Kettering and several dormitories and other classroom buildings. Even before we moved in, I received a phone call from a lady who explained that she “was the math department, but they’ve cut me back to half time. And might there be any job opening for her at the new Rockefeller station?”*

From there on the college declined further. I remember looking at its catalog to see what our new neighbor was like. The English Department listed two courses with approximately these titles: “English literature from Beowulf to Thomas Wolf” and “Witchcraft.” But there were a couple of pages describing studies in “Equestrian Science.” By the late ‘70s, the college closed its doors and the buildings were empty. We learned that in its state of bankruptcy, they would be glad to rent us the infirmary for \$300 per month including utilities. On inspection, we found 20 or 30 rooms with hospital beds, two kitchenettes and a large sitting room. There was a complete set of china and utensils, including a cabinet full of egg cups. A great bargain, it provided more than enough living space for a handful of students, postdocs and the Griffins who worked at the Field stations on a part-time basis. Jocelyn organized a small apartment around one of the two kitchens, and it was a real improvement over the LaGrange motel.

After a year or two, the bankruptcy progressed and we were asked to take over the fuel and electricity bills. Since the usage was quite light, we were annoyed that the electric bills ran \$300-350 per month – more than the rent – although nothing was operated in the infirmary building but two refrigerators and a few lights when anyone was there. As principal user of the building, I investigated what could be draining so much power and found four half-underground storage sheds, each containing lawnmowers and related equipment plus a 1500watt electric heater which someone had decided would keep the shed dry and slow the rusting of the equipment. With these unplugged, the bills dropped to a reasonable level.

After we moved in, Kent Leavitt continued to be an active observer of our activities and helped in several ways. He found a neighboring farmer who owned Coon Hill and was willing to let us move the radar there for at least one season, the spring of 1971. This hill was devoted entirely to pastures for his milk cattle, and in good weather we could drive to a fine open hilltop. We had a V-8 carryall belonging to the NYZS which could haul the heavy radar trailer and other mobile facilities, so that from April to early June we had a sort of temporary radar installation on Coon Hill. It had almost no trees so that a clear view was open in almost all directions, and the extensive pastures provided space for activities such as kite flying and handling the kytoons or kite balloons to carry aloft known radar targets so that we could tell what the capabilities of our radar actually were. Kent once brought his wife to visit this set-up, which she dubbed “Kickapoo Hollow.” Kent also brought into our lives his friend Alethea Michie who lived in a village adjacent to Millbrook, and who became an effective all-

around assistant for our radar studies and for the general business operation of the Field station in its early years. In the section on the Witch, I will describe how she and Kent participated in a cruise with the Witch on the Woods Hole Oceanographic Institution's Atlantis II on which we tracked migrants over the western North Atlantic during the fall migration of 1971. [CR: Ms. was not found, probably not written.]

At the Millbrook Field Station²⁵

Happily, Flying Squirrels, Bats in the Roof and Brock Fenton

*The Innisfree mansion turned out to have a colony of flying squirrels as well as bats. The roofs of both the main house and the service building which became headquarters of RUCFR had slate shingles, which are an expensive but very durable type of roofing. But after 40 years they provided many inviting crevices into which *Myotis lucifugus* [Little Brown Bat] could settle. I'm not sure just what sort of crevice the flying squirrels occupied, but we sometimes watched them emerge in the evening from near the top of the gable roof and glide across the lawn south of the building towards the lake. ("Lake" by the way is a term whose application varies with location, primarily the abundance of bodies of fresh water. The Millbrook area had relatively few and the Innisfree "lake" was simply a dammed-up brook, not more than a couple of hundred meters long north-south and less than a hundred meters east-west at its northern end. On Cape Cod it would have been a small pond.)* [CR: We may note Griffin's attention to the rather technical details of size and orientation, while he does not enthusiastically extoll the beauty of the Innisfree Gardens.]

DRG: *When Brock Fenton spent part of a sabbatical leave at Millbrook [1976], he discovered that the local *Eptesicus fuscus* [Big Brown Bat] used one corner of the house as a night roost.* [CR: Brock Fenton was a well-known bat researcher, particularly interested not only in echolocation but in bats' foraging techniques and the evolution of echolocating. His students' interests involved him in fairly diverse efforts, including the study of snakes. (It is heartening to note his flexibility and generosity in adapting some of his own work to the interests of his students; many scientists are instead quite adamant that students who wish to be associated with them continue on one of the professor's chosen projects.) During Fenton's RU sabbatical, as one of his endeavors, he explored the calls of various bat species, recording their vocalizing and playing the sounds back to the bats, documenting their responses.]

DRG: *He [Fenton] had an early model of a night vision scope with which we watched them [the Big Brown Bats]. This part of the house had outdoor walls and arches, so the bats could find sheltered roosting areas without entering the house itself or crevices in its walls or trim as they often do in wooden buildings. We watched the *M. lucifugus* [Little Brown Bats] from the main house rather seldom, because we had a splendid nursery colony under the slate shingles of the main lab building (former servants' quarters). Unlike almost every other nursery colony I have studied, they emerged from dozens of crevices under the slate shingles, so that catching them in any numbers was very difficult. A few did roost in openings in the wooden trim at one end of the building, and these were studied by Ed Buchler, as I will describe below. (PROMISE)*

Bat Predictions?

Bats were quite abundant around the Field station, and I often watched active insect catching over the small ponds on the RUCFR property as well as by the Innisfree "lake." I was not concentrating on insect catching, but could often hear feeding buzzes as they fed close to the water surface. One aspect of insect hunting did strike me, however. This was the concentrations of insect catching bats at certain spots on some nights but not others. Having watched a dozen lucifugus feeding in a small area on one night and preparing to record them on the next night, I was often disappointed when almost none appeared. I suspected that they had some way of predicting whether hunting would be good at a particular spot, because on one of these disappointing nights they did not arrive at all. It did not look as though they had come, found few insects and then left. I never followed up on this casual observation, but wondered whether particular local conditions were well enough correlated with insect abundance at various feeding areas that the bats had learned where it was best to fly. One of many "opportunities" for future investigations. [CR: And yet another example of Griffin's being ever alert to possible correlations and patterns occurring in nature and in an animal's behavior as potentially influenced by environmental factors or inter-species behavior.]

A Post-Doc: Edward R. Buchler

*Ed Buchler had been a graduate student at the U of Montana with Don Jenni, and his thesis work had been on evidence that shrews (*Blarina*) used a simple form of echolocation.²⁶ He came to work with me as a postdoc or perhaps research assistant for a couple of years,²⁷ living in Millbrook with his wife and children and spending most of his time at RUCFR. I probably hoped that he would extend and improve his experiments, because the evidence was not entirely conclusive.²⁸ But he became interested in the lucifugus colony and added significantly to our knowledge of the ontogeny of echolocation and the selectivity of insect capture. He obtained an assistant professorship at U of Maryland but did not get tenure and went into some kind of business in the Washington, D. C. area.*

Among Ed's accomplishments was the use of Cyalume to track the flight and other movements of bats. Cyalume glowed and was thus visible in the dark. Ed blew little glass balls from glass tubing,²⁹ then filled them with Cyalume immediately before use in the field and attached these to the bats.³⁰ By varying the component ratios, Ed could adjust the brightness and duration of the lights, producing a product that lasted 2 to 3 hours.³¹ Importantly, other researchers, some modifying the original creations, also later used them in their own research. Patricia Brown, for example, part of the group including Griffin and other scientists to Chillagoe, Australia, used Cyalume containers to track the foraging activities of bats.³² Putting the Cyalume inside gel capsules instead of glass was one of the improvements; a broken capsule would not be as troublesome as broken glass.³³

Ed's specific interest was the ontogeny of flight, foraging and echolocation abilities. Capturing young bats (*Myotis lucifugus*) when they were just about to fly out for their first explorations outside the nursery colony at Millbrook, he attached the Cyalume balls and monitored their flight insofar as possible. He did the same with somewhat older juveniles and adults from the colony. Occasionally, Ron Larkin, when up at the Field Station, volunteered to assist Ed. "Like moving, twinkling stars," Ron said, delightedly recalling the light-tagged bats. The "stars," blinking from the motions of the bat's wings, were hidden sometimes behind trees and then finally disappeared into the distance.³⁴

Ed found that the young bats, at only 19-20 days, without the opportunity to practice flight in their roosting area, would emerge after the adults, but only for very brief flights, only a few tens of seconds or less. They flew slowly, near the roost, avoiding other bats and acoustically complex environments. Neither did they pursue insects, but made frequent, awkward landings. Within about 3 ½ weeks or so, they were already making continual flights and hunting insects. Their echolocation improved even more rapidly and markedly, so, at about a week old, all the parameters of their echolocation calls were similar to adults'.³⁵ Decades later, "higher-tech" research by Yossi Yovel and others has confirmed these findings and added significantly to the developmental details.³⁶

Ed also discovered that the little brown bats were identifying and then carefully *choosing* which preferred prey to hunt. All this by echolocation.³⁷ The bats also established scent posts, as dogs and many other mammals do.³⁸ These various studies were part of the work to which Griffin was referring.

The quoted writings by Don are the only unpublished Griffin memoirs that apparently exist about the times at Millbrook and Rockefeller University. Much, however, can be reconstructed from his letters held in the Rockefeller University Archives³⁹ and from recollections by those who knew him.

Millbrook Becomes a "Ferment of Activity"⁴⁰

The First Junior Faculty in the Animal Behavior Group

Recall that with the opportunity to add two junior faculty members Griffin chose, (and convinced to come) Roger S. Payne (RU:1966-71) and Richard (Rich) L. Penney (RU:1966-69). Roger initially continued his work with the barn owl's (*Tyto alba pratincole*) acoustic location of prey and then turned to studies of whale songs (*Megaptera novaeangliae*). (Roger and Katy Payne's work is described later in this chapter.) Rich Penny was known for his research with Adélie Penguins (*Pygoscelis adeliae*). (His work was discussed earlier in this chapter.⁴¹) Peter Marler persuaded Thomas Struhsaker to leave the Ugandan forest (for a while) to join the faculty (RU:1966-72) and Tom remained affiliated through the early 1980s. Tom's primary "residence," however, continued to be the jungles of Africa, where he continued his primate fieldwork. Peter's interests in birdsong development were furthered with the addition of Fernando Nottebohm (RU:1966-2016) as the second junior faculty. Fernando made field trips to Trinidad in 1968 and then largely "stayed put" in Manhattan at the RU campus and at the Millbrook Field station. Over time, Fernando moved from Assistant Professor to Associate, then Full and head of his own lab, continuing to maintain facilities at both locations. (See discussion of his career later in this chapter.) All the junior faculty mentioned, as well as Griffin and Marler, had been hired in "pre-Millbrook" days.

The Directorship of the Field Station ... Cooperation and Conflict

To review: An Institute for Research in Animal Behavior (IRAB) had been the brainchild of President Bronk, who recruited Donald Griffin (1965) to establish and organize it, becoming the director. Marler accepted an invitation to join RU (1966) and the new IRAB being formed and became co-Director with Griffin and the sole director of IRAB in 1969. With the disbanding of IRAB (1971) and acquisition of the Millbrook, New York property, the Rockefeller University Center for

Field Research (RUCFR or FRC) was established (1972). In a memoir (1985), Peter's commented that, as director, Griffin was "generous to a degree" in the administrative help provided. Marler did also note that "Above all, his [Griffin's] scientific stimulation and advice, although never forced on anyone, was always wise and creative."⁴²

Initially, Griffin seems to have been the Director of RUCFR. After Griffin stepped away, Marler assumed the position of RUCFR Director. Both seemed pleased with this arrangement. Marler had the status and control, but also the administrative hassles, and Griffin had more opportunity to do his own research.⁴³ Griffin had established a culture of "independent" research at the station and in his lab. One was free to choose a topic within the lab's broad, general area and then was free to pursue one's interest. Griffin offered supportive advice. For a while, Marler maintained a somewhat similar policy. But Marler was driven to create an empire at the Field station, his empire, and he did, successfully expanding his lab's areas of investigation and promoting many scientific advances. He also promoted the careers of many of his postdocs and students, as they will attest.⁴⁴

As is typical of Don, he did not make any public statement about Marler's administration. An October 1980 letter⁴⁵ from Fernando Nottebohm to Griffin (on fieldwork in Chillagoe, Australia) expressed Fernando's concerns about Marler and the tensions between them. Presumably, Griffin was considered a sympathetic recipient. Nottebohm simply stated, "... things with Peter had come to a head." Peter had told Fernando that Fernando had not been "generous enough in sharing with him my research." Ostensibly, Peter thought he should have been included as a participant in much of Nottebohm's research plans and work. In Fernando's view "I imagine he could not bring himself to accept that the FRC [Millbrook Field Research Center or RUCFR] was not just his own lab." Fernando expressed regret about this "sad and confusing and most difficult period in my relations with a man who otherwise has been to me exceedingly kind, helpful and supportive." Nottebohm notes that Peter "for whatever reasons" had been "under enormous emotional stress" during the past two years. I do not know the reasons, but I do know that both men had suffered from very difficult situations involving their children, Fernando's at a later time when his son died in an accident. The letter mentions that Marler no longer wanted to be RUCFR Director and that Marler had discussed this with both Griffin and RU admin the previous spring.

One can imagine some of Marler's misgivings. Nottebohm had been his student; Peter had brought him to RU. Fernando's visions of his research domain were very expansive, as shall be discussed. Marler's and Nottebohm's actual research activities were beginning to overlap more and more. Both were becoming increasingly concerned with the physiological basis of avian communication, including hormonal impacts and neurological underpinnings. Since Nottebohm's work had been more physiological from the onset, this shift was largely Marler's. I would surmise that Peter was responding to two issues: 1) the plausible "next steps" in understanding the basis of the phenomenon of birdsong and 2) the potentially more significant interest and funding for physiological rather than behavioral studies. Marler, did, however, remain a strong advocate of the need for behavioral research; he adamantly stated exactly that in his autobiographical memoir of 1985.⁴⁶ The results of their changing and expanding interests caused them to become, in effect, competitors on the same turf, rather than partners.

As Jack Bradbury remarks about the situation, "... it is always tricky in our field to have a student work on the lab head's project. It always leads to conflict down the road. Fernando was so

good at what he did and so insightful, that Peter must've been jealous." In many institutions, including Rockefeller, the lab "head" usually became an author of the papers produced "under" him, whatever his contribution or lack of such to the enterprise. (There are notable exceptions, Griffin being one who did not do this.) Marler was "head" of the Field Station, though Nottebohm, while working at the Field Station, was likewise head of his own lab. Jack further notes a perception shared by others: Fernando's personality seemed to change from a "more easy-going nature" to considerably more authoritarian. Both Peter Marler and Fernando Nottebohm were highly ambitious persons.⁴⁷ Conflict was inevitable.

In 1981, Nottebohm assumed the RUCFR directorship; Marler left RU in 1989. Nottebohm continued as Director until 2016. Upon leaving Rockefeller, Marler returned to California, this time to U. C. Davis, finally retiring from there in 1994.⁴⁸ He passed away in 2014. Nottebohm retains a position currently (2022) as an Emeritus Professor at RU, having retired around 2016.

PART FOUR

THE RU ANIMAL BEHAVIOR GROUP: THEIR RESEARCH (Griffin, Marler and Nottebohm Labs)

Overview – Part Four

Most of the Griffin lab's work is described in Part 5 and subsequent chapters but he and his team were a part of the "ferment of activity" characterized by the research endeavors of the RU Animal Behavior Group labs at the Field Station:

- Peter Marler's group (bird song and primate communication/social structure), including Jack Bradbury's sociobiological approach, John Wingfield's establishing a new field of etho-endocrinology," which examined the interaction of avian hormonal systems and social behavior, including song.)
- Fernando Nottebohm's lab (neurophysiology of bird song. They make the astonishing discovery of avian seasonal neurogenesis.)
- Donald Griffin's lab/associates
 - Roger and Katherine Payne (cetacean studies, particularly whale songs)
 - Katherine Payne's later studies of elephants' infrasonic communication

Lab Members

I refer the reader to the various editions of the *Rockefeller University Annual Reports* (1966-1989) and the *Rockefeller University Scientific and Educational Programs* (to 1991) for brief summaries of the lab members' research and citations of their publications. Since Nottebohm remained at RU after both Griffin and Marler left, later volumes primarily reference his subsequent lab research. Other descriptions of the Animal Behavior Group's research may be found in the previously mentioned memoirs of Donald Griffin,^{49,50} one by Marler⁵¹ and one by Nottebohm.⁵² Several books written or edited by each of the three men also include the work of their lab members and other distinguished colleagues in their respective fields of interest.^{53,54,55,56,57} For descriptions of Peter Marler, the man and the scientist, I strongly refer the reader to several obituaries, in particular, that written by Gregory F. Ball and Robert J. Dooling,⁵⁸ who both had initially been postdocs with Peter at RU. Likewise, there are numerous obituaries and memorials of Donald Griffin, which have been referenced earlier in this book.

Lists of the RU Animal Behavior Laboratory members are compiled in the Appendix in Volume Three titled, "Members of The Rockefeller University Animal Behavior Group (Griffin, Marler & Nottebohm Labs)." More detailed information about Griffin's Lab members are contained in other Appendices in Volume Three.

Everyday Life at Millbrook Field Station

Daily life at the Field station included bi-weekly, sometimes more frequent, research talks by an invited speaker or someone at RUCFR.

Jack Bradbury recalls Griffin's attendance at some of these. Don was "infamous for appearing to fall asleep" during those seminars. "His head would tip down and he would appear to be completely asleep. However, as the talk came to an end, he would perk up. Then, during the question and answer period, he would ask the most penetrating question of anybody, clearly on

material that had been covered partway through the talk. I know other people noticed this as we often shook our heads in amazement afterwards." I, too, noticed this, even in the large audiences attending lectures in Caspary Hall Auditorium on the Manhattan campus, feeling embarrassed for him, but only until the discussion time, when he again demonstrated his perspicacity.⁵⁹

During Marler's directorship at Millbrook, the jousting with the speaker was very vigorous; the lecturer had better be well-prepared and highly articulate. These interactions were typically led by one of the young, male, "rising" grad students or postdocs. A few achieved the status of Marler's "golden boy;" there was never a "golden girl." But likewise, there were extremely few female grad students or postdocs in the Marler lab, though young women comprised all or almost all lab assistants, undertaking the challenging tasks of hand-raising the songbird chicks for research. One Assistant, Susan Peters, who worked with Marler for eight years, studying birdsong development, did become an author of a few publications with him and others in the group.⁶⁰

There was also "play-time" ... a little. After everyone's sandwich or other home-brought lunch, and the "requisite ... talking about science," an outdoor volleyball game, weather permitting. Once or twice, Marler joined in, but the games did seem, at least to Marler, too long; time to return to research work. The adjacent, extensive gardens of Innisfree were exquisite and peaceful, as described earlier. But seldom did anyone indulge in a lunchtime stroll; that would seem a "guilty pleasure." Those who didn't play in the volleyball game simply ate lunch, joined the ongoing science discussions, and went back to work.

But there were parties. Some were held among the junior faculty, postdocs, and grad students. Sometimes, there were dinner parties, including the previously mentioned big Christmas party at the Marlers. Again, science talk was an important part of Marler's agenda, but he would tend to veer the topic away from behavioral ecology and sociobiology which particularly interested many of the younger participants. Jack Bradbury recalls that Marler's preferred issues were more mechanistic. But these discussions generally occurred in the living room after dinner among ... the men; the women were with Judith Marler in the kitchen for cleanup and "womanly chatter." That social division was "expected." The scene didn't "sit well" with some of the women ... and men, both thinking, "more equality preferred." Within the group were several "liberated," professional women, who chafed at the perceived old-fashioned "British sexual hierarchy." A solution emerged. A few guests brought along musical instruments, guitars, and banjos. The interested women came out to join the group; the new social scene became the norm, not thoroughly to Peter's delight. The music-making continued at the other staff and student parties. And, in later years, as Peter recounted those Millbrook times, he would proudly comment on how the music at his home brought everyone together.⁶¹

Donald R. Griffin

The research of Griffin and his RU lab members has already been discussed extensively and is further described later in this chapter and subsequent ones.

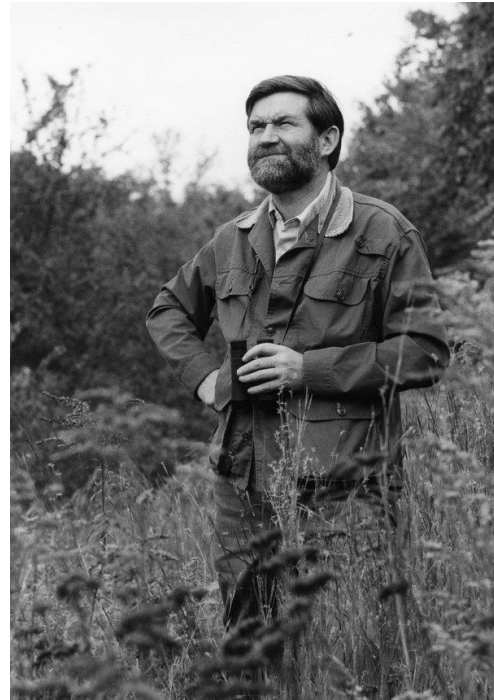
Peter R. Marler

Some labs are more conducive to congenial relationships than others. Griffin's domain at RU was remarkably congenial. The scene in Marler's group over the years was considerably more complex. Marler was a very outgoing person. Recall his being described as a "Teddy Bear" by Carl

Hopkins. Carl, an RU grad student, chose to do his Ph.D. studies with Peter rather than, in Carl's view, the more formidable Professor Griffin. Even the appearance of each professor was strikingly different: Griffin was always more than a little lean and angular while Marler was usually at least a bit rotund and seemingly less threatening. Peter's smiling eyes peered from above a well-groomed beard; he spoke with an appealing British accent. Greg Ball and Bob Dooling, in their obituary for Peter, described his "gentle, disarming manner at seminars" ... "Undergirded by an understanding of critical questions."⁶² But, as already suggested, Marler could have a sudden, strong temper as well.

Peter Marler's fascination with birds was lifelong. First, however, he had earned a Ph.D. in botany in 1952 from the University of London, believing no gainful employment would result from bird study. He was otherwise convinced during postgraduate work under the noted avian ethologist, William Thorpe, and so, in 1954, earned a second Ph.D. in ornithology with Thorpe at Cambridge. Until 1966, he was on the faculty of the University of California, Berkeley, and was then persuaded to join the new RU Institute for Animal Behavior (IRAB).

Over the course of his life, Marler received numerous honors for his work. Most meaningful to him were probably his induction in 1971 into the National Academy of Sciences (NAS) and then in 2008, into the Royal Society, the British equivalent of the US NAS.⁶³



Peter Marler in the Field

(by Ingbert Grüttner. The Rockefeller University)

The Marler Group's Significant and Wide-Ranging Scientific Research

Marler's most significant scientific contribution was his study of the ontogeny of birdsong. These interests developed from his graduate work with Thorpe who had established that "young birds must learn their species songs by listening to adults during a critical period of their development."⁶⁴ Marler and his colleagues discovered the great variety in songs and number of songs in a bird's repertoire (a few to a hundred). To their surprise, they also determined that some species had distinctive dialects within the same species. Peter had remarked, "Dialects are so well marked that if you really know your white-crowned sparrows [*Zonotrichia leucophrys*], you'll know where you are in California."⁶⁵ He continued the studies with hand-raised birds under laboratory conditions at RU, finding quite astonishing parallels to the development of human language. Like human children, some bird species *learned* their "language" (their songs) particularly well during a critical period. During this time, they readily learned the various songs/sounds to which they were exposed, then "babbled" with them, producing "subsong"^a and then "plastic song." During those phases, the birds had more diversity in their repertoire than the song(s) produced as an adult. The young birds

crystalized the song in another period. Afterwards, it was difficult, if not impossible, for birds to learn a different song. The resemblance to human language and dialect learning is persuasive.⁶⁶

Just as Griffin's research was intricately dependent on technological advances, particularly for bats' echolocation, but also for avian migration studies, so also was the work of Marler and his group. Marler's lab relied greatly on the development of portable, battery-operated tape recorders and the Kay-Electric Sonagraph.⁶⁷ Thankfully, the latter was eventually replaced by computer analysis, many programs having been written or enhanced by Marler lab members. Christopher W. Clark was particularly involved and developed further improvements during his long, successful career at the Cornell University Laboratory of Ornithology. He founded, then became a long-time Director of the Bioacoustics Research Program in that Cornell lab.

Over the years and with many additional lab members, the group's work expanded into population biology, song production mechanisms, perceptual processes, and hormonal and neurochemical factors. Primate communication and sociobiology were other lines of interest. Those latter aims were to generate new understandings of "the network of relationships between primate social behavior, population dynamics feeding ecology, digestive physiology and sensory physiology,"⁶⁸ using insights from the field and testing in the lab. The years of study led to an influential paper written in 1987 by Marler and Jim Gould dealing with the highly controversial nature-nurture issue, what they both saw as a false dichotomy (as did Griffin, among others). Marler had developed the concept of an innate program with built-in guidelines and referred to it as an "instinct to learn." That drive to learn was an adaptive trait, innately present in both humans and animals, but its development depended on both nurturance and environment. Marler believed the concept applied to human speech as well.^{69,70,71}

Primateology: Thomas Struhsaker, Steven Green, John Oates

Peter Marler had numerous graduate students over the years. As Fernando Nottebohm describes, when he was Peter's grad student at Berkeley, Peter "encouraged his students to follow their interests wherever they led." Though Peter's interest was birdsong, one student was studying the tarantula's integration of movements by its eight legs, and another, the wing vibrations and sounds of courting flies. I recall Peter's collaborating at RU with a musician.⁷² (Don Griffin was another lab head who so encouraged the individual research passions of his students.) However, as Marler's stature increased, his efforts became more focused, yet broad, and he both attracted and directed students more closely to his own expanding interests.

Many in the lab contributed to the general concern with sociobiology and communication. As discussed, Tom Struhsaker's discovery of vervet monkey's (*Chlorocebus pygerythrus*) use of predator-specific vocalizations was further explored in acoustic playback studies, by Marler and the postdoctoral wife-husband team, Dorothy Cheney and Robert Seyfarth. Another Marler grad student, Steven Green (Ph.D. 1973), and Karen Minkowski, Marler's research assistant and Steve's future wife, conducted related field research. They investigated possible plasticity in primate behavior and communication systems. Their species of choice were Japanese macaques, aka snow monkeys (*Macaca fuscata*), and, in South India, the black leaf-eating monkey, aka Nilgiri langur (*Presbytis johnii*), and lion-tailed macaques (*Macaca silenus*).

An eight-year study of five sympatric rainforest primates by Struhsaker, John Oates and their associates led to a reevaluation of the usual idea that "gross ecology and dietary habits are the

major determinants of primate social behavior.”⁷³ John, officially a member of the Marler lab (1975-78), worked as a postdoc under Struhsaker’s tutelage, publishing numerous articles together. Both, experiencing the continuing devastation of rain forests, became increasingly involved with conservation efforts, as did Steve Green in India. Among Oates’ several books is one centering on Conservation strategies, upending most commonly held beliefs,⁷⁴ as well as a co-authored field guide and natural history, *Primates of West Africa*.⁷⁵ Both books were the culmination of almost 30 years of fieldwork, conducted primarily as a faculty member at Hunter College and the CUNY Graduate Center.⁷⁶

Primateology: Alison Jolly

Though not listed in the RU Annual Reports and similar RU publications, the primatologist Alison Jolly was a visitor (and my office mate) in the Marler lab for several years. She continued her prolific writing as well as her annual expeditions to study lemurs (*Lemuroidea*) at the Berenty Reserve in Madagascar.⁷⁷ Her work of the 1960s with lemurs had disproved the long-held conviction that males were dominant in all primate societies. She found that this was not so for lemurs. “... all females, whether dominant or subordinate in the female hierarchy, are dominant over males.”⁷⁸ (Female dominance was later found to occur in various other primates.) Even the most subordinate lemur females would “at times pounce upon a dominant male and snatch a tamarind pod from his hand, cuffing him over the ear in the process.”⁷⁹ She,⁸⁰ along with Nicholas Humphrey,⁸¹ independently suggested that the hours spent in social relations and networking, i.e., the complexities of social behavior, may have been as important to the evolution of intelligence as was tool making and use.⁸² Their ideas were termed “the social intelligence hypothesis.” In commemoration of her long devotion to the scientific study and conservation of lemurs, a new species of mouse lemur was named for her in 2006, the very tiny *Microcebus jollyae*. She died in 2014.

Sociobiology: Jack Bradbury

Jack Bradbury was another Marler postdoc, but studying sociobiological issues with bats rather than primates or birds. Recall that he had received his Ph. D. (1968) with Griffin on echolocation by *Vampirus spectrum*, carnivorous, bird-eating bats which face very different problems in locating prey than do the insect-eating bats. During his post-doctorate with Peter Marler (1968-1969), Jack worked in Trinidad, building upon his prior observations of the social organization of emballonurid bats. Although he and his wife Inger had worked together earlier in Trinidad, by this point, they decided to separate. In 1969, after the postdoc, he became a Cornell Assistant Professor and met his future wife, Sandra Vehrencamp, an Animal Behavior graduate student. He and Sandra studied the relationships between bats’ social organization and foraging and group size.^{83,84} In 1972, he again returned to RU as an Assistant Professor in Peter Marler’s group at the Millbrook Field station. Both he and Sandra next accepted faculty positions in 1975 at the University of California, San Diego, and remained for 24 years, teaching, doing research, and raising a family with two daughters. They conducted fieldwork on the social organization of many species, from bats to ungulates. Together, they jointly authored articles and books; their very thorough and thoughtful book, *Principles of Animal Communication* was used widely as a college

textbook. In 1999, both accepted faculty positions at Cornell, remaining until Jack retired in 2009, and Sandy in 2010.

Communication: Carolyn A. Ristau

My work as a postdoc in the Marler lab examined whether primates, like songbirds, learn their vocal repertoire or whether it was innately programmed. Initial plans were to study Rhesus monkeys (*Macaca mulatta*) roaming freely on Cayo Santiago, Puerto Rico,⁸⁵ a mini tropical paradise for the monkeys cavorting about. My fellow postdoc and the only other woman then in the Marler lab, Elizabeth A. Missakian, had already worked on that island, investigating the macaques' social organization and behavior (1968-1969).⁸⁶ But the promised outdoor monkey compound was non-existent, so I turned to a group of squirrel monkeys (*Saimiri sciureus*) at the Yerkes Field station⁸⁷ in Georgia and others hand-reared by myself. Unfortunately, the claimed "simple" vocal communication system⁸⁸ was anything but, and I spent years using a Sonagraph to analyze the vocalizations of deafened and normally hearing monkeys to no avail. My Barnard College student, Danielle Leone (now Mc Mahan), continued the task for her senior research project. Finally, we obtained a computer program from an NIH scientist to analyze the vocalizing more easily. Both the Sonagrams and computer analysis portrayed no differences in one group that could not be found in the others. There were, however, hints of possible different usages between groups.

The "backstory" to the research is rather unsettling. At the start of my work, Peter Winter, of the Max Planck Institute, had visited Marler's lab. Winter had a colony of squirrel monkeys and Marler confirmed with him that he was not conducting work similar to my proposed endeavor. It would be foolish to expend such enormous effort on the same project. He was not. But he and a team of scientists raised four normally hearing and one deafened infant squirrel monkey, all with muted mothers. This design tackled the same theoretical issue, but with a different methodology. (He had other hand-raised and normal mother-raised infants also available, as I did.) The results were the same as mine, finding no different vocalizing when comparing normally-reared young exposed to species-specific vocalizations, hand-raised young with no such auditory input and the one deafened infant.⁸⁹

Other attempts in the Marler lab to find evidence of primate vocal learning similar to the processes in birdsong or human language likewise found no supporting evidence. A possible exception existed, when Steven Green (Ph.D. 1973), working with free-roaming Japanese macaques (*Macaca fuscata*), found some evidence for different dialects in different troops, specific to each artificial feeding site.⁹⁰

Communication: Stephen Zoloth

A persistent puzzle remained in all the communication studies: which features of an animal's vocalizations are *significant* ones to the animals? Stephen Zoloth (postdoc: 1974-78), began to tackle this problem by working in conjunction with Haskins Laboratories. He produced synthesized sounds incorporating certain features of four monkey species' vocalizing. The monkeys were trained to discriminate the sounds. They showed distinct differences in the ease with which specified characteristics of the sounds could be discriminated.⁹¹ Thus, a useful technique to begin to understand what components of the sounds "mattered" to the monkeys.

“Etho-endocrinology”: John C. Wingfield

In 1981, John C. Wingfield arrived as an Asst. Professor and introduced “etho-endocrinology,” as Marler termed it.⁹² He was soon the Associate Director of the RU Field station (1982) with Peter Marler, the Director. Wingfield studied the interplay of environment and endocrines. In particular, he examined the effects of sex steroids, such as testosterone, on the reproductive cycle and its functioning in birds. How much control did endocrines have on the timing and flexibility of the cycle? How did the hormones impact territoriality; could they modify the type of mating systems used by the birds? (They could, turning normally monogamous birds into polygynous!⁹³) This work was allied with the overall lab interest in communication, for the primary function of the birds’ singing is courtship and associated territorial claims. These behaviors are, in turn, dependent on hormonal effects. The Millbrook Station facilities afforded an excellent opportunity to integrate both lab and field research.

Initially, Wingfield studied the song sparrow (*Melospiza melodia*), a local species and a frequent RU Field Station research choice. From his field and lab work, Wingfield discovered measurable changes in plasma levels of testosterone in birds exposed to song playback under field conditions.^{94,95} The significance of this work was showing that the *behavior* of another bird, its singing and actions (possibly specific bodily movements and stances), *caused* the hormonal change in the recipient (listening) bird.

When John left RU (1986) for the University of Washington, Seattle, he expanded his interests to high latitude passerines and even more broadly to species of birds breeding from the Arctic through the tropics to the southern tip of South America. He discovered very different degrees of flexibility in the breeding times of the birds, particularly of “Crowned sparrows” (Genus: *Zonotrichia*) which bred throughout the regions. Most inflexible were the birds of the Arctic, while those of the equatorial regions were most flexible and asynchronous. Such variation would appear to reflect the relative rigid harshness/“forgiveness” of the respective environments.

I cannot do justice to all the significant, fascinating and groundbreaking work of Marler and his lab members over the many years. Do consult the references given earlier.

Thomas Struhsaker (Initially RU Assistant Professor in Marler Lab)

Tom, recall, was one of Marler’s first two hires as Assistant Professors. Tom was the quintessential field researcher: very tall, lean, strong, rough, with an enormous, unkempt beard, appearing ready to stomp off into the jungle at any moment. But sometimes, he was in New York City, and not very pleased about that. But to return to the field, data had to be analyzed, library studies conducted, research papers produced, grant proposals written. Of such times, in particular an 18-month stint in 1968 and ’69, he summarized, “I was miserable.”⁹⁶ He did enjoy gatherings with the lab members and compatriots from the NY Zoological Society (at the Bronx Zoo), the American Museum of Natural History, and some universities, but had no desire to avail himself of the city’s other offerings. Proudly, he’d play his tape recordings of the spontaneous music and singing from the folks who lived in the village or worked in the research camp set up in his Kibale Forest site, Uganda. In his view, that was music as it ought to be happening.

In the field, he was a thorough researcher and observer. In his 1985 memoir, Marler describes Tom as having become “a world authority on the behavioral ecology and biology of forest primates.” Tom’s Ph.D. and 40 years of work on Red Colobus monkeys (*Ptilocolobus badius*

temminckii) resulted in his book of that title, a classic.⁹⁷ More recently, he has published a 50-year retrospective on his life and research as a field biologist.⁹⁸ He mentored primatologists, such as John Oates and Tom M. Butynski, and was instrumental in helping develop African primatology.

During the late '60s and '70s, Tom had studied some of the same primate species as another primatologist, J. Stephen Gartlan, and would grumble at what he presumed was Gartlan's careless work. Gartlan was finding a completely different social organization among his study subjects. At that time, it was widely believed that a given species always maintained the same type of hierarchies and social groups. What began as animosity became a strong friendship and life-long collaboration between the men as they communicated and realized they were discovering that the organization was not stringently and innately organized for each species. Instead, the social systems exhibited considerable plasticity, depending on such factors as group size and membership, food distribution and availability, and other habitat and social characteristics. Physiological and anatomical characteristics, such as body size and digestive capacities, mattered as well, influencing social organization. Significantly, Gartlan was studying the social organization and ecology of savannah-living species, while Struhsaker's primates lived in the forest. Steve Gartlan joined the Marler lab (1969-73), a positive, warm, friendly, and, of course, most capable, addition.

Tom, the confirmed bachelor, did meet and marry Lysa Leland, a photographer. For many years, they worked on his project and published together.⁹⁹ Tom later married another young field researcher and settled eventually as an adjunct Professor on the Duke University faculty, still active (2023) in his research and conservation efforts, primarily in Uganda, Tanzania and Cameroon.

The Field Study Courses – “Extraordinary Opportunities”

Yes, “an extraordinary opportunity” ... that was the description offered by a Griffin grad student, Beverly Greenspan, who participated in the Africa expedition; others offered similar comments. There were two such foreign expeditions, the first to Central and South America (1969) and the second to Africa (approximately 1971). The courses were life-changing events for many of the attending students; they found their life's research work during the stay, often arising from the required “student projects.” The expensive undertakings were funded by a federal government science granting agency (likely the National Science Foundation, NSF) until they weren't, until budget cuts upended the program.

Central and South America: Trinidad and Panama were the sites of the first course, in January and February 1969, fine research/training sites and warm respites from the frigid Northeastern USA. As a junior faculty member and also a most experienced tropical field researcher, Tom Struhsaker was designated by Peter Marler to be the course leader. The five students were in several different labs: R. Haven Wiley and Carl Hopkins, both from the Marler lab, Robert Johnson (studying olfaction in the hamster, Carl Pfaffman lab), Roland C. Richmond (studying genetics using fruit flies, Theodosius (“Dobie”) Dobzhansky lab) and Ron Larkin (neurophysiology of hunger in rats, under Harry R. Kissileff in the Carl Pfaffman lab. Ron was later a Postdoc, then Asst. Prof. in Griffin's lab). The first four-week stint was at Simla, Trinidad. Griffin was there, as was Fernando Nottebohm and Marler, all contributing to the course with various levels of involvement.

Also in Trinidad, Jack Bradbury was conducting his postdoctoral work with Marler (1968-69). He became the local guide, he and Tom escorting the “city slicker” students to several bat colonies and caves that Jack knew well. These were rather dirty, mucky explorations in the caves, but part of the challenges in fieldwork. Everyone was “protected,” wearing masks in the caves and “safe” with their rabies shots. But, no one was aware of the possibility of histoplasmosis,¹⁰⁰ and Carl was stricken, experiencing his symptoms a while after the course.¹⁰¹

Flying bats, Griffin’s demonstrations, were an intrinsic part of the course. Carl Hopkins enthusiastically recalled caged fishing bats. A bat flew over an artificial pond and, via echolocation, detected a live fish below from the ripples made on the water’s surface. Carl could barely believe it.¹⁰²

For the second four weeks, the group was based at the Smithsonian Field station on Barro Colorado in Panama. This time, Theodosius Dobzhansky, the RU geneticist and evolutionary scientist, was also available for mentoring.¹⁰³

By that time, the course had already made a significant impact. The weeks in Trinidad had set Carl Hopkins’ direction for his Ph.D. topic and lifetime of research, the study of electric fish.¹⁰⁴

Africa: The expedition to Africa was the grand one. Again, Tom’s organizing help and then his leadership and mentoring, this time at his Kibale forest research, were absolutely essential to that study trip. Though a very expensive expedition (again government-funded, either by NSF or NIH) and laborious to plan, it was a significant stimulus for the life studies of several students fortunate to participate. The 12-week trip entailed months of preparation by the students beforehand, reviewing and discussing together the relevant literature on the areas’ ecology, flora and fauna.. They critiqued the studies and sought to frame pertinent and significant research questions. They also learned something of the local culture and undertook a crash course in Swahili. This trip, they were more truly “roughing it.”

By then, Steve Green was close to completing his Ph.D. and functioned as one of the instructors. For the six weeks at Tom’s Kibale forest field site, Tom oversaw and mentored the group, while Peter Marler was the primary mentor during the following six weeks at the savannah site in Queen Elizabeth National Park, Uganda. The students chose diverse projects:¹⁰⁵ Peter Waser, then a Griffin student, studied mangabeys (*Cercocebus albigena*).¹⁰⁶ He had, in his words, previously explored several research areas with Griffin’s “incredibly generous” support. The field trip convinced him that he wanted to continue working with the mangabeys for his Ph.D. thesis (1974). He did so, as a member of Marler’s group, with Griffin’s gracious and strong encouragement.¹⁰⁷ Owen Floody (Ph.D. 1974) was a neurophysiology student with Profs. Donald Pfaff and Carl Pfaffman in the Pfaffman lab and joined Peter Waser in the Mangabey study during the trip. José Torre-Bueno (Ph.D. 1975) was another Griffin student on the expedition. Arthur (Art) P. Arnold (Ph.D. 1974) was a Nottebohm student in the Marler lab. (Nottebohm was not a lab head until becoming a full professor in 1976.) Art and Beverly Greenspan worked together on an army ant project; Beverly (Ph.D. 1975) was a Griffin grad student mentored also by Jocelyn Crane.

So, there *was* a female in this group, Beverly, but it hadn’t been a “given.” I’d heard, first-hand and second-hand, comments by the organizers, meaning Peter, Steve Green, and indirectly by Tom Struhsaker (who, I believe was in Uganda at the time), of the initial plans *not* to include any women. They would be “distracting” to the men who needed to concentrate on the research. And

the added difficulties of logistics for housing arrangements; women would need a separate tent. But it was the early 1970s; the project was funded by the US government and an undertaking by Rockefeller University which espoused high ideals. How could women not be part? Finally, women were included, i.e., Beverly.

The other woman postdoc at the time, Elizabeth Missakian, and I, both absolutely yearned to join the expedition. We had our own funding through our NIH fellowships. Before the trip, we were permitted to join the group research reviews and discussions ... for a while. Then it was determined that our presence would interfere with the group bonding and cohesion as an entity, and not only were we not permitted to go to Africa, but we could no longer participate in the learning sessions. The reason given was that we were not students and this was a student course. It's quite unclear who was the actual impetus for the decision. Sometime after the expedition, as Peter Marler and I were chatting one day, he suddenly said to me, "You should have gone on that field course." Hmmm.

Fernando Nottebohm (Initially RU Assistant Professor in Marler lab)

Birds' Left Side

Like Tom Struhsaker, Nottebohm was another grad student of Peter's from Berkeley. He too was invited by Peter in 1967 to take a junior faculty position in the new IRAB; IRAB then metamorphosed into RUCFR at Millbrook. As already noted, Fernando spent his entire academic career at Rockefeller, finally heading the Field station himself for almost 16 years.

When a Berkeley graduate student, Fernando had been intrigued by the work of his fellow Marler grad student, Mark Konishi. Konishi's research showed different effects of early and late deafening on birdsong development in several songbirds. These included the white-crowned sparrows (*Zonotrichia leucophrys*), the species Marler was studying intensively. Konishi found that the songs were highly degraded with early deafening. But what controlled the process?¹⁰⁸

Nottebohm decided to tackle the question of proprioceptive feedback,¹⁰⁹ (non-acoustic feedback) and muscle control and their roles in vocal development. Konishi taught him the necessary surgical skills. Working with canaries (*Serinus canaria domestica*) and other songbirds, Fernando found that cutting certain nerves to the syrinx (the avian equivalent to our larynx) showed a left-side dominance. In other words, the destructive impact on song production was much more severe with cuts to nerves controlling the left syrinx. That immediately raised analogies to the typical left-hemispheric control of human language and speech production. As another set of Marler students, Greg Ball and Bob Dooling, have summarized, the work of these students was path-breaking. It "laid the foundation for the discovery of the avian song control system by Nottebohm in the 1970s and the remarkable development of the field of birdsong neurobiology."¹¹⁰

Upon joining the RU faculty, Nottebohm decided to observe the naturally occurring communication of another avian species whose talents for learning sounds far surpassed that of songbirds ... parrots (family: *Psittacidae*).¹¹¹ He spent time at the Simla station in Trinidad, trying to determine the full number of sounds that wild parrots had in their repertoire; he had, as well, a pet parrot to aid the study. Fernando Nottebohm and Marta's time in Trinidad overlapped some of Jack Bradbury's stay for his postdoc bat studies (1968-69). However, Nottebohm decided to return to neurological studies of birdsong. Perhaps, his decision was due to the complicated vocalizing of the

parrots or, perhaps, the lack of control that fieldwork affords compared to the lab. Maybe he was dissuaded by the very long process of data gathering and analysis in most field research, again as compared to at least some lab work. In retrospect, it was a wise career move. Interest in strictly behavioral studies was declining yet more, while attention and funding for neurobiology were emerging and soon to become a major surge, continuing to this day.

Expanding Bird Song Studies

Initially, the Nottebohm lab interest was directed toward understanding the brain pathways that control the learned motor skills in birdsong. He expanded the research far more broadly to the relation between brain changes and learning, again using birdsong as the example and model.¹¹² Most studies were focused on canaries' songs, the species chosen because they create a new song each year, affording new opportunities for neuroscientists to study the learning involved. In a letter to Don in the fall of 1980, Fernando had noted that he was reorganizing his lab in the city to "have the full spectrum of approaches from Golgi, EM [Electron microscopy],¹¹³ [enzyme?] culture and neurophysiology to the study of animal behavior." [The handwritten letter is indistinct and difficult to read in parts.] Nottebohm summarizes his approach (1989): "We have chosen to integrate molecular, cellular, neurophysiological, neuroanatomical, neuropharmacological, psychophysical, and ethological approaches to study learning and brain repair in vertebrates."¹¹⁴ Many in the Nottebohm lab were involved;¹¹⁵ I can mention only a few.

Theories derived from human speech analysis impacted the direction of some research. I note Lieberman's "Theory of Motor Perception," that humans *perceive* speech as a series of articulations, i.e., how we motorically "produce" the sounds, and then assign acoustic and phonetic values. According to this theory, human babies learn motor actions, including the lip movements associated with sounds and their production. Analogous perceptual processes were found in the birds studied by **Heather Williams** for her Ph.D. Sounds *presented* to a bird engaged not only the classical auditory pathways but also the neuronal circuitry involved in song production, all the way down to the level of the motor neurons that control the syrinx.^{116,117}

Investigating other neural aspects of song production, **Art Arnold** found sexual dimorphism of the brain centers controlling songs with seasonal increases in males' dendritic growth.¹¹⁸ Thus, male songbirds, who usually do most or all the singing, must literally have more brain space and more connections between brain cells to use in dealing with their songs. But *what* is the increased brain volume ... do the existing neurons grow larger (there *is* more dendritic growth) or are new neurons created? The latter possibility was anathema, for all "knew" that adults cannot grow new brain cells. But they can.

New Brain Cells?

The work of Joséph Altman and colleagues in the 1960s had already shown that new cells could be produced in the hippocampus and olfactory bulb in various vertebrates they studied (e.g., rats, cats, guinea pigs, etc.). That work, like so many scientific advances, was possible due to new technology, autoradiography, using tritiated thymidine to label and visualize cells.¹¹⁹ But the work was too revolutionary; it was not believed at the time; it was largely forgotten by many. This was likewise the situation with Barbara McClintock, who claimed in the 1960s to have found evidence of new neurons in adult rodent brains. This work, like her research of the 1950s and '60s with

“jumping genes” was dismissed and she was considered “out on the fringe.” Later, in 1983, she received a Nobel Prize, awarded for much of this work.¹²⁰



Prof. Nottebohm presenting the first lecture in the NYAS series on Neuroscience (2000) (by Lisa Stillman)

In the Nottebohm lab, very significant advances were made, beginning in the 1980s. The researchers were gathering evidence to explore the possibility of, and then to prove, adult neurogenesis in songbirds. According to Nottebohm, the idea arose during a most relaxing, hot, end-of-day shower: Might new neurons be created in the seasonally larger male brains, replacing old neurons that had died? He suggested this “fantasy” to his resourceful new graduate student, **Steve Goldman**. Steve immediately stated that the idea could quickly be tested by a method he knew, using tritiated thymidine to mark DNA synthesis. But warned Steve, we should be mum about this ... people will wonder about the lab if they hear of such efforts. To shorten the story, which may be read in detail in a recounting of the lab’s work by Nottebohm,¹²¹ the neurogenesis was confirmed, being Goldman’s thesis work (1983).¹²² The lab research continued, particularly with the help of **Gail Burd**,¹²³ an electron-microscopist, **John A. Paton**,¹²⁴ a neurophysiologist and others. Some of that work entailed repeated confirmation of neurogenesis, using different methods, an important way science progresses by establishing converging data for a phenomenon. The Paton and Nottebohm work established that some of the new, labeled neurons were recruited into existing, functioning circuits. The neurons were part of the HVC (High Vocal Center), one of the forebrain nuclei, considered to be analogs to Broca’s area in humans that controls motor output for language. HVC was later found to play a significant role in the patterning of learned birdsong.¹²⁵

In work four years later (1988), **Arturo Alvarez-Buylla**, then a Nottebohm grad student, used cell labeling with both 3H-thymidine as a birth-date marker and fluorogold as a retrograde tracer. He found that some HVC neurons are created after hatching, some when song is learned as an auditory-motor skill, and some later in adulthood.¹²⁶ These, together with others’ efforts, showed basically that new brain cells are created and the young neurons migrate to the parts of the brain where they do their work.^{127,128}

Arturo spent much of his early career at Rockefeller University.¹²⁹ In 2000, he joined the University of California San Francisco (UCSF) as a Professor, becoming an internationally recognized leader in the study of developmental neuroscience and stem-cell neurobiology research.¹³⁰

The ambitious work of the Nottebohm lab continued, delving more deeply into the neural generative process, showing that neuronal stem cells are responsible for the replacement of cells. He has received numerous awards, in particular, in 2006, the Benjamin Franklin Medal in Life Science to honor those “whose innovation has benefited humanity, advanced science and launched new fields of inquiry.”¹³¹ Both Altman and Nottebohm have been described as the two researchers who changed the course of history in the field of adult neurogenesis.¹³² Nottebohm recognized

Joseph Altmann as a “true pioneer,” as the first to publish evidence that, in mammals, even adults produced new brain neurons.¹³³

Most recently, Nottebohm has turned his attention from experimental work to a broad review of the genesis of key ideas in science, philosophy and religion. He is considering the emergence of culture as a biological process, with laws of its own.¹³⁴

Roger Searle Payne (RU Assistant Professor)¹³⁵ and Katherine (Katy) Boynton Payne (Scientist)

Roger Payne has an ebullient presence. (Age mellowed that only slightly; unfortunately Roger passed away in June 2023.) A tall, large-framed man with a huge, welcoming smile, his being fills the room. He could enthusiastically and knowledgeably speak about many a subject, whether on a tour through the Metropolitan Museum's Egyptian collection or spouting on about his favorite topic, whales and their conservation.

And Katy, his first wife, as well, has an extraordinarily warm presence, accepting and understanding. She, too, was (and is) a scientist, now retired. Both also had strong artistic interests, he, a cellist, and she, a violinist and painter. Having met at Cornell when she was an undergraduate (AB 1959) and he a graduate student (Ph.D. 1961), they married in 1960 and soon had a thriving family of four children.

Roger was one of Don Griffin's first Asst. Professor hires (1966), soon after Don himself had arrived at Rockefeller. But they had known each other already for over a decade; Katy knew Don through Roger.¹³⁶ As a Harvard undergraduate (class of 1957) taking Griffin's Intro Bio course, he'd visited Griffin's lab. Don had delightedly played the group of students his recordings of oilbirds (*Steatornis caripensis*), birds echolocating with sounds that humans can hear. Don was “really interested in what he was doing,”¹³⁷ recalled Roger; he joined Griffin's lab. In Roger's words, “He [Griffin] became one of the two most important influences in my life.”¹³⁸ Katy notes how deeply grateful Roger was for the huge roles that Don played in his life and how fond Roger was of Don.¹³⁹

When Roger went to Cornell for his doctorate, he studied directional sensitivity of hearing, this time of owls, specifically Barn Owls (*Tyto alba*). For them, it is a highly accurate skill that allows these silent flyers to locate and catch mice and other small creatures in total darkness, using only acoustic information.¹⁴⁰ That owl work was very highly respected and has been referenced repeatedly over the decades since.

(His research was funded in part by the American Museum of Natural History and also from grants awarded to Charlie Walcott at Cornell. Interestingly, those funds derived from the US Army and the Office of Naval Research (ONR).¹⁴¹ Whether the military is still so expansive in its funding priorities, I do not know. We do know, however, that the military was a substantial funder of the early work of Donald Griffin and avian migration researchers over the decades, e.g., Tim Williams and Ron Larkin, as examples. ONR continued to provide substantial funding, particularly for cetacean research. Cornell's extensive Macauley Library of wildlife sounds, photos and videos, under Jack Bradbury's direction, was generously funded by ONR to archive whale and porpoise vocalizations. Chris Clark's Cornell Bioacoustics program was similarly well funded by ONR.¹⁴²)

As a graduate student, Roger was very strongly influenced by a second professor Thomas Eisner, who instilled a fascination with insects. With that inspiration, Roger joined Kenneth Roeder at Tufts University for postdoctoral research¹⁴³ on the directional sensitivity of certain moths that

could detect bats' ultrasound; such abilities helped moths avoid predators.^{144,145} He continued his studies at Tufts as an Asst. Professor.

Roger Payne is Lured to Griffin's RU Lab

Griffin tried to lure Roger to Rockefeller when he had a position to offer. Payne's research focus paired well with Griffin's interests in the sensory systems and cues used by migrating birds and echolocating bats, and they much enjoyed each other's company. But Roger declined; the thought of a frantic New York City life was utterly unappealing, particularly with a family that included four young children. In his inimitable way, Don persisted. He toured Roger around RU's Manhattan campus; the "green oasis" hidden from the city's bustle. Roger acquiesced. The family remained in Massachusetts for a while, with weekend visits. But, then, with the assistance of a New York relative of Timothy Williams, a mini-miracle.¹⁴⁶ Space, large, affordable space, was available in a basement at Wave Hill,¹⁴⁷ a spacious mansion on extensive public grounds in the Bronx, a borough of New York City. 'Twas a most desirable "underground" existence with a wall of glass overlooking the palisades, the cliffs across the Hudson River.

The owls got a home too. On the top floor of Smith Hall on the RU Manhattan campus, Roger constructed a flight cage to continue his studies.¹⁴⁸ That didn't last long. An incident that had occurred while he was at Tufts continued to haunt him. He was a neurophysiologist at the time, still working in the lab one chilly, sleeting March night. The local news had reported a beached, dead whale nearby. Having never seen a whale, after completing his work, he went through the storm to the nearby beach. By then the area was deserted, except for the small whale, a porpoise (family: *Phocoenidae*), glistening in the cold rain. Others had been there first. Someone had hacked off the flukes for souvenirs; two others had carved initials into the skin; someone had stuck a cigar into its blowhole. Roger removed the cigar and simply stood there ... for a long while. Was there anything he could do to change such human behavior, to impact positively on the whales' existence?¹⁴⁹

So, though very successful with his owl auditory endeavors, and "having a wonderful time," with this RU research, he searched for work that seemed more meaningful to him. He asked himself, "What can I do if I only have experience in studying the sounds of animals and their acoustic systems?"¹⁵⁰ He thought of whales: They made many sounds, but little was known of their behavior. Thus began his studies and conservation efforts with whales. Commercial whaling was then at its peak.¹⁵¹ There was urgency.

The Navy's Secret Mission Records Sounds

And then a bit of serendipitous good fortune. During a meeting of the NY Zoological Society, Henry Clay Frick II, physician and millionaire, was chatting with Roger. Frick mentioned frequent sightings of humpback whales (*Megaptera novaeangliae*) from his Bermuda estate. Off to Bermuda. There, Roger and Katy were encouraged to meet Frank Watlington, an engineer with a great passion for whales. Watlington was on a secret Navy mission, recording sounds within the ocean.¹⁵² (No longer a secret: they were searching for acoustic evidence of foreign submarines.) But during the eavesdropping, some long, beautiful sounds had also been recorded, comforting, yet somehow melancholy too. Both Paynes were awestruck by them. Katy recalls, "We were just completely transfixed and amazed because the sounds are so beautiful, so powerful – so variable. ... My God, tears flowed down our cheeks."¹⁵³ Watlington suspected the source was humpback whales, which

occasionally swam by. Roger realized this was an incredible tool, a way to make the public listen to and care about the whales. Watlington gave them the recordings and said “Go save the whales.”¹⁵⁴

A few years later, in 1971, Roger and Scott McVay, with the able help of Katy, produced sound spectrograms of the recordings and published the lead article in *Science*.¹⁵⁵ They verified that the sounds were songs, as Roger had thought from hearing them many times over, memorizing some of them.¹⁵⁶ The sounds were repeated sequences at regular intervals, “songs,” structured songs. Some lasted even 30 minutes, then repeated.¹⁵⁷ Such repeated rhythmic sounds, are considered “songs,” notes Roger, whether they be by humans, birds, frogs or crickets, and now, whales.¹⁵⁸ In 1970, the year before the *Science* article, Roger had produced a phonograph record of the “Songs of the Humpback Whales,” an extraordinarily popular *Nature* recording. A flexible record of the song was also included within an issue of *National Geographic* magazine, which, as of 2017, remained “the single biggest print order in the history of the recording industry.”¹⁵⁹

(The songs are emotionally powerful. As I would begin a lecture on animal communication, I often dimmed the classroom lights and played songs from that record to the students. They would remain silent, listening in awe. Marie Claire Busnel, French physiologist and ethologist, who studied fetal audition, once told me that in some French hospitals, the whale sounds were played during labor and birth to calm the mothers, perhaps the fetus too, and so ease the birthing.)



Two Humpback Whales Swimming (by Wirestock)

Argentina: The Paynes and 100 Trips to the Whales

Katy and the family, including all four children, joined Roger on almost all of the hundred-plus expeditions to study whales,¹⁶⁰ including such areas as the repeated trips to Bermuda, Hawaii, Mexico, Alaska and Argentina. (As will be described, Jim Gould and his wife Carol once accompanied them to Argentina, which convinced Jim to return to honeybee studies.¹⁶¹)

Fieldwork in Patagonia, Argentina, was the better part of 12 years, usually 3-4 months at a time, though once as long as 18 months. The break during that long time was a drive down and back from Tierra del Fuego, searching for evidence of whales.¹⁶² Katy describes the time as an immersion in wilderness, not just whales, but wilderness. Their site was one of the wildest, windiest places in the world. During the first year, they lived in tents, but the winds were simply too intense. A simple, quite small cement structure was built instead, including an office and a lab. Katy recalled,

Our little camp was always very crowded with family and students. ... Chris Clark came, now, perhaps, both one of the leading whale persons in the world and also Director of the Bioacoustics Group in Cornell's Laboratory of Ornithology. Bernd Würsig,¹⁶³ Later, Peter Tyack came. Lysa Leyland also joined us; not a professional photographer, though 'a wonderful one;' she later married Tom Struhsaker. ... We always seemed to have some photographer from National Geographic. ... The photographers and journalists usually established their own camp nearby.¹⁶⁴

The whole family joined in the efforts. Katy had sometimes been a substitute teacher and was usually the children's teacher, though others helped, including Lysa Leyland. Not school in the usual sense: The children created daily journals, with artwork, recording their observations and thoughts.¹⁶⁵ Evening entertainment? They played together as a string quartet: Roger and/or John on cello, Holly, Laura and Katy on the violins and viola.¹⁶⁶ When Chris Clark came, they gave him a guitar; he joined too. "It was a free and playful time. God, it was wonderful," recalled Katy. "It was all a big challenge, such fun and so intense. ... The family was tremendously bonded from that experience. ... Uncomfortable, but Roger and I loved it."¹⁶⁷

I delve into the details of their research experience because I have also described other, very different ones. The others serve as models for scientific research, but so do theirs. Theirs was a family affair, a bonding experience from sharing the rigors and joys of the wilderness, passion for the work, and achievements, both scientific and those specifically dedicated to the well-being of the environment and its creatures. Katy and Roger's joint undertakings lasted a long time, from 1960 to '85 when they divorced. Roger continued his whale conservation work with a second wife, Lisa Harrow, and conducted further whale studies. Katy turned to significant research in elephant communication and conservation. More on that later.

Saving the Whales: A "Golden Record" to Space

Roger and Katy, with their associates, made several outstanding scientific findings over the years of study, as well as Roger's spearheading intensive campaigns to save the whales. Katy also joined that conservation effort, though focusing on the necessary song analysis. In 1971, Roger founded and became President of the Ocean Alliance, an NGO to protect the whales and their environment. Over the decades, he has received numerous honors, including the prestigious McArthur Fellowship (1984), a Netherlands knighthood, United Nations awards and others. Public interest in whales was aroused, thereby encouraging conservation efforts. Central to these changes were the three recordings of the humpback whales' songs^{168,169} and sounds of blue and fin whales,

several television and film natural history documentaries, including the IMAX film “Whales,” Roger’s books about whales,¹⁷⁰ and albums and popular movies which featured excerpts of some whale songs. In 1977, Roger Payne’s recordings of humpback whales were included in the “golden record” aboard the Voyager spacecraft, among the first human artifacts to leave our solar system, continuing still today on their 2.5-billion-year voyage across the galaxy.¹⁷¹ Roger gave lectures at International Whaling Commission conferences and other meetings including both scientific findings and the urgent need to protect the whales. Once, at a meeting in Bergen, Norway, a significant part of a conference included both a lecture by Roger and an exhibit of 40 of Katy’s watercolors and drawings of the whales and the sea. All these activities sparked Greenpeace’s “Save the Whales” campaign. Finally, in 1982, bowing to global pressure, the International Whaling Commission banned commercial whaling, to begin in 1986. That has worked ... to a degree.

Whale Songs, Bird Songs ... Sexy?

Back at Rockefeller, in the *Annual Reports* and *Reports on Scientific and Educational Programs*, Griffin summarized the discoveries of his distant faculty lab member to the resistant RU scientific community. First, in the 1968 *RU Report*, before the public whale song recording had been produced, Griffin wrote of the startling fact that humpback whales, recorded off the Bermuda coast, sing songs, similar to birdsongs. Yet the whales’ shortest phrase, a few minutes, is longer than the longest of any birdsong, a few seconds. Individual whales sing their own variants of the underlying group theme and structure. As Katy once remarked, these variations bore a striking resemblance to the improvisations so typical in jazz. And inventive males seem to be attractive to females, a phenomenon Darwin originally termed “sexual selection.”¹⁷²

Songs Across the Oceans?

Griffin noted, very conservatively, that these sounds are emitted at depths of several hundred feet, some within the deep sound channel where sound travels much farther than in any other place in the ocean. Whales *may* communicate in this way over hundreds of miles. That long-distance sound travel is considered by many to be Roger Payne’s other most significant finding about whales. By 1970 -71, Griffin extended the possibilities of long-distance sound travel to include those of baleen whales which make very high-intensity, low-pitched sounds. (Baleen whales (*Mysticeti*), which include the humpback, are distinguished from toothed whales (*Odontoceti*), such as orcas (*Orcinus orca*). The baleen are usually much larger animals and do not have teeth, but huge filters. Through these baleen filters, they strain enormous volumes of seawater to get their food: tiny zooplankton, particularly krill (*Euphausiacea*), and other small marine life.)

Don’s summary was based on research presented in 1971 to the New York Academy of Sciences by Roger and Douglas Webb, a WHOI engineer and oceanographer. Together, Roger and Doug had analyzed the transmission characteristics in the ocean of some sounds made by fin whales (*Balaenoptera physalus*), a type of baleen. The communications were extremely intense, nearly pure tone blips centering around 20 Hz sounds, each pulse lasting about 1 second, in trains lasting as long as 15 minutes, then possibly repeated in a few minutes.¹⁷³ These were nothing like the songs of humpbacks. Roger and Doug took care to state that they were not claiming complex communication through these sounds, merely a whale’s indication of its presence. The researchers showed an impressive array of mathematical calculations. The sounds’ range was at least 525 miles

traveling in the deep channel, with some computations indicating the possibility of 3,500 miles, or even more.¹⁷⁴ They argued against echolocation via the 20 Hz sounds, for the pitch was too low. But why would this particular species, and some others, e. g. blue whales (*Balaenoptera musculus*), have evolved such powerful long-distance communicating? The researchers suggested that fin whales lacked fixed breeding sites and needed to communicate their location and reproductive readiness. A perusal of their migrations supports the view that fin whales can aggregate at will, even over their entire range.

Roger and Doug Webb were prepared for a hostile audience and it was. A seemingly polite, but pointed remark queried evidence for the *use* of the sounds, noting the authors were “unhampered by any evidence on the hearing capacities of these whales...”¹⁷⁵ [Whew- rather nasty in a scientific discussion.] Roger noted that their claim of the sounds traveling thousands of miles in a quiet ocean, “...came closer to destroying my whole career than anything else I did.”¹⁷⁶ People thought he was just a whale enthusiast. Later investigations *did* show that, under adequate conditions in the sea, and depending on pressure and water temperature, these and other very low-pitched whale sounds could travel an estimated 10,000 miles. Simply stated, the whales’ sounds could travel from one ocean to another. Later research also demonstrated that fin whales could definitely hear the low-frequency sounds, aided by vibrations in the skull.¹⁷⁷

Knowing the “Right” Whales

The Paynes were not only recording whale sounds but intently observing social behavior. From aerial photos taken near their Argentinian camp, they could individually identify right whales (*Eubalaena australis*) from natural markings on the head. Over the many years, the researchers created a photographic record of 1,700 Argentine right whales. (These whales had historically been termed the “right” ones, for several reasons. During mating and birthing seasons, they tended to come into shallow waters, useful for research observation, but also deadly. Being so close to the shore, they could readily be spotted by land lookouts and hunted by beach-based whaleboats; sometimes they could even be hunted directly from the land. They were slow swimmers and floated when dead, thus, not dragging the harpoon (or more modern implement) and harpooner into the ocean depths. So huge, the whales provided large amounts of valuable materials, particularly oil for illumination and lubrication, even soap.)¹⁷⁸

Since both a right whale “nursery” and separate, nearby mating grounds were close to the camp, Roger and Katy could gather information about the pod’s behavior, including the developing mother-young relationships, even into adolescence. Griffin, in his 1973-74 *RU Report*, thinking more about animal consciousness, delightedly reported the Paynes’ discovery that adults and young spend much time playing with each other and even with other species, such as sea lions and porpoises.¹⁷⁹ Griffin’s 1975-76 *Report* described more apparent “play” by the whales. The whale holds its tail up above the water for up to 20 minutes and “sails” downwind. Then ... often, the whale turns around, swims back, and does it again, and again, and so on, for several times. How is this “practical behavior”? asked Don. It does not help food procurement, or courtship, or any obvious social communication.

Peter Tyack On and In the Sea

The next phase of research focused again on humpback whales. Peter Tyack, newly graduated from Harvard (A.B. 1976) took the year “off,” attempting to determine what was “next” for him. He worked with Roger Payne in Hawaii, continuing the studies of humpback whale songs and trying to sort out the whales’ social interactions. No question, that would be his “next.” Peter applied to RU and was accepted for Fall 1977. But a problem: At that point, Roger was “Adjunct” faculty at RU and so could not officially take on an RU graduate student. Tyack explored the possibility of working in Peter Marler’s group, but Marler was adamant that Tyack work on birdsong, not whales. Tyack spoke to the Dean, for, in his application to RU, he had specified the general research he wished to pursue. Next, a meeting with Don Griffin. Don was completely open-minded and supportive. Peter would be Don’s grad student and would “split” between two mentors: Roger teaching him the practical “how-to” at sea and Griffin mentoring the theoretical. Don was very interested in the issues and incredibly supportive of Tyack’s proposed Ph.D. project to further study the whales’ communication and social interactions (Ph.D. 1982).¹⁸⁰ Years later, Peter reflected that Don had been very emotionally supportive while intellectually very critical: no fuzzy thinking. Griffin had allowed him to explore many options in his work. As Peter Tyack continued his own career at WHOI, Don served as his model. Don Griffin had been so inspiring to him as his mentor that Peter tried to incorporate Griffin’s approach as he mentored his own students.¹⁸¹

Back to Peter Tyack and Roger Payne’s work with the humpback whales. They went out in small boats among the whales. Peter could hear faint sounds just at the water’s surface and thus determine which whale was singing below. (In fact, an Inuit hunter would put his wooden paddle into the sea, leaning the other end against his ear, to help determine a whale’s location.) The researchers could pair each mother with her calf. All this is aided by the individual IDs from the natural white markings on the whales’ flukes. The IDs let them track individual song changes over a season and over years.¹⁸²

To explore how the whales’ sounds functioned in their communication, Peter conducted underwater acoustic playback experiments of the whales’ sounds made during social interactions. Females are often accompanied by several males, each competing to be her principal escort. Other males will detect and then approach these groups from several kilometers away. How do the other males determine the location of these groups? How do the males recognize that the group’s activities are of any interest to them? From a hilltop, using a theodolite,¹⁸³ observers could determine the locations of all the animals. During the playback of the whales’ sounds, some caused several humpbacks to suddenly charge at high speed toward the underwater speaker.^{184,185} Alarming, their own little boat was not so far away.^{186,187,188} Don described this work as a “first step,” but “significant” in attempting to decipher whale communication over long distances.¹⁸⁹ Peter has continued studies of various cetacean species over his career.

Together and Apart

By the mid-1980s, as Roger and Katy were going their separate ways, they nevertheless continued their joint analyses of data collected over the decades. In particular, they published a major paper detailing the large-scale changes over 19 years of the humpback whale songs, using sonographs largely created and analyzed by Katy.¹⁹⁰ It was indeed Katy’s arduous, long analysis of the whale songs over time that led her to propose that whales changed significant parts of their songs from one season to the next. Another signature achievement, initially detected by Katy, was

the recognition of actual *rhyming* within the whales' songs; Linda N. Guinee joined her in these analyses.¹⁹¹

Katy Payne: The Rumbblings and Ramblings of Elephants

When Katy decided to pursue her independent research project, she turned to elephants. These land giants had long intrigued her. They, too, faced some of the same problems as whales, sometimes separated by huge distances in the oceans. Elephants were often similarly separated on land but needed to come together during the very brief periods when the females were able to conceive. The female releases an egg only about three times a year and is fertile only a few days around that. Furthermore, after calving, she is typically not fertile again for about four to six years. She does signal her receptivity and fertility both chemically in her urine and by her changed behavior, but a male must be present to sense her welcoming signals. To be attractive to her, he too should be in musth, a period of both increased sexual interest and aggressiveness. All males enter musth once a year, but older bulls, preferred by females, have a very long musth period, even up to six months. Researchers knew males would come from kilometers away to a fertile female. How do they know she is enticing them?¹⁹²

Switch to a different scene: It was 1984, in the Washington Park Zoo in Portland, Oregon, a zoo with 11 Asian elephants (*Elephas maximus*). Katy had permission to "hang out" with the elephants for a week, and so she did, meeting each and hearing their stories from the zoo staff. It was a week of immersion and bonding, but no striking new insights ... except, once. She was quite close to a caged elephant; she thought she *felt* a faint throbbing within her body. Another scene later flashed by, recalling how, as a young teenager, singing in a choir, the church organ was producing very loud sounds. The pitch grew ever lower and lower until the tone became quite indistinct. Finally, she *heard* nothing but *felt* a strong shuddering.

Was that happening with the elephants? Were they producing sounds so low she could not hear them but could feel them? Powerful infrasounds to communicate with each other? Back at Cornell, where she was now affiliated, she talked with Carl Hopkins and Bob Capranica, faculty members, who immediately lent her the equipment necessary to measure the low sounds, and said, "Go!"

She left for the Washington Park Zoo with two old friends, Bill Langbauer, who'd studied captive porpoises for his Ph.D. (and later worked a season in the field with me studying cognition in Piping Plovers (*Charadrius melodus*)) and Elizabeth Marshall Thomas, an anthropologist, enthusiastic animal observer and author. As so many of us have, they began the work "on a shoestring," even sleeping in the laundry room of a nearby college. Taking turns, they worked, literally night and day, recording both sounds and behavior, noting especially any "throbbing" they felt. "They" were Liz and Katy, for Bill did not sense anything ... nor did most persons. After the recordings at the zoo, Katy listened to the tapes for the first time in Carl Hopkins' lab at Cornell. They played the tapes at a speed high enough to be able to *hear* the infrasound. Would they find anything? Yes ... the elephants had been producing infrasounds.¹⁹³

Katy notes that persons who knew elephants well were not particularly surprised by their findings. Others had suspected some low-frequency communication in both Asian and African savannah elephants (*Loxodonta Africana*). But no one, other than Katy and her colleagues, had yet

recorded the sounds and, by measuring their intensity, recognized that the sounds' energy had the potential for long-distance communication. The researchers initially considered it likely airborne but suspected the vibrations might (also) be transmitted through the ground.^{194,195,196}

Let me shorten the story and strongly advise you to read, in addition to the journal article,¹⁹⁷ Katy's book, *Silent Thunder: In the Presence of Elephants*,¹⁹⁸ a thorough, engaging and intimate narrative about her work with these elephants and her continued explorations of elephant communication, behavior and conservation.

To Africa: "In the Presence of Elephants"

Within two months (January 1985), she was in Amboseli National Park, Kenya, beginning a study of savannah elephant communication with Joyce Poole. Their site was a small, but well-established research camp, where others, e.g., Cynthia Jane Moss, had studied the elephants for a decade and a half and could identify the 650 resident elephants.^{199,200,201} Katy worked for about eight years with different teams in different parts of Africa studying elephant communication. The technology advanced; the team utilized radio-collared elephants with embedded walkie-talkies. These were to permit coordinating the sounds with each other and the elephants' locations. But the walkie-talkies were not adequate for the task.²⁰²

In yet another project, Katy and her team worked in Etosha Park in Namibia. They recorded infrasound calls of females in estrous; male elephants had come after such calls were made. But, from how far? Could attractive smells of female fertility have lured them? Could there have been a *chain* of communication with each call functioning over a short distance?²⁰³

"Double-Blind"

Back at Cornell, Bill Langbauer analyzed the tapes and suggested the need for a particular experiment, the "gold standard" of experimental design, the "double-blind." In this instance, they would mount a loudspeaker atop a van. Then they'd build a tower near the watering hole with two video cameras, recording the behavior of the elephants that came to the pool. Surrounding the pool would be an array of transmitting microphones (another techy advance), recording all the acoustic productions. Occasionally, the van would broadcast pre-recorded low-frequency and other calls of different types, while the van was stationed at pre-arranged distances from the pool. The varied distances would test the range over which calls, at a pre-determined volume, could cause a response by the elephants. The critical bit, the "double-blind" part, was that "Neither the people making the videotapes, nor the people who analyzed them would know the exact timing, location, or contents of the broadcasts."²⁰⁴ The broadcast sounds and videotaping would simply be part of the day's ordinary videotaping. With such an arrangement, the scientists, both those conducting the experiments and those analyzing the recordings, would be "blind" as to whether or not a broadcast was occurring. Potential biases would be eliminated concerning the time selected for broadcasting calls or the interpretation of the elephants' behavior portrayed in the videotape.

The team varied, as necessary, from year to year, and in the first year were familiar folk: Katy, Bill, Liz Marshall Thomas (taking excellent notes of the observations) and Holly, one of the Payne daughters, doing admirable photography. A bigger team of familiar folk the second year: (Katy, Bill, Russ Charif (Cornell bio acoustician), Loki Osborn, Lisa Rapaport). But tensions emerged anyway. Out in the field, during the hot, dry seasons, the watering hole would be the only relief for

disparate and, indeed, desperate animals ... perhaps springbok, zebra, giraffe, or even a jackal, or lion, or others. "Let them drink," was Katy's or another's usual concern, before barging through with the truck and lumbering over to each mike to attach a huge truck battery, thereby scattering the animals. So, the team would wait ... an hour might pass. "They're so thirsty," Katy might growl, "baring my teeth." Bill similarly growled, "Dammit, we've gotta get started."²⁰⁵ Ever good friends, they would finally resume conducting the research.

That tension is the same faced by many researchers. They want to continue their study. But by spending more time in the field and knowing "their" animals more intimately, the scientists grow ever more sensitive to the animals' needs and well-being. Many field researchers become strong conservation advocates as they witness environmental degradation and their subjects' declining populations.

Katy's team often waited under trying conditions in the scorching sun for hours and hours for elephants to appear. Fifty-eight playbacks later, they had produced the needed data, analysis and *evidence* of elephants' response to low-frequency calls. These were responses simply to the calls, definitively *not* requiring certain odors or "chain communication." The evidence indicated that the elephants hear and respond to others' loud calls at distances as great as four kilometers. Male elephants walked, even a kilometer or more, towards the sound source.^{206,207,208} (Since many of the sounds were such low frequency, the humans, particularly those at the observation site, were not able to detect them.)

In somewhat later years (approximately the late 1990s), Katy also studied forest elephants (*Loxodonta cyclotis*) in the Dzanga National Park in the Central African Republic (CAR) with Andrea Turkalo. Andrea, having worked at the site for 12 years, could identify 80% of the approximately 3000 elephants in the park, a great advantage in any studies.²⁰⁹ During the coup in CAR, even though Andrea was headhunted, she nevertheless remained at her project site. (This is literal "headhunting," not the corporate candidate-seeking sort.)

ELP and Beyond

In 1999, with support from the World Wildlife Fund and National Geographic Foundation, Katy founded the Elephant Listening Project (ELP) at the Cornell Laboratory of Ornithology. This was a collective enterprise, including Andrea Turkalo, among others. The focus of the ELP was just that, listening and attempting to understand the elephants' communication along with their social interactions.²¹⁰

A major technological advance occurred with the PAMs (Passive Acoustic Monitors), developed through Cornell. PAMs permitted the accumulation of months of acoustic recordings time-synchronized with GPS readings. As part of the ELP, several of these devices were set out in a forest, then later collected and analyzed at Cornell. Simultaneous video recordings were made when possible, aiding in the ID of the elephants and proper attribution of the calls to the vocalizing elephant. The analysis yielded a further understanding of the elephants' movements, communications and the nature of their interactions.²¹¹ There are now hundreds of PAMS in trees in about 15 African countries, documenting the gunshots and locations of poachers, among other uses.²¹²

Griffin was extremely interested in the ELP, seeing an excellent potential for gathering further persuasive evidence for animal consciousness via analysis of elephants' communicating. In

his later years, during his retirement, he enthusiastically conveyed to Katy his ideas for potential experiments with the elephants to investigate more precisely the nature of their communication, cognition and consciousness. As part of his efforts to encourage research in Cognitive Ethology, Katy's project with elephants had been one of the applications to receive financial support from the Harry Frank Guggenheim Foundation when Griffin was its President. Indeed, during the 30-plus years of her research life, Katy relied on grant support, never holding any position at an institution except through a grant. There was always another interesting question and from it would arise a grant proposal(s) and, in most cases for Katy, a grant received.²¹³

Around 2000 was Katy's last time in the field and, in 2006, Katy retired, still very interested in conservation.²¹⁴ She also has plans, maybe, maybe, to create a book with her children from all those years of their art and journal writing on expeditions with herself and Roger.

In Summary, the Animal Behavior Group at Rockefeller University was and still is a “ferment of activity,” whether on the RU Manhattan campus, the Millbrook Field Station, or off in the field somewhere. Many promising and accomplished scientists, with diverse talents, professional and personal, spent time as part of that group. I have been able to describe only a few. I hope the reader has gained some sense of the researchers and research endeavors undertaken.

ENDNOTES

PART THREE ENDNOTES BEGIN HERE

¹ Richard N. Nash, 2016, p. 228, Footnote #36. Having researched a significant part of Griffin's career, Nash concurs with this assessment of RU terminating its association with the Tropical Research Station in Simla, Trinidad. As noted, the matters are discussed more fully in this biography in Volume 2-Chapter 14, “Behind the Man Significant Women,” section titled “Jocelyn Crane Griffin ...”

² See Volume Two – Chapter 14, “Behind the Man: Significant Women,” subsection “Jocelyn Crane Griffin...”

³ Donald R. Griffin to Theodore H. Bullock of UCLA, 12 September 1967. - Series 2: Projects -Alpha Helix Expedition (1969), Box 14, FA# 164, 450G-875, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. (This correspondence included a Research proposal.)

⁴ Donald R. Griffin (DRG), 1958a and reprinted 1974, p. 289-295, especially p. 290.

⁵ Alpha Helix Expedition in Series 2: Projects, Alpha Helix (1969), Box 14, Folder 141, 450G-875, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed Dec. 11, 2018.

⁶ Alan Grinnell's research as an undergraduate, graduate student and postdoc in Griffin's Harvard lab is discussed primarily in Chapter 11, “Bat (And Bird) Science At Harvard ... And Afterwards” in two Parts: Part 1, “Griffin's Harvard Lab: The People, The Projects,” and Part 2, “Echolocation Research by Griffin and Others.”

⁷ William R. Dawson, 2011.

⁸ Jared Diamond, 1997.

⁹ Jared Diamond, n.d., personal website.

¹⁰ Donald R. Griffin to Theodore H. Bullock of UCLA, Department of Neurophysiology, 12 September 1967, Series 2: Projects -Alpha Helix (1969), Box 14, Folder 141, 450G-875 Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

¹¹ Donald R. Griffin to Theodore H. Bullock of UCLA, Department of Neurophysiology, 11 January 1971, Series 2: Projects -Alpha Helix (1969), Box 14, Folder 141, 450G-875 Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

¹² DRG, 2003, “Millbrook,” unpublished ms. Unless otherwise referenced, the Griffin quotations in this section are from this document,

¹³ Henry Fairfield Osborn, jr. (1887-1969) had been the long-time New York Zoological Society President, succeeded by Bill Conway upon Osborn's demise. Both were conservationists, though, at least in the view of

Marler and Griffin and colleagues, Osborn emphasized the importance of scientific research in that effort. Conway, instead, in 1967, focused on developing worldwide conservation programs and structural changes at the Bronx Zoo to create more naturalistic settings for the animals. With Conway's efforts, the Zoo later acquired the Central Park Zoo (1981) from New York City and greatly improved the display facilities.

¹⁴ Jack Bradbury, personal communication, November 13, 2021, E-mail. The course, which Bradbury and likely Carl Hopkins attended, delved into such matters as circuit analysis using LaPlace transforms. So, not a simple course.

¹⁵ NSF refers to the National Science Foundation, a government entity that awards grants for basic scientific research instead of applied work. However, noting a useful application for proposed projects is certainly helpful in the grant application process.

¹⁶ Research by Fernando Nottebohm and his lab is described in Volume Two – Chapter 12, Part 4, “The RU Animal Behavior Group: Their Research ...”, subsection “Fernando Nottebohm ...”

¹⁷ Photos with the “Witch” radar apparatus are also located in Volume Two - Chapter 12, “A Tropical Paradise, Bucolic Field Station, And Early Years At RU,” Part 5, “Griffin Lab Research: Early RU Years.”

¹⁸ James and Carol Gould, personal communication, May 29, 2019. In-person interview conducted in Princeton, N.J.

¹⁹ José Torre Bueno, personal communication, April 15, 2019. Telephone interview.

²⁰ Anne Raver, 1944, September 1.

²¹ Mesabi Range, n.d.

²² Anne Raver, 1994, September 1. This *New York Times* (1994) describes the acquisition as 750 acres.

²³ Millbrook Hunt, n.d.

²⁴ Department of Environmental Conservation, n.d.

²⁵ DRG, January 4, 2003, “Millbrook,” unpublished ms. Unless otherwise identified, italicized parts are excerpts from this ms.

²⁶ Edward R. Buchler, 1976b.

²⁷ Ed Buchler had been a Postdoctoral fellow at RU with Griffin.

²⁸ Since that time, research has indicated that at least certain shrew species emit modulated constant frequency pulses rather than mere clicks. The vocalizations seem to be used to locate holes and to determine some surface characteristics. There is no clear evidence for prey detection. See a brief discussion in Chapter 11 and review in Thomas and Jalili (2004).

²⁹ It is possible that the glass-blowing shop at Rockefeller created the spherical containers rather than Ed Buchler. But, since by the late 1970s, RU no longer provided the “fountain” of research money that it had earlier and the use of any of the facilities was expensive relative to the funding available to the Griffin lab, I would guess that Ed Buchler himself created the glass spheres.

³⁰ Edward R. Buchler, 1976a.

³¹ Edward R. Buchler, 1976a.

³² The Chillagoe expedition and their use of Cyalume in the bat research is discussed in Volume Three - Chapter 15, “Before the Cognitive Revolution ...” in the section, “The Trip to ‘The Middle of Nowhere.’”

³³ M. Brock Fenton, personal communication, June 22, 2021. Zoom interview. Fenton described some aspects of both Edward Buchler's work and the Chillagoe Expedition.

³⁴ Ronald Larkin, personal communication, June 14, 2019. Telephone interview.

³⁵ Edward R. Buchler, 1980b.

³⁶ Some later research on the ontogeny of echolocating and flight is described in Volume One - Chapter 11, Part 3 – “Echolocation Research by Griffin and Others” in the subsection, “Sci-Fi Tech for Baby and Adult Bats.”

³⁷ Edward R. Buchler, 1976b.

³⁸ Edward R. Buchler, 1980a.

³⁹ In 2020, these and the other documents from Rockefeller University were removed from the Rockefeller Archives in Sleepy Hollow, and, as of April 2022, can no longer be accessed by researchers.

⁴⁰ Peter R. Marler, 1985, p.339. This chapter's sub-section title is Marler's characterization of the many research activities of Millbrook's Griffin, Marler and Nottebohm labs.

⁴¹ Richard Penny's research is described in this chapter, Volume Two - Chapter 12, Part Three, section, “Time to Establish a New Field Station with a Home for the “Witch,”” Text Box: “Short Bios of Griffin's Colleagues.”

⁴² Peter R. Marler, 1985, p.332.

⁴³ Both CR and Jack Bradbury concur with this interpretation of the events, Bradbury voicing his opinion in the telephone interview by CR on July 8, 2020.

⁴⁴ Gregory F. Ball and Robert J. Dooling, 2017.

⁴⁵ Fernando Nottebohm to Donald R. Griffin, 1 October 1980, Rockefeller University Laboratory of Animal Behavior [Griffin lab], Box 11, Folder 113, 450G-875 Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

⁴⁶ Peter Marler, 1985, p. 342.

⁴⁷ Jack W. Bradbury, personal communication, July 3, 2021, email. The quotations are from the email as are Bradbury's views about Marler.

⁴⁸ Paul Vitello, 2014.

PART FOUR ENDNOTES BEGIN HERE

⁴⁹ DRG, 1985, in Dewsbury.

⁵⁰ DRG, 1998a, in Squire.

⁵¹ Peter Marler, 1985.

⁵² Fernando Nottebohm, 2015.

⁵³ DRG, 1958a, Reprinted 1974. This is a reference to *Listening in the Dark*. However, Griffin's three books (and their revised, updated editions) which are about animal thinking and consciousness also review the work of relevant colleagues; the books are discussed primarily in Chapters 15 and 16.

⁵⁴ DRG, 1964. This is a reference to *Bird Migration*. As indicated in the previous End Note, Griffin also wrote books about animal thinking and consciousness, including research by others.

⁵⁵ Peter R. Marler and Hans Slabbekoorn, 2004.

⁵⁶ Peter R. Marler and H. P. Zeigler, 2008.

⁵⁷ Fernando Nottebohm, 1985.

⁵² Gregory F. Ball and Robert J. Dooling, 2017.

⁵⁹ Jack Bradbury, personal communication, September 19, 2020, Email.

⁶⁰ Susan S. Peters, William A. Searcy, and Peter R. Marler, 1980.

⁶¹ Jack W. Bradbury, personal communication, October 19, 2020 and July 6, 2021, Email. Compiled from Bradbury's comments about science discussions and music at the parties.

⁶² Peter R. Marler and H. Slabberkoom (eds.), 2004. This book, *Nature's Music: The Science of Birdsong* is one of the more "user-friendly" books about avian communication by Marler.

⁶² Gregory F. Ball and Robert J. Dooling, 2017, p. 934.

⁶³ Robert D. Davila, 2014.

⁶⁴ Wynne Parry, 2014.

⁶⁵ Paul Vitello, 2014b. The quotation cited by Vitello is from the newspaper, *The Sacramento Bee*, 1997.

NYTimes

⁶⁶ Simply put, human babies both in the womb and after birth are exposed to a wide variety of sounds from a specific language. The repeat these and produce other sounds in their babbling stage. The young are very receptive to learning new sounds, i.e., those of other language(s) during this time. Then, around puberty, the ability to learn other languages declines drastically, as the existent language or languages become crystallized.

⁶⁷ The Kay-Electric Sonagraph is described in Volume One - Chapter 10, "Snagging Bats ..., Part One, The Extraordinary Summer of 1950," in the subsection, "The Wonder Machine, Bats and Fish (and von Frisch's Honeybees)"

⁶⁸ Peter Marler, 1977, RU Annual report, 1976-77, p. 3.

⁶⁹ Paul Vitello, 2014. Vitello describes the significance of the Gould & Marler paper.

⁷⁰ James Gould and Peter R. Marler, 1987.

⁷¹ Wynne Parry, 2014.

⁷² Wynne Parry, 2014.

⁷³ Peter Marler, 1977. RU Annual report, 1976-77, p. 3.

⁷⁴ John F. Oates, 1999.

⁷⁵ John F. Oates, et al., 2010.

⁷⁶ John F. Oates, 2012.

⁷⁷ Alison Jolly, 1966.

⁷⁸ Alison Jolly, 2006, as cited in Paul Vitello, 2014a.

⁷⁹ Paul Vitello, 2014a.

- ⁸⁰ Alison Jolly, 1966.
- ⁸¹ Humphrey, N. K., 1976.
- ⁸² Alison Jolly, 1998.
- ⁸³ Jack W. Bradbury and Sandra L. Vehrencamp, 1976a.
- ⁸⁴ J. W. Bradbury and S. L. Vehrencamp, 1976b.
- ⁸⁵ Cayo Santiago is an island Field Station of the Caribbean Primate Research Center – University of Puerto Rico.
- ⁸⁶ Elizabeth A. Missakian, 1973. This is one of several papers published in 1973 and 1974 deriving from Missakian's studies on Cayo Santiago, PR.
- ⁸⁷ The Yerkes Field station is located in Lawrenceville, Georgia, and is part of the Yerkes National Primate Research Center, with its main facility in Atlanta, Georgia.
- ⁸⁸ Peter Winter, Detlev Ploog and J. Latta, 1966.
- ⁸⁹ Peter Winter, Patricia Handley, Detlev Ploog and Ditmar Schott, 1973.
- ⁹⁰ Steven Green, 1975.
- ⁹¹ Stephen Zoloth et al., 1979.
- ⁹² Peter Marler, 1985, p. 342.
- ⁹³ John C. Wingfield, 1984.
- ⁹⁴ Described in Peter Marler, 1987, RU publication, p. 31.
- ⁹⁵ John C. Wingfield, 1985.
- ⁹⁶ Thomas T. Struhsaker, 2021, p. 146-147, p. 471.
- ⁹⁷ Thomas T. Struhsaker, 2010.
- ⁹⁸ Thomas T. Struhsaker, 2021.
- ⁹⁹ Thomas T. Struhsaker and Lysa Leland, 1979.
- ¹⁰⁰ Jack W. Bradbury, personal communication, July 10, 2021, E-mail.
- ¹⁰¹ Carl D. Hopkins and Jack W. Bradbury's encounters with histoplasmosis is discussed in Chapter 12, A Tropical Paradise, Bucolic Field Station, And Early Years At RU," Part 2, "Trinidad - A Research Station in Paradise ... Muddy Roads, Many Bats."
- ¹⁰² Carl D. Hopkins, personal communication, October 1, 2020. Telephone interview.
- ¹⁰³ Thomas T. Struhsaker, 2021, p. 472.
- ¹⁰⁴ Carl Hopkins' research with electric fish is discussed further in Volume Two, Chapter 12 - Part 2. "Trinidad - A Research Station in Paradise ... Muddy Roads, Many Bats" in section, "Carl D. Hopkins, Rockefeller University Graduate Student."
- ¹⁰⁵ Beverly Greenspan, personal communication, May 16, 2019. Telephone interview. The names of the persons on the trip and their projects were reconstructed from Beverly's memories of the expedition and some published ms. of the students' work.
- ¹⁰⁶ Peter M. Waser and Owen Floody, 19745
- ¹⁰⁷ Peter Waser, personal communication, January 31, 2022, E-mail.
- ¹⁰⁸ Marler, 1985, p.334. The information about Nottebohm's graduate studies with Peter Marler is derived from Marler's memoir in Dewsbury, 1988.
- ¹⁰⁹ Proprioception refers to sensory information from the skin, muscles and joints.
- ¹¹⁰ Ball and Dooling, 2017, p. 933.
- ¹¹¹ Peter Marler, 1985, p. 334.
- ¹¹² Fernando Nottebohm, 1983, p. 39.
- ¹¹³ Electron microscopy (EM) is a technique for obtaining high-resolution images to investigate the fine structure of tissue and cells, including neurons, dendrites and associated entities.
- ¹¹⁴ Fernando Nottebohm, 1991, p. 37.
- ¹¹⁵ See the previously referenced bi-annual RU publications with summaries of RU research, written by the lab heads.
- ¹¹⁶ Heather Williams and Fernando Nottebohm, 1985.
- ¹¹⁷ Heather Williams, 1989.
- ¹¹⁸ Fernando Nottebohm and Arthur Arnold, 1976, cited in Marler, 1985, in Dewsbury, p. 335.
- ¹¹⁹ Autoradiography is a technique using X-ray or photographic film to visualize molecules or fragments of molecules that have been radioactively labeled. It is often used with radioactively labeled thymidine, uridine and amino acids to determine which cells are synthesizing DNA, RNA and proteins, i.e. which cells are generating new cells. Specifically, tritiated thymidine (3H-Thymidine) was used by Altman. Likewise

Nottebohm's grad student Steven Gold suggested its use as a quick way to visualize the presence of proliferating cells.

¹²⁰ Unfortunately, I am unable to find a reference to McClintock stating precisely that adult rodents could add new brain cells. "Jumping genes" refers to the movement of genes to other places on the chromosome or even to other chromosomes. Thus, even though the genes themselves might be unaltered, the resultant manifestation in the living organism would be different. Hence the different patterns in multi-colored maize that she studied over long times. That work, like her research exhibiting the control of gene expression, would not be published and she simply stopped trying to publish her continuing research on those topics for a couple of decades. Finally, in 1983, she was awarded the Nobel Prize in Physiology or Medicine for her studies, being the first woman to win a Nobel prize by herself, not jointly.

¹²¹ F. Nottebohm, 2011.

¹²² Steven Goldman and Fernando Nottebohm, 1983.

¹²³ Gail D. Burd and Fernando Nottebohm, 1985.

¹²⁴ John A. Paton, and Fernando Nottebohm, 1984.

¹²⁵ F. Nottebohm, 2011, p. 51. The work of several researchers on this topic is briefly summarized.

¹²⁶ Alvarez-Bully et al, 1988a as cited in F. Nottebohm, 2011. p. 64.

¹²⁷ F. Nottebohm, 2011, p. 64.

¹²⁸ Arturo Alvarez-Buylla et al., 1988.

¹²⁹ Rockefeller University, 1987, p. 36-37. RU Annual, 85-87, p. 36-37.

¹³⁰ Arturo Alvarez-Buylla, n.d. website.

¹³¹ Rockefeller University, 2006, March 1.

¹³² T. Seki et al, 2011. The comment was made in the Introduction to the volume.

¹³³ F. Nottebohm, 2011, p.47.

¹³⁴ Rockefeller University, 2006.

¹³⁵ Diana Kwon, 2019. Much of the information in this section about Roger Payne derives from the cited article by D. Kwon that was based on interviews with R. Payne. My other sources are referenced as appropriate.

¹³⁶ Katherine Boynton Payne, personal communication, November 18, 2020. Telephone Interview #2.

¹³⁷ Diana Kwon, 2019.

¹³⁸ Diana Kwon, 2019.

¹³⁹ Katherine Boynton Payne, personal communication, July 28, 2021, E-mail.

¹⁴⁰ Roger S. Payne, 1971.

¹⁴¹ Roger S. Payne, 1971, p. 570.

¹⁴² Jack W. Bradbury, personal communication, November 13, 2021, E-mail. The funding information about Cornell and its scientists was related by Jack Bradbury. It pertains to grants received in the early 2000s.

¹⁴³ Diana Kwon, 2019.

¹⁴⁴ Roger S. Payne, Kenneth D. Roeder, Joshua Wallman, 1966.

¹⁴⁵ Roger S. Payne, 1971

¹⁴⁶ Timothy C. Williams, personal communication, October 14, 2020, E-mail.

¹⁴⁷ Wave Hill, n. d. Wave Hill was designated a public garden and cultural center in 1965.

¹⁴⁸ Jack W. Bradbury, personal communication, July 6, 2021, E-mail.

¹⁴⁹ Roger Payne, 1970.

¹⁵⁰ Library of Congress Interview, 2017, p.1. Quote of Roger Payne. March 3, 2017.

¹⁵¹ Diana Kwon, 2019.

¹⁵² Diana Kwon, 2019.

¹⁵³ Katherine Boynton Payne quoted in Bill McQuay and Christopher Joyce, 2015.

¹⁵⁴ Bill McQuay and Christopher Joyce, 2015. Frank Watlington is quoted in this broadcast.

¹⁵⁵ Sonagrams and the Kay Electric Sonograph are described in Volume One - Chapter 10, "Snagging Bats, Tropical Trekking And Still Flying With Birds: Later Years At Cornell," Part 1 - "The Extraordinary Summer of 1950," section, "The Wonder Machine, Bats And Fish (And Von Frisch's Honeybees)"

¹⁵⁶ Library of Congress, 2017, March 31, p. 2.

¹⁵⁷ Roger Payne and Scott McVay, 1971.

¹⁵⁸ Roger Payne, 1970. In Liner of "Songs of the Humpback Whales."

¹⁵⁹ Library of Congress, 2017, p.3.

¹⁶⁰ Diana Kwon, 2019.

¹⁶¹ The Goulds' trip to Argentina with the Paynes is described in Volume Two - Chapter 12, "A Tropical Paradise, Bucolic Field Station, and Early Years at RU," Part 5 – "Griffin Lab Research: Early RU Years," in section, "A While with Whales ..."

¹⁶² Katherine Boynton Payne, personal communication, July 28, 2021, E-mail.

¹⁶³ Bernd Würsig was then a graduate student at the State University of New York (SUNY), Stony Brook. Both Roger Payne and Charles Walcott (also at SUNY at the time) were functioning as Würsig advisors. Würsig became a well-recognized cetologist (researcher of whales and dolphins).

¹⁶⁴ Katherine Boynton Payne, personal communication, November 1 and 18, 2020. Telephone Interviews. The quotes by Katy and the information in this paragraph as well as that about family life in Patagonia are derived from the two telephone interviews.

¹⁶⁵ Katherine Boynton Payne, personal communication, November 18, 2020. Telephone Interview #2.

¹⁶⁶ Katherine Boynton Payne, personal communication, July 28, 2021, E-mail.

¹⁶⁷ Katy Payne quoted in Bill McQuay and Christopher Joyce, 2015.

¹⁶⁸ Roger S. Payne, 1970.

¹⁶⁹ Peter Winter, Roger S. Payne, and Paul Halley, 1987. C

¹⁷⁰ Roger S. Payne, 1995. Scribner Book Company.

¹⁷¹ Library of Congress, 2017, p. 3.

¹⁷² Katherine Boynton Payne's remarks as contained in an interview by Bill McQuay and Christopher Joyce on NPR, August 6, 2015.

¹⁷³ Roger Payne and Douglas Webb, 1971, p. 112.

¹⁷⁴ Roger Payne and Douglas Webb, 1971, p. 138. The authors also note that "... it has remarkable low attenuation with distance (3 dB in 5,600 miles,) and is the best octave for lang-range propagation under polar ocean conditions."

¹⁷⁵ William N. Tavolga, cetacean scientist, quoted in Roger Payne and Douglas Webb, 1971, p. 140.

¹⁷⁶ Quotation by Roger Payne taken from Diana Kwon, 2019.

¹⁷⁷ Ted W. Cranford and Peter Krysl, 2015.

¹⁷⁸ National Oceanic and Atmospheric Administration, U.S. Department of Commerce, n.d.

¹⁷⁹ DRG 1974, p. 2. In *R. U. Annual Report, 1973-74*.

¹⁸⁰ Peter Tyack, 1982.

¹⁸¹ Peter Tyack, personal communication, June 26, 2019. Telephone interview. The descriptions in this paragraph and others of Tyack's work and his reflections are derived from this interview. Other references are noted as appropriate.

¹⁸² DRG, 1978. In *RU Annual Report, 1977-1978*, p. 1.

¹⁸³ A theodolite is a surveying instrument with a rotating telescope for measuring horizontal and vertical angles.

¹⁸⁴ DRG 1985, in *RU Sci. & Ed. 1983-85*, p. 29.

¹⁸⁵ Peter Tyack, 1983.

¹⁸⁶ Peter Tyack, 1981. Cited in Griffin, 1985, *RU Sci. & Ed. 1983-85*, p. 29-30.

¹⁸⁷ Peter Tyack, 1982. [Ph.D. Dissertation]

¹⁸⁸ Peter Tyack, 1983.

¹⁸⁹ DRG, 1985, in *RU Sci. & Ed. 1983-85*, p. 29.

¹⁹⁰ Katherine Boynton Payne and Roger Payne, 1985.

¹⁹¹ Linda N. Guinee and Katherine Boynton Payne, 1988.

¹⁹² San Diego Zoo Wildlife Alliance Library, n.d.

¹⁹³ Katherine Payne, 1998. Chapter 1-"A Throbbing in the Air," p. 13-29. The episodes described can be found in greater detail in this section of the book.

¹⁹⁴ Katherine Boynton Payne, personal communication, November 18, 2020. Telephone Interview.

¹⁹⁵ Katherine Boynton Payne et al, 1986.

¹⁹⁶ Katy Payne, 1998, p. 14-15

¹⁹⁷ Kathryn Boynton Payne et al., 1986.

¹⁹⁸ Katherine Payne, 1998.

¹⁹⁹ Katy Payne, 1998, p. 44-45.

²⁰⁰ Joyce H. Poole et al., 1988.

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- ²⁰¹ Note that Cynthia J. Moss, the elephant researcher is *not* the bat scientist, Cynthia F. Moss.
- ²⁰² Katherine Boynton Payne, personal communication, November 18, 2020. Telephone Interview.
- ²⁰³ Katy Payne, 1998, p. 109-110.
- ²⁰⁴ Katy Payne, 1998, p. 110-111. The description of the experiment is also from p.110-112. Additional details continue through p. 114.
- ²⁰⁵ Katy Payne, 1998, p. 113-114. Comments on these pages by Katy Payne and Bill Langbauer have been slightly paraphrased and used in my text.
- ²⁰⁶ William R. Langbauer et al, 1990.
- ²⁰⁷ William R. Langbauer, Jr., Katharine B. Payne, Russell A. Charif, Lisa Rapaport, Ferrel Osborn, 1991.
- ²⁰⁸ Both Langbauer et al (1991) and Katy Payne, in her book of 1998, note that the 4 kilometers was an extrapolation based on the fact that the elephant could respond to a sound at half volume at two kilometers distance. Louder sounds were distorted by the loudspeakers, and so were not used.
- ²⁰⁹ M. Thompson, S. J. Schwager, Katherine B. Payne, and Andrea K. Turkalo, 2010.
- ²¹⁰ Elephant Listening Project, n.d.
- ²¹¹ Katy Payne, personal communication, 2002, Competitive and Cooperative Behaviors among Forest Elephants in the Presence of a Limited Resource, Summary of Research Grant. Unpublished ms.
- ²¹² Katherine Boynton Payne, personal communication, August 28, 2019. Telephone Interview.
- ²¹³ Katherine Boynton Payne, personal communication, November 18, 2020. Telephone Interview.
- ²¹⁴ M. Thompson, S. J. Schwager, Katherine B. Payne, and Andrea K. Turkalo, 2010.

CHAPTER TWELVE

A TROPICAL PARADISE, A BUCOLIC FIELD STATION, AND EARLY YEARS AT ROCKEFELLER

PART FIVE - GRIFFIN LAB RESEARCH: EARLY RU YEARS

Overview

Griffin and his lab continue to focus primarily on bird navigation, the phenomenon of echolocation, and the mysteries of the honey bee “waggle dance.” While such investigations require researchers to invent new technologies, solving these scientific puzzles also requires long hours of lab work and expeditions to far-flung places that harbored bat or avian species of particular interest.

a) Birds

Griffin is concerned both about the actual paths followed by migrating birds and the sensory basis of their navigation. The “Witch” and his team join the WHOI Researchers aboard the vessel “Atlantis II.” As the WHOI group studies deep-sea marine life, Don’s tracks migrating birds over the ocean past Bermuda.

How do the birds arrive at their destination without any land cues? Can they fly between clouds with *no* visual information? Is there a “silver bullet,” *the* sensory basis for avian migration and navigation? Do birds use multiple cues, with various species possibly relying on different cues? Might different stages of the birds’ flight depend on different cues? Are birds sensitive to magnetic fields, to infrasound?

b) Bees

Other students deal with the sensory basis of honeybees’ ability to determine the correct direction and distance of a food source that the forager bees then communicate to other bees. Are bee dances symbolic? Jim Gould’s ingenious experiments with “lying” bees firmly establish the locational information contained in the honeybees’ waggle dances. But how accurate is the bees’ information given to other hive members? What factors facilitate or constrain the bees’ proficiencies? “Sky maps” of polarized light are shown to contain useful information for bees and other species.

Griffin’s Lab Members

The Appendices of Volume Three include some with information about both Griffin’s work and that of his associates in his labs at Rockefeller and other universities, and others with information about the entire RU Animal Behavior Group:

- “Timeline: Griffin’s Life, Honors and Major Projects” reviews the major events of Griffin’s life and research projects.
- “Timeline: Griffin’s Students and Associates (Cornell, Harvard and Rockefeller Universities)” lists known students and associates, the dates of their degrees, their research interests, and main affiliation(s) post-Rockefeller days.
- “Research by Griffin’s Students and Associates (Partial) – Location in Book” indicates the primary locations in this biography where that individual’s research is described.
- “Members of The Rockefeller University Animal Behavior Group (Griffin, Marler & Nottebohm Labs” contains a list of the members of Griffin’s RU Lab as well as those of

Peter Marler and Fernando Nottebohm along with known dates of association and/or Ph.D. degrees.

Track the Birds! ... the Voyages of Atlantis II

The Atlantis II sea expeditions were among the efforts requiring numerous volunteers. She was a 200-foot seagoing vessel belonging to the Woods Hole Oceanographic Institution (WHOI) traveling to Bermuda in the autumns of 1971 and 1972. Ronald P. Larkin was among those on board in both 1971 and 1972 and I in 1972.¹ Other “Griffin crew” members included Donald and Jocelyn Griffin (1971), electronics engineers (Larry Eisenberg, 1971 and Mike Rosetto, 1972), and Susi and José Torre Bueno (both trips, though José only the first half of 1972). José was Griffin’s grad student and Susi was Griffin’s research assistant.

Ron and I were the “outside” volunteers. Ron was then a Rockefeller grad student in Carl Pfaffman’s lab engaged in a Ph.D. study of the neurophysiology of hunger in rats. I was a post-doc with Peter Marler and deep in the throes of data analysis on monkey communication. We were delighted to get away for a while. After completing his Ph.D., Ron joined the Griffin lab and became the lead author of the research resulting from the two Atlantis voyages. Both expeditions were joint undertakings between Rockefeller University, specifically Griffin’s team, and the Woods Hole Oceanographic Institution (WHOI) of Cape Cod, Massachusetts.

The Question

Griffin and his team were studying the migratory flights of birds from the New England coast of Northeast USA to overwinter in the Caribbean or South America. So very few of the migrating birds were seen or captured in Southeastern USA. Were these birds, many tiny 15-gram warblers (Family: *Parulidae*), actually flying across the North Atlantic Ocean, through the Sargasso Sea by Bermuda, to points southeast in the neotropics? That seemed quite unbelievable. It was such an incredibly long voyage! No distinctive visual cues were available from the “ground,” in this case, the sea. What was guiding them? If they were actually crossing the ocean, what route did they take? Did they fly in a direct path? What was their orientation, i.e. “heading,” during the flight? At what altitude were they flying; how fast? What might such findings suggest as to the physiological adaptations needed to survive such an arduous, long over-water flight ... if that was what they were doing? In short, what was the land migrants’ flight *behavior* over the open ocean? Could the birds be identified, perhaps by their size or specific “flight signature” (i.e. wing beat frequency, style of flight) or even vocalizations made as they flew?

There was already a large body of data, some from a decade earlier, indicating that many bird species from the UK and Europe as well as North America *did* migrate over large bodies of water. These data were drawn from radar on mainland sites, a few observations from radar on islands and ships as well as banding studies and direct observations of birds from ships at sea.^{2,3,4,5} Except for data from migration across the Mediterranean Sea,⁶ no substantial amounts of data had been collected from radar on ships. None were available for a journey from New England to Bermuda. During the time of the Atlantis II voyages, another Griffin protégé, Timothy Williams, and his colleagues⁷ were conducting a five-year study, begun in 1969, with a network of 11 “search” and “tracking” radars. Data from the 1971, 1972, and other Atlantis II voyages as well as those from a 1973 voyage of another ship, the R/V Knorr,⁸ were to be included. The network stretched from Nova Scotia to the Caribbean.

The essential difference between “search” and “tracking” radar is that “search” (aka “surveillance”) radar, does not identify a single target but scans a volume of airspace for detectable objects. These might be the presence of a plane(s) or a flock of birds or any mass of flying objects; it plots range and azimuth. (Loosely speaking, “azimuth” is the vertical angle of an object with respect to the observer.) The “tracking” radar locks onto and follows a single item, extracting maximum information. It can produce quite precise data about range, azimuth, and, in particular, altitude. Thus, unlike a search radar, a 3-dimensional track can be plotted.^{9,10} A tracking radar also records the radar echo from an individual bird, thus possibly permitting ID of the species from wingbeat signature, size, etc., as indicated by the echo. The “Witch” (a “tracking” radar), could lock onto and follow the height and direction of travel of individual birds, second by second.¹¹

The network of radars supported the data that were gathered from the joint RU-WHOI Atlantis II voyages. That network also added further evidence for the prevalent theory of the day that many birds from North America *did* follow a coastal route, generally south/southwest/southeast. That coastal route had been well-known for a century and had long been considered the *only* route. The overwater route was the newer idea.¹² Quite where the many coastal migrants left the coast and turned southeast, heading over water, appeared to be, then and now, quite variable.^{13,14} As Williams notes, it is quite likely that some birds cross the coast, turning and heading southeast from points “all along eastern North America.”¹⁵

But even the precise definition of “coastal route” to tropical regions was a matter of considerable heated controversy, especially during the late ‘60s, but also beyond. Whether some passerines were flying south/southwest *following* the coast or whether they were simply flying south/southwest was a point of contention ... to this day.¹⁶ That is a more interesting question than it may seem to a non-ornithologist because flying along the coast could be done by attention to visual and acoustic cues. Flying in a specific direction suggested “vector” flying. To do so meant the birds were genetically programmed to head in a specific direction, perhaps aided by learning, perhaps using stars and the sun to guide them. Another alternative: the controversial “drifting” hypothesis, spearheaded by the ornithologist, Bertram Murray.^{17,18} Were the birds possibly reaching sites such as Bermuda, not by following a trans-Atlantic route, but merely “drifting in” with offshore winds?

Existing radar reports did indicate birds leaving New England and then flying south over water. But that was not evidence of what happened next. Did birds, or some birds, continue flying south or southeast over the waters of the Western North Atlantic? Might they instead turn back southwest towards the coast and then follow the coast? Thus, Griffin’s proposal to gather radar data from aboard a ship all the way from New England to Bermuda was splendid. The Atlantis II voyages provided the first detailed, three-dimensional data on tracks of migrants flying without land-based visual cues.¹⁹ As we shall see, data from both the Atlantis II voyages as well as that gathered by the Williamses from the big NASA tracking radar at Wallops Island²⁰ indicated avian directions and groundspeed (as well as wind speed), which showed the birds were not merely “drifting” into their destinations with the winds. Furthermore, the specific flight speeds and direction used, a result of severe evolutionary selection, were necessary to survive several days of flying without food or water in varying winds and likely challenging weather.²¹ Numerous birds do die on their migratory flights.

The Equipment: A “Witch,” Susi Balls, and Balloons

For the Griffin team to track the migrating birds over the seas was not a simple matter. A ton of the lady “Witch” had to be hauled from Rockefeller Field Station in Millbrook, New York to Woods Hole, Massachusetts, and then raised onto the ship Atlantis II. More volunteers were needed. As far as memory provides, even José’s mother, Evelyn Torre-Bueno, joined the effort. She drove the truck loaded with the “Witch” bound for WHOI.²² “She” (the “Witch”) was then welded into position.

The “Witch” would permit radar tracking, but ... would she be able to withstand the pitch and roll of the ship and still function effectively? To test that, beforehand, Griffin had devised a “Tilting Machine” aka the “Seasick Machine” as everyone termed it. The device mimicked the motions of the sea. At IRAB in the Bronx Zoo, NYC, the “Witch” radar and shack were placed atop the machine.²³



The “Seasick Machine,” 1971. (Photo by Ronald P. Larkin)

(Don’s green Rambler station wagon is off to the left, pulling the machine slowly back and forth to simulate a ship’s roll. The plywood doors are open just enough to let air in for the radar operator without permitting unsecured items to fall out.)

The “Seasick Machine” was yet another example of Griffin’s thinking through possibilities and concocting a “Rube-Griffinberg” machine to handle the situation. (Such was the term used by Don and colleagues to describe his typically quite effective, but peculiar inventions. The label was derived from the inane contraptions devised by the cartoonist Rube Goldberg, famous for his illustrations in many newspapers of the time.) Success: Dipping as the waves might, the “Witch” still found and tracked the birds.

Among the lighter bits of equipment brought to Atlantis II were bright red balloons and “Susi balls.” The balloons were sturdy weather balloons chosen for their visibility, filled with helium, and released into the sky. Though the helium was light, the tanks that held it were not, and

secure fastening was needed to prevent their careening about on deck. Attached to each balloon was one Susi ball from the huge pile brought to the ship. The balls had been invented and “manufactured” by Susi Torre Bueno. Onboard for both voyages, she was promoted to a higher-level oversight role on the second, when Griffin was not on the ship. As Ron Larkin noted, “Susi was an amazing assistant; she put her heart into it.”²⁴ Back at Rockefeller University, in the old 5th-floor lab rooms of Smith Hall, up in Millbrook, onboard the Atlantis II, or working just about anywhere, Susi had patiently scraped out most of the insides of numerous Styrofoam balls to lighten them. She then covered each ball with aluminum foil. Many, many were needed for, often, several were used each night in the land radar studies back “home” and numerous ones during the days and nights onboard the Atlantis II. (Alas, at the end of the voyage, the crew misunderstood directions and tossed overboard a bag of Styrofoam bits given to their temporary care, mistaking them for refuse. Susi had painstakingly saved every scrap of Styrofoam, keeping it all in that bag for still other uses.)

Once attached to a freely rising balloon, a ball was to be “caught” on radar, so altitude, wind speed and direction could be determined. Before a bird appeared on screen, one needed to be ready with that wind information and to be certain the Witch had “decided” to perform adequately that day. (An essential team member was an onboard electronics engineer, available for immediate repairs.) Then the same radar would hopefully “capture” birds flying by and similar information could be gathered for them. Yet another piece of data was the velocity and direction of the ship itself, so still more tedious calculations. That information was kept in the ship logs and checked by the researchers.²⁵

Where Are the Birds?

The exact dates of the trips were planned far in advance, determined primarily by the availability of the vessel, but necessarily at times of expected significant avian migration. The WHOI aquatic project was more flexible in that its “target” population didn’t show such extreme variation over time. The marine research, however, was central, for it was paying the \$3,000/day charged to funded projects and the Griffin team were, in effect, “guests.”²⁶ The marine scientists were capturing fish and other marine specimens from “the deep,” working in the dark of night and bringing forth the most exotic species. The lift to the surface was done as slowly as possible, in hopes that the creature would not explode from the huge pressure decrease as it rose. Each night was thrilling, and we non-WHOI sorts would rouse ourselves to be there as the newest specimen appeared, some being entirely new species, not previously known to science.

As to the birds, they did not appear so reliably. Who’s to know exactly when a bird will choose to fly? A great deal of research had been conducted on that topic by the time of the Atlantis II voyages,²⁷ but planning the trip a year in advance does not permit exact specification of the date(s) of each species’ major migration. Weather was a significant factor. A “cold snap” aka “cold front” was the usual immediate impetus for flight, particularly if followed by “favorable conditions.” Such conditions were usually strong northwest winds²⁸ which helped the birds move off the coast and along their way towards Bermuda. More recent research indicates that the entire “synoptic” weather summary has to be considered, i.e., the pressure pattern fronts, wind direction and speed, as well as likely changes over the next few days.^{29,30,31}

In 1972, the anticipated cold front on the New England coast did not initially materialize. After a front passed the coast, birds were always observed on the ship’s radar and/or through

binoculars, but during the two voyages, there were long periods between “waves.”³² So, we patiently sat in the claustrophobic tiny dark cabin that housed the Witch, slowly turning the handle that moved the old radar to scan the skies. We stared at the green radar display screen, hoping for one or more moving brighter green blips that indicated a flying object. Nothing, for hours and hours and days and days.

Tracking the Birds (and the “Unseen Listener”)

Two persons were “on duty” at a time, one adding voice and other data recording if necessary, during a four-hour shift, two shifts per day. We had two screens available: one, the “scope” aka “A-scope” (from “oscilloscope”) and the other the PPI (plan position indicator). Once a blip appeared on the radar “scope,” if it were strong enough, we could activate the auto-track circuit to follow it. This was the case for most single songbirds tracked to ranges of 1,000 to 1,500 meters. If not auto-tracked, as occurred when targets were very far, e.g. some birds that appeared at altitudes of 4,500-5,000 meters, then we could make manual radar fixes every few seconds. (Birds were also flying at higher altitudes, but the “Witch” could not track them.) The scope was displaying the range (distance), but not the direction, of a target. Information contained in the radar echo, that had bounced off the target, was extremely useful. Fluctuations in the radar echo indicated changing strengths of the echo, as occurs when the bird beats its wings, thus, possibly a creating “wing signature,” distinctive for that species.

To determine the direction and height of a target, we turned to the PPI screen. Here, displayed in polar coordinates, with the radar antenna as its center, were the range and direction of the target from the radar. Knowing the angle the radar was pointed, using trigonometry, the height of the target was calculated (back at RU). Specifically, the tracking radar generated information about azimuth, elevation and range. These appeared as proportional DC voltages, then converted to meter readings, manually recorded every 15 seconds. There was also audio backup for the meter readings, namely, recorded tones, with frequencies proportional to the DC voltages. By 1972, for at least part of the cruise, additional backup was provided by digital recordings on standard magnetic tape. To be certain to capture all relevant information, the audio recording was on continually, time synced to the other automatically recorded data. Later, with the aid of the Rockefeller University Computer Center, “the altitudes and flight paths of the birds were determined from the meter readings or the analog or digital tapes;” comparisons yielded satisfactory agreements.³³

When birds *were* detected, life in the tiny cabin was extraordinarily busy. On the many hours of “no birds,” the radar scope still demanded close attention, for, at any moment, a “blip” *might* appear; a bird *might* be discovered. While watching, the radar operators either sat silently or chatted and gossiped, quickly oblivious to the unseen “listener,” the continually active audio recorder. Those tapes still exist, perhaps affording interesting “inside” views socially and scientifically.³⁴

Expedition Life

Back to the expeditions: Both voyages were conducted for about three weeks in September and October, sailing from Woods Hole, though for the second trip, there was a two-day stop in Bermuda with a crew exchange. Many arrived early to explore Bermuda, typically on an inexpensively rented motor scooter. The Bermuda Biological Station staff was most friendly and

welcoming and hosted the Griffin team for a night before the voyage with a tour and lecture. The splendid slides of ocean creatures and marine studies enthralled the group; what new sea creatures might be found on the expedition?

But the voyage: I opted for the 4 am and 4 pm shifts, thinking, with the transition between day and night and the sunrises and sunsets, it was likely to be a beautiful and stimulating time on the sea. Even with radar duties, particularly given the many “birdless” days, one person could reasonably be “on guard,” with the other just outside. Weather permitting, one could also open the cabin door and see outside. And what marvels! The tropical sun in its constantly varying grandeur, flying fish, silvery and skimming above the water.

On “off-hours,” a surreptitious climb below into a small room in the bow of the ship, illuminated with only a dim red light. There, visible through the portholes, might be dolphins swimming and cavorting together. They undulated through the water in balletic movements close to the slowly moving vessel. Off hours, there was also a most pleasant library room with scientific books and well-chosen leisure reading. Delicious food appeared for dining, a surprise. It was a wise staffing decision, for good food certainly bolsters morale, when, as *does* happen, the science is not progressing as rapidly as one hoped. The chef also wisely chose to work in warm weather onboard the ship and at upper-echelon ski lodges during the winter. And even on a 4-8 pm shift, one could be excused on occasion to accept an invitation to a small cocktail group with Professor John Teal, a WHOI marine ecologist and leader of the expedition.

Dining was highly segregated by rank. As described by José Torre Bueno:

Officers and crew had a separate mess. All scientists were defined as officers, but the table where you sat depended on your rank, so each of us had to be given an equivalent rank. As a senior professor, Griffin was equal to a captain so he and Jocelyn ate at the captain's table with the captain and chief engineer. As a mere graduate student, I was a very junior officer and ate with the 3rd engineer. I think Ron was senior to me and ate with a more exalted officer.³⁵ [CR: The memories are foggy after all these years, and I have no idea where I ate.]

There were few women on board, for in those days in science, including Rockefeller University, women were not considered truly able ... at least, that is my point of view of the prevailing culture. (The issue of women in science will be discussed in Chapter 16, “Revolutions.”³⁶) And the sea was a “man’s world.” Jocelyn had accompanied Don Griffin on the first, the 1971 joint voyage, but there was no co-habiting permitted on board, even for married folk. José and Susi Torre Bueno were a case in point; she recalls it being considered “bad luck” on the ship for a couple to bed together while on board.³⁷ Quite possibly, there was likewise a lingering sense that even having women aboard was playing with one’s luck. There are vague reports of the soft-spoken, restrained Don Griffin not being either, and an exception made in their case, but that cannot be verified. Neither Don nor Jocelyn came in the second year. When volunteering with Griffin, I kept mum about my condition, though as has been seen and shall further be seen, he was supportive of women scientists. At the time of departure, my pregnancy was obvious, but too late, I was there. I did my tasks with no difficulties. People were solicitous, overly so, but I politely managed to assert my independence.

The “No Bird Blues”

Despite the intelligent company, good food, glorious sunsets and engrossing deep-sea finds by the WHOI team, no birds were appearing for the Griffin team; things got depressing. To counter it all, the scientists, non-musicians all, composed the “No-Bird Blues,” singing and performing music with homemade, or rather shipmade, instruments. A rattle was among the simpler creations, while more advanced instruments were boxes with rubber bands to plunk. Recordings, perhaps moldy by now, exist somewhere among the participants’ stuff.

But then the birds *did* arrive. One afternoon, a very small flock landed on the ship, appearing to empathetic eyes, quite exhausted. They had not been seen on the radar, for that was aimed higher up, where migrants typically fly, usually even higher in the daytime than at night. (José Torre-Bueno experimentally investigated the physiological basis of the “high-flying” for his Ph.D. and subsequent research, which shall be described more fully later.)

Fun Times? Data Analysis ... and Even Computers!

Other migrants did finally arrive in good numbers within a few more days and the Griffin team was enthusiastically busy. After the voyage, back in the far drearier lab setting at the Manhattan Rockefeller campus or in the old barn, Griffin’s chosen research domain in Millbrook, Ron Larkin, José Torre-Bueno and Donald Griffin conducted data analysis; John Teal added input as needed. Susi Torre-Bueno also helped, including tedious data entry,^{38,39} a task finally eased by Ron and José’s computer programming. But that required a computer. Some persuasion was applied to Griffin and he responded by purchasing a new, sophisticated computer for them, “sophisticated” for its time.

That’s a story in itself. First, a bit more about the “tedious” data entry as described by the researchers themselves. The “Witch” yielded data in spherical coordinates, i.e., 1) azimuth (roughly, the horizontal angle of a compass bearing), 2) elevation and 3) range. But biologically relevant data is more meaningfully expressed in XYZ, i.e., Cartesian coordinates 1) (North, South, East, West), 2) AGL (Above Ground Level, where “ground” is whatever surface is directly below) and 3) distance. To do so involved hours upon hours of converting each data point by use of an HP (or other) hand calculator to do the trigonometry involved. Not fun.⁴⁰

As previously noted, Griffin himself was neither computer “literate” nor a programmer, nor did he wish to be. (He did, later, use a computer to “write.” His preferred method, ‘til the end of his life, was handwriting, typically on a yellow-lined pad.) But then Ron, maybe others, did some persuading: Griffin purchased a computer for the lab, this in the early 1970s. That was a PDP-8, the first under \$10,000, and one of the first you could actually sit at and program. Unlike others, it did not fill an entire room but was a mere 2 feet by 2 feet by 18 inches high.

It was in Griffin’s lab that José was first exposed to computers, this one. (As we shall see, computer programming became a major focus of José’s much later life.) Both Ron and José taught themselves to program in FOCAL, a major programming language of the day. However, one could not construct a program larger than 4K. These days, one digital photo on our “Smartphones” is likely to be several Megabytes, i.e., around a thousand times the size of one of the programs they were writing. (A Kilobyte (K) is 1024 bytes and a Megabyte is 1024 K.) Ron and José were stymied, needing at least another 8 K of memory to write any program; that was more thousands of dollars.

They approached Griffin. “What are you doing” he queried. “Bird tracking.” Don said OK with little hesitation, though he was quite amazed that “so much memory” was required to write a program.⁴¹

Ron described the computer usage with the Witch:

The old Witch would grind and clunk as it pointed its antenna at a flying animal and the TTY [teletypewriter] would punch holes at 10 characters/second. The racket was fatiguing. Griffin was delighted with these advances, appreciated the computer technology strictly from a distance, and was wont to tell people the little cab on the Witch trailer ... was a “space capsule on an NSF budget”.

[As Griffin described the marvel, he would be] grinning, holding his hands out with clenched fists and making motions like a dog digging a hole, motivating everyone in earshot. ... His infectious enthusiasm was one of his best assets as a scientific leader⁴²

However, no storage space was available on the computer; storage was on paper tape. The tape was an advance from its forerunner, thin cardboard cards, aka “Hollerith cards,” with punched holes indicating data or programming ... *if* the cards were kept in the proper order. And they, in turn, had been an adaptation from “pre-computer” days when similar cards drove automatic weaving machines and were used in census tabulating mechanisms. (Wonder if there were “hanging chads” in those days, too?) There was no ROM (Read Only Memory) which importantly holds “start-up” memory to begin the computer’s working each time. Thus, if the computer crashed, which it did just about every day, one restarted with paper tape reload and binary codes, an annoying task. The “one” who performed the operation was Susi.⁴³ To simplify the startup, Susi just memorized the entire required binary code.⁴⁴

Even with computer assistance, the data analysis was long and complex. Griffin’s letter to his collaborator John Teal after the second voyage certainly implies that.⁴⁵ In it, Griffin discusses wind velocity and bearings taken via balloon before and after bird trackings. Should Teal wish to see them, Don offers to photocopy 300 + pages of such tables. The difficulties of precise data analysis are further suggested by the considerable delay between the voyages of 1971 and 1972 and the journal publication finally in 1979. That may not be unusual for some scientists, but for the efficient Griffin lab, it was.

There was never a third joint voyage and even RU’s participation in the second cruise had been problematic due to funding needs for an electronics expert.⁴⁶ Although Rockefeller *had* an excellent electronics staff, individual laboratories *paid* for their assistance at rather stiff rates. During WHOI planning for a third voyage, the radar was having problems, and Griffin wrote to John Teal that he didn’t think he could persuade another Larry Eisenberg or Mike Rossetto to join the expedition and one was *needed*.⁴⁷ (Both Larry and Mike were deeply involved in other RU projects.)

The Results ... After Intense “Discussions”

After the enormous amount of data analysis, discussion ensued, sometimes quite heated, over the best and most plausible interpretations. Finally, some remarkable results emerged from the two voyages. Previously, it was widely thought that migrating birds, particularly small birds like warblers, with relatively little fat reserve, must fly overland for much of the journey and stop for rest and foraging. But the Atlantis II data were gathered out at sea, several hundred kilometers from land. Extrapolations of the birds’ flight paths strongly suggested that birds, even those flying at high speeds, may take several days to cross the western North Atlantic. This occurs without

stopping for rest, food or water, for there is no place to stop. Some pelagic birds may eat fish or other marine organisms along the way, but they are the exception. An impossible overseas migration ... but it was happening! Birds have much greater endurance in both their time aloft and the distance flown than had previously been thought.⁴⁸ The data from the other radars involved in the network of installations supported these and the other findings of the Atlantis II voyages.

The Atlantis II data (and the other sources) also showed that the birds' flights were generally oriented correctly, without visual ground cues to guide them. Thus, the birds turning off the coast of the eastern USA were moving southeast until they hit the area of the Sargasso Sea. Once there, "they turn as they encounter the northeast trade winds."^{49,50} Data from the Atlantis II 1971 and 1972 voyages and other installations in the radar network showed that "aided by those winds, they move in a southwesterly direction over the region occupied by the Caribbean islands."⁵¹ Thus, they can reach their final destinations in either the Caribbean or South America. As summarized by the Williamses, "The analysis of headings suggests that a remarkably simple guidance system is adequate for this 3,000 km. flight."⁵² The birds described, apparently small passerines, need only to head Southeast, and then, impacted by the trade winds, reach their "intended" destinations. (Note that "heading" is the bird's orientation, whereas the "tracked flight direction" is the heading as impacted by the prevailing winds.) From a scientific viewpoint, some consider this consistent heading of songbirds while out at sea to be the *most* significant finding of the two Atlantis II voyages and the other Atlantic Ocean radar work.⁵³

Flocks or No Flocks?

Furthermore, surprisingly, the birds captured on the radar usually seemed to be flying alone or in small groups, though when a "wave" of birds appeared, others were not very far behind. Diffuse targets indicative of flocks were simply not observed. However, with further research, the data were more mixed, in part depending on one's definition of a "flock." Ron was involved in research using a different tracking radar that occasionally showed species, probably the same as those observed on the Atlantis II 1971 and 1972 voyages, that *did* fly together, but in dispersed aggregations. Those birds could be apart by a hundred meters or more.⁵⁴ Similarly, Tim Williams notes that from extensive studies with radar at Antigua in the Caribbean, "diffuse targets" were observed with airspeeds suggesting songbirds, in turn suggesting flock flight formation.⁵⁵

Who's Migrating?

Identification of the species on target was typically not possible. Large birds such as waders, do have distinctive, slow wingbeats that can be preserved in the radar's returning echo. With the data set available, the only distinctions that could be drawn definitively were between slow and rapid wingbeats or continuous and intermittent patterns of flapping flight; i.e. not identification of individual species.⁵⁶ The inadequacies of the old radar (the "Witch"), complexities introduced by the pitch and roll of the sea, and the data analysis techniques simply did not allow more precise determinations.⁵⁷ Yet, as Tim Williams insists, "Don't sell the 'Witch' short. ... With the data she gathered, one should be able to do as good an ID as any of the NASA radars."⁵⁸ (Maybe not with the rolling and roiling of the sea.)

On both cruises, however, observations were made of all land birds *seen* far from land, defined as >110 km away from North America. Twenty-three species from 11 different families

were identified by some very excellent, avid birders aboard.⁵⁹ These were John M. Teal and David D. Masch,⁶⁰ a long-time member of the WHOI Biology Department as Teal's Research Assistant as well as an ardent fisherman and raconteur on the local Woods Hole public radio station. Crew members likewise did sightings, all of the above vying to be the one to first identify a bird.

The "Mystery" Targets

There were also "mystery" targets. Some, many, were showing perplexing slow airspeeds⁶¹ of less than five meters per second. That speed seemed inconsistent with the energetic requirements of long-range flight.⁶² Just exactly what these targets might be was the matter of the most intense discussion. The targets were certainly small, perhaps small warblers? Ron thought they were likely insects, for many insects do migrate and would be flying more slowly than birds. The others were not so convinced, although at least one other scientist, Roger Payne,⁶³ did agree with Ron Larkin.

Several factors argued against the insect interpretation, in particular, the timing. It seemed unlikely that insects would be starting a journey that late in the year and after a sudden cold. Furthermore, the slow targets were being detected at altitudes higher than previously reported for insects over the ocean.⁶⁴ With some hesitation, and with distinct recommendations for further research, the authors concluded the slow flyers were probably birds as well. More to come!

There were other matters of intense "discussion" in addition to the issues of species identification and the bird/insect controversy. In Ron's view, the electronic filters used with the data blurred details and prevented one from seeing critical aspects of the flying patterns. Thus, it was harder to pick out different kinds of animals – bats, birds, insects, and, of course, the species. Other bird/radar researchers trusted and used the same standard signal-processing methods as Griffin. If one analyzed the data differently, applying computer power instead of then-standard electronics, Ron insisted that one could see "remarkable stuff" in the wing beat information. In Ron's memory, Don Griffin disagreed, and, when the issue was raised, simply stared at the wall. Whatever their differences in these data interpretations, Ron did admire Griffin: Don Griffin was "very insightful." In Ron's view, Griffin knew so much more than many others using radar techniques for animal studies, including the physics involved. As a member of Griffin's lab, Ron worked on numerous projects, with both advice and supervision from Griffin.⁶⁵

Ron Larkin, the "Witch" and Bugs

A further word about the "Witch." It was bequeathed to Ron Larkin by Griffin when Ron left Rockefeller University in 1980. Griffin had decided that after 12 years of working with the radar on avian migration, he was ready to move on to other research endeavors. He was already deeply ensconced in issues of Cognitive Ethology.⁶⁶ He recognized Ron Larkin's avid interest in the radar research and was happy to support that. (As an aside, even in 2020, Larkin, likewise "thrifty," as was Griffin, still often used the Witch, but installed on a "new" 1984 trailer.)⁶⁷

While at RU, Larkin had created some essential improvements in computerizing the research, some on his own, some collaborating with José Torre-Bueno. Griffin was justly proud of their work. The computer could analyze in real time the range of the birds, their azimuth and elevation. Griffin could plot the flight paths of individual birds before him in three dimensions. It

was accurate, even to about a meter, though the birds could be flying hundreds of meters above. As he operated the equipment, he was absolutely delighted. Said he, "I felt *was* a bird."⁶⁸

As so many of Don's former students and lab members have asserted, Don Griffin had creative, significant new ideas, and formidable persistence. He happily admitted, however, no interest nor ability in computer programming. He did admire engineers and engineering and was most ingenious throughout his life in designing rather esoteric instrumentation for the task at hand. However, he could perform only minor repairs on the Witch. That needed a bona fide engineer as well as *someone* who "knew" the Witch and the tasks she needed to do. There was the superb (and expensive) RU electronics lab to help, but Larkin's expertise was going to be sorely missed.

Ron's departure was occasioned by a Rockefeller University policy change. RU President Seitz had decided that the university was becoming too "ingrown," with graduate students often becoming Assistant Professors and then continuing up the RU Professorship ladder. Thus, a new criterion ensued, probably appropriate for the long-term development of RU but harsh on the young faculty. No Assistant Professor who was a Rockefeller Ph.D. would be able to advance to an Associate Professorship and be granted tenure. This caused the immediate departure of young faculty intent on obtaining a tenure-track position or beginning some other potential long-term appointment. Ron Larkin was among them.

Thus, in 1980, Ron Larkin moved to a position at the Illinois Natural History Survey (INHS), an appointment that Griffin was instrumental in helping Ron obtain. A 1982 letter from Griffin congratulates Larkin "on getting so many interesting projects underway" and writes that he is glad that Ron has been recognized for the "good job you have done getting real data out of such an ancient radar." Griffin does, however, wonder, "Are you now tending toward the view that the low airspeed targets are insects? I should think not, because of your actually seeing birds ..."⁶⁹

Larkin, however, remained convinced that the radar on the earlier Atlantis II expeditions was finding slowly moving targets that were insects, not birds. He continued research on the matter while at INHS. After determining flight speed distributions of over 1,800 "birdlike" targets and over 700 "insect-like" targets as well as reanalysis of data from the Atlantis II voyages, he provided convincing evidence that the slow movers *were* insects. To accomplish this, he used "that ancient radar," the "Witch." He also had equipment not available on the Atlantis II journeys, namely a radar-controlled high-power telescope and a very bright spot lamp that permitted one to see the magnified "target" under high illumination. The analysis also included different filtering methods for the data. The data were most surprising; they showed that insects were not only abundant in the warmer months but even fly overland during March and November in temperate North America. And to provide confusing data for future researchers, "the insect targets overlap with birds in the amount of radar echo returned."⁷⁰

Too esoteric?

I have described in some detail both the data collection process and just a few of the intricacies of analysis to give a sense of the complex difficulties of the tasks and the dedicated effort and expertise needed by researchers to conduct the studies. Should the reader consider the various migration studies as just "too esoteric," do consider the implications for conservation. We need to know where the birds and insects fly and when, which species, and the factors that promote or impede their flight and well-being. A world without insects and birds, or even reduced numbers of

such, is a world without adequate pollination of our foodstuffs and of the flowers that grace our gardens and tables. It reduces the populations of animals up the food chain dependent on plants and animals below ... all this including the animals which provide the meat we humans choose to eat.

Research by Griffin Lab Members

José Torre Bueno, Griffin Graduate Student, and Susi Torre Bueno, Research Assistant (Hot Birds?)

José and Susi were another young couple, married but a year before José began RU grad studies. José had graduated from Stony Brook State University, New York with a biology degree (physiological and evolutionary). After much volunteer radar work, Susi had been hired to be Griffin's Research Assistant.

Challenging Times: Guyana and Electric Fish ... and a Snake

Other fieldwork, besides the Atlantis II voyage, engaged José during his RU graduate days. He was part of the previously described special Africa trip offered to the Animal Behavior graduate students. By Marler's suggestion, José had a preparatory "practice tropical immersion" in Guyana, South America. There, he was to help Carl Hopkins, who was completing his Ph.D. thesis research with electric fish. On Carl's initial flight to Guyana, he had brought a massive load of new scientific equipment, suspicious, new, expensive equipment that could take photographs and make sensitive recordings, among other mystifying functions. Most suspect. At the time, Guyana had just "finished up a revolution."⁷¹ So, Carl's trip into the interior to his research site was delayed by the authorities for several weeks, until, somehow, it was decided he was not a security risk. Perhaps, once again, it was the many bright red "official" stamps on Rockefeller University stationery that helped to convince the powers-that-be of the scientific merit of the situation.

About a year into Carl's research, José came to help, together with Susi and Carl's sister, Dolly. Once again, they were held up in Georgetown, the Guyanese capital, for what at least *seemed* like several weeks. Finally, they received permission to join Carl. Americans were highly suspect characters. Approved to travel, the threesome set off via a local plane to the interior, a DC-3, a propeller-driven aircraft, one of three in Guyana. They unpacked their folding chairs for the flight; not too many amenities were provided. Trying to ignore the various bullet holes, left over from the recent Revolution, they concentrated on the close-up landscape view provided by their low-flying plane. Presumably, the plane was flying so low, since it probably couldn't be fully pressurized with all those leaky little holes.⁷²

At the project site, they all helped. José was the designated "Research Assistant." He did his best, though not convinced he was actually of much aid. But José also actually helped save all their lives. It was rainy season when José and the women were visiting. During one particularly drenching night, the small stream near their tent, usually six feet or less deep, had flooded and risen to 30 feet. The water was above the wooden platform where their tent was laid and the entire group was sitting outside on the platform. Suddenly, a snake was seen climbing on the platform. Maybe José was closest, but, for whatever reason, Carl directed José to get a stick and flick the snake away. José did so. Only hours later, did José realize how dangerous his move had been. The snake

was a fer-de-lance, the most dangerous snake in Central and South America, causing more deaths than any other American reptile. José stopped shaking after a while.⁷³

Carl's thesis project concerned the electrical communication system of *Sternopygus macrurus* fish that lived in the stream, the nearby one, the one usually far below them. As a key step in data gathering, Carl transformed the varying electric pulses produced by the fish into acoustic signals, and the researchers determined which series merited further attention and recording. For Carl, the determination was quite simple, for Carl had "perfect pitch." José notes that he, himself, was tone-deaf. Nevertheless, data were gathered and it was time to return to RU and analyze those data.

At the airport, a panic. Carl had forgotten the trunk with all the research data at the hotel. As he dashed back, José tried to stop the plane as the doors were being closed ... to no avail. José left with the equipment and Carl was stuck in Guyana with the data, all the funds and the official export papers for the equipment. They were all anxious: Marler was going to be furious about this mess-up. And Susi was covered so badly with insect bites that she was medically "suspect" and scheduled to be placed under quarantine upon arrival. José had Carl's sister with him. The three arrived in the U.S., there to face Customs in New York City. How to be allowed through?

Susi's father, Bill Kramer, to the rescue:

A thief had abandoned a car in front of Bill Kramer's home the week before; he had alerted the police several times, but they never came. Finally, Bill broke into the car and found the owner's info from papers in the glove compartment. Quite serendipitously, the car belonged to the Head of New York Customs. With the official license plates, it could have easily driven into any Customs area in New York, and the car thieves were very shortsighted to have abandoned the car without making nefarious use of it. The grateful Customs officer exclaimed, "If ever I can do anything for you ..." and he handed Bill a box of Scotch (probably confiscated) when he picked up the car. Bill told him, "My daughter is coming back from two months doing research in the rain forest in Guyana, and if there is any way you can help them get through Customs quickly, that would be great." The official gave Bill a letter that was, essentially, a get-out-of-jail-free card for Susi and her travel companions.

Susi had been pulled aside at Customs in New York; her hundreds of mosquito bites suspected of being smallpox. José, of course, had no paperwork for all the scientific equipment, and no clearance for all the specimens of electric fish bottled in alcohol. Customs started taking everything apart and spreading it all out for very close inspection, when - lo! - Bill Kramer walked into the Customs area waving a seemingly magical document. The Customs people hurriedly re-packed everything, and virtually shooed the intrepid trio, with all their gear, out of the area. Carl's equipment arrived safely back with them at the Rockefeller Campus. Even in "developed" countries, luck and the right paperwork pave the way.⁷⁴

As previously noted,⁷⁵ when Carl Hopkins analyzed the data, the results provided a significant advance in the field of electrical signaling: *Sternopygus macrurus* was the first known example of a fish with sexually different electrical discharge, peculiar to each mated pair.^{76,77}

An Advisor and a Thesis Project

Having thus explored some research projects, including significant time with the radar research, José decided he was definitely interested in conducting a thesis project with Griffin. As they spent nights in the radar shack at Millbrook together, José felt that Don Griffin was an easy person to work with. Despite the age disparity, he was always a good companion. He seemed always like a colleague, not “the” mentor. “He always made you feel comfortable.” One night at dinner, José recalls Don and he arguing with another professor, possibly about animal intelligence, but whatever the topic, they agreed strongly with each other and disagreed with the professor. At one point the professor made a comment, thinking that José was Don’s son. “We were close,” remarked José to me. In the British system, José continued, there is much ranking (a subtle reference to Peter Marler’s group?); “It was never like that in his [DRG’s] lab.”⁷⁸

On another occasion, José’s very first day at the RU campus, Griffin took him to lunch in the main dining room. They sat at one of the “long tables,” intended to encourage the social mixing of people and ideas from different labs. As José described the scene:

*We sat down across from the great geneticist Theodosius Dobzhansky and Griffin politely introduced me as a new graduate student. The very first thought that popped into my head that I had to bite my tongue to keep from uttering was “Oh I thought you were dead.” Meeting someone out of a textbook was that overwhelming.*⁷⁹

A wind tunnel was necessary for José’s proposed research. In the attic of the Millbrook Station barn, José was instrumental in both designing and helping construct a wind tunnel, part of Griffin’s dream to investigate the behavior of both birds and bats as they were flying ... but close at hand. As described by his friend and fellow Griffin lab member, Ron Larkin, José was on top of all the construction efforts. There was local carpentry help and Griffin himself, who simply “couldn’t keep his hands off” the building project.⁸⁰

By this point, and indeed continuing throughout his research life, José chose to investigate the physiological aspects of avian migration and other phenomena, rather than the strictly behavioral. How did the migrating birds manage their daunting task?⁸¹ Most often, they were tiny warblers, the most common taxon of North America’s four billion migrants, As the Atlantis II research had indicated, some warblers, as small as 15 grams, managed to fly non-stop, even 1000 or more kilometers. Why didn’t they get overheated with their enormous effort and simply die? Migrating birds often flew at quite high altitudes. As generally assumed, were they doing so to fly in a cooler environment and thus dissipate their rising body heat by conduction to the colder air? (It should be noted, that others, such as Timothy Williams, had radar data showing that high-altitude flight occurred when that altitude afforded favorable winds, and that lower-altitude flight occurred when winds were favorable at such lower altitudes.^{82,83} Quite possibly, body temperature, altitude temperature and wind direction were all factors impacting the bird’s choice of altitude.)

Flyin’ in the Wind

Up in the Millbrook attic, the wind tunnel was drawing air in one roof gable and blowing it out the other. The air temperature was controlled by warming with an electric heater, or simply by placing the room thermostat inside the apparatus. Cold was produced by conducting research on cold nights and blowing the cold air into the tunnel. Initially, the subjects were warblers. In the apparatus, one small warbler actually flew for 16 hours straight.^{84,85,86} And José’s admiring friend,

Ron, who'd spent much of his night with the radar apparatus, noted how at 6 am, José was still awake, having observed the bird throughout the night.

But José wanted to be able to measure the bird's temperature regulation as it was flying at different temperatures in the wind tunnel. In natural circumstances, birds are capable of flying through the hottest deserts as well as -50 degrees C. air, that encountered at altitudes of about 11 km.⁸⁷ Were the birds adjusting their internal temperatures to be able to do so without fatal consequences?

When José conducted the research, scientists had studied thermoregulation in resting birds, but almost nothing was known about flying birds.⁸⁸ To measure both the internal core temperature and skin temperature of the flying birds, José used very lightweight thermistor transmitters surgically inserted in the peritoneal cavity and under the breast skin. But the skin varies in thickness and hence temperature readings might also vary, so he had four thermistor transmitters under the breast. Even though these small apparatuses were very light, they were still a concern for implantation into so tiny a bird as a warbler. For his dissertation studies, José, instead, used the common, locally available and more hefty starlings (*Sturnus vulgaris*). In others' prior experiments, birds had been carrying either heavy, bulky transmitters or trailing wires behind them, both likely to interfere with natural flight. By using implanted transmitters, José's experiments did not face those confounds. His research entailed longer, more realistic flight times, namely between one-half to two hours, whereas previous work involved flights of less than 10 minutes, sometimes less than two.⁸⁹

Training the starlings took considerable time, such that after three weeks to two months of daily training, only about one-third of the starlings would fly in the wind tunnel for more than an hour without disturbance. One starling did fly continuously for eight hours. During their training, the birds had to be convinced to *fly* in the wind tunnel. They were to do nothing else but fly, no landing, no clinging to the net at the outtake. A stick or a hand placed in front of the likely landing site discouraged those unwanted behaviors.

Hot Birds

After this arduous, often extremely chilly work, José obtained some noteworthy results. Initially, for most flights, a core temperature overshoot occurred, lasting between five and ten minutes (the duration of others' previous research). It then settled into a lower, steady state, maintained as long as the bird could fly without disturbance. Presumably, this represents the temperature maintained during an extended flight in the wild. The slightest disturbance, however, even loud noise, would substantially change the core temperature, suggesting possible hazards faced by migrating birds, which suffer significant losses during their travels. The bird's skin temperature became constant even more rapidly than did its core.

The birds adapted behaviorally as well, increasing their beak opening and opening an initially closed beak as ambient temperatures rose.⁹⁰ But the core temperatures (42.7 and 44.0 degrees C) were among the highest observed in healthy birds and 2-4 degrees C above a starling's resting temperature. They were probably just a few degrees below lethal values. Remarkably, "the core temperature was independent of ambient temperature over the entire range at which the birds were willing to fly."⁹¹

José proposed several *possible* functional explanations for this sustained high core temperature. His suggestions derived from the intriguing fact that, for humans, with increasing core and muscle temperature, both maximal work output and muscle efficiency increase.⁹² The research on humans also showed the same initial temperature overshoot seen in the starlings, perhaps giving an extra boost to the muscles at this critical time. In short, it was likely *efficient* to have both a fairly high core temperature and an even greater “boost” from a yet higher temperature when beginning flight or exercise.

His other Ph.D. studies concerned the rate of evaporative cooling by starlings, a challenge faced by birds flying long distances. Long-distance avian migrants typically arrive at their destination, having lost weight (fat reserves), but not dehydrated. Yet José’s work described above showed an increased body temperature incurred during even 90 minutes of flight. In cooling studies, he showed that evaporation in the wind tunnel accounted for a significant part of the heat loss and radiation and convection the rest. Migrating birds, he suggested, might fly to higher altitudes and lose heat by convection to the atmosphere, rather than evaporation, thereby maintaining the adequate water balance required for survival.

Decisive Birds?

But does a bird actually *make* such a decision? How to demonstrate that experimentally? José further adapted the wind tunnel, so that a starling could choose the side to fly through: one side had heated flowing air while the other simply used the cold night air from the outside. An ingenious, simple invention up in the Millbrook barn attic. However, for the previous experiments, it had taken four months for only two of the 30 birds undergoing training to reach the criterion of 90 minutes of uninterrupted flight. The training for the choice problem was even slower, but the birds that were trained *did* choose to fly in the cold air.⁹³

High Flying in a Low-Pressure Chamber

Afterwards, during his post-doctoral fellowship at Duke University, North Carolina, José continued his studies with much more sophisticated equipment. The wind tunnel was inside a completely sealed, airtight pressure chamber. Clad with an oxygen mask, and sitting outside the wind tunnel, but inside the chamber, José could continue breathing as the air in the chamber was evacuated. The chamber thereby achieved the low pressure encountered by birds flying at high altitudes. Wind speed in the tunnel could be modified. Since the wind tunnel was sealed, carbon dioxide and oxygen levels of the air could be measured while the bird was flying. Thus, the bird’s consumption of O₂ and production of CO₂ were determined.

But even with this equipment, training was tedious, requiring 1-2 months, and then only 5 of the 100 birds beginning the regime reached the 90-minute criterion. But the results were quite startling to theories of the time, which proposed a large change in metabolic rate at the flight speeds for which Torre-Bueno and Larochelle determined quite stable rates.⁹⁴ “Ground-breaking research” exclaimed Ron; in his view, José was not sufficiently appreciated for this thermoregulation and metabolism work.

Magnetic Fields Again

While at RU, José had conducted pilot studies of avian response to magnetic fields. Likely, an interesting line of persuasion underlay this particular research. Jim Gould and Mike Brines had demonstrated the presence of magnetite and magnetic orientation in honey bees (*Apis mellifera*).⁹⁵ Griffin's response to that result was a sardonic, "Magnetite? Very nice, very nice." Jim's interpretation was that Don thought, "we were out of our minds." To begin to be convinced, Griffin wanted potential receptors and neural mechanisms to be identified. Nevertheless, Jim believes he was instrumental in inspiring Griffin to consider the possibility of magnetic sensitivity seriously enough to initiate experiments investigating the phenomenon. In Jim's view, Griffin had lived through so many of the "false alarms" in that field, that he was even more skeptical than his usual skeptical self. Jim thought Don was probably convinced that any evidence for magnetic sensitivity was an illusion created with statistics.⁹⁶ I'd surmise that José's magnetic fieldwork with starlings may have originated via Griffin's characteristically subtle persuasion.

The research history entailed Griffin's and others' failed attempts to train birds to make choices based on sensing earth-strength magnetic fields. Torr -Bueno decided to test the possibility that birds needed to be flying to be able to respond to the fields. As José recalls the project, Ron and Don constructed the magnetic field apparatus, including a means to switch polarity.⁹⁷ Using the same wind tunnel, José attempted to condition starlings to fly to one side or the other dependent on the direction of the magnetic field in each; that direction was manipulated by magnetic induction coils on each side. The results: no suggestion of any sensitivity to magnetic fields, none. There were no published results.^{98,99}

Gould was quite dismissive of the approach. As he described it, Don wanted the bird to fly left, flip a switch, then fly right, click again, fly left, etc. [In other words, Jim thought that Don wanted the birds to exhibit their sensitivity to magnetic fields by responding immediately and distinctively to any changes. If, in an experimental setting, the birds were flying to the right with one field orientation, should the field direction be reversed, the birds should instantaneously make an about-face and fly left.]

Jim recalls Griffin's flippant remark, "If they don't use it, they should try."¹⁰⁰

Jos 's Later Work

After his Duke University postdoc, Jos  stayed as faculty, conducting related physiological studies with starlings, then humans. His sabbaticals at U. C. San Diego and the Max Planck Institute led to an increased interest in programming, then in imaging hardware. He left Duke after 10 years, forming a company to create color-based imaging for medical use, a first for those times. He was particularly gratified by his developing an algorithm to detect a subtype of breast cancer. Most recently, "retired," he designs energy optimization software for his son's solar energy company.

Magnetic Fields and the Navy

Ron Larkin continued some research investigating avian magnetic sensitivity. For one spring migration season (1975), while in Griffin's lab, Ron and Pamela Sutherland, an RU grad student, joined Timothy and Janet Williams' ongoing Ornithar ("search") radar study of bird migration. The project was conducted at the Clam Lake Navy Test Site in Wisconsin (WTS) (fall 1974 and 1975).^{101,102} The Navy's interest in funding the studies was less about bird migration than a concern about the environmental impact of the Navy's Clam Lake antenna system. That system

generated Extremely Low Frequency (ELF) radio frequencies and associated electromagnetic fields, which might interfere with bird or other migration, and possibly even other wildlife behaviors.

The “Witch,” a “tracking” radar,¹⁰³ came with Ron and Pam. With its short 80-100-meter *minimum* range, the “Witch” provided detailed movement data for birds flying at very low altitudes. For the Clam Lake project, the team tracked to only about 300 meters above the ground.^{104,105} The intensity of the A-C magnetic field declined linearly from the antenna, so one expects that major impacts, if any, would occur closer to the source. The Ornithar had a shorter minimal range, capable of detecting birds as close as 10 meters, while it could also detect small birds up to about a kilometer.¹⁰⁶

Both data sets indicated that the direction of the migrating birds was impacted somewhat when they flew over the antenna region. The Ornithar results indicated a change in average flight direction of 5 to 25 degrees when the antenna was activated. The “Witch’s” data showed that individual birds (about 12% of them) turned or changed altitude more frequently and that, at least up to 1 km distance, no effects of distance from the antenna were noticed. The “non-linear” tracks were more frequent when the antenna was on than off and even more frequent when the antenna was modifying its condition.¹⁰⁷ But ... importantly, some “Witch” tracking data showed that many affected birds quickly recovered the correct migration direction.

Also, importantly, by moving the Ornithar to three different locations, the Williamses showed deviations in bird flight as great as those occurring when the Ornithar was stationed at the antenna. Possibly, some geographic variability, perhaps due to rich iron ore deposits in the region,¹⁰⁸ could have at least temporarily distorted any sensing of the earth’s magnetic field that the birds might be using. The Williamses concluded that “migration in that area was geographically highly variable and there was no clear antenna effect.” Larkin and Sutherland, however, concluded that there *was* an antenna effect,” but could “not say whether it is merely temporary or may seriously affect their migration.” They did note that “many birds resumed nearly their normal course after swerving,”¹⁰⁹ i.e., the behavior appeared correctable by many, if not all, the birds observed in the radar data.

In short, both teams had somewhat different, though limited, conclusions, with Larkin and Sutherland being warier about the potential effects of ELF on bird migration. The Williamses concluded that the ELF was “unlikely to have a major impact on the orientation of birds migrating over the site,” but both teams recognized their research was just a beginning and further work was needed. The Navy’s proposed further development was a very large-scale antennae grid, much, much greater than the ELF at Clam Lake. The intended grid would serve as part of an extensive communications operation. Even the ELF’s broadcast signals were “powerful enough to be detected deep underwater in any ocean on Earth. The antenna wires were something like two cm [about 0.8 inches] in diameter and the capacitors the size of a kitchen garbage can,” i.e., very large.¹¹⁰ If a far more powerful grid was planned, distance and exposure duration should be investigated.¹¹¹

Although the Navy may not have been totally pleased with the study’s potential implications, the research did provide some evidence supporting avian sensitivity to magnetic fields. To be specific, the flying birds were sensitive, at least, to alternating current electromagnetic fields, during night-time migration. Their sensitivity was even greater than that required to detect the earth’s magnetic field, at least as concluded by the Larkin team.¹¹² (Williams does note significant differences between the ELF field and the earth’s: “... the “ELF, like all radio waves, has a

magnetic component, but would not be considered equivalent to a static magnetic field such as the earth's field.")¹¹³

As Ron commented, even though an article about the "Witch's" data was published in *Science*, "no one believed it."¹¹⁴ Having testified about his findings at a Navy meeting, he was met with "Harrumphs."¹¹⁵ And, several years later, writing in 1985, Griffin recognizes that while scientific interest had shifted to exploring the possibilities that birds both sense and use the earth's magnetic field for orientation, "the marginal evidence leaves me unconvinced."^{116,117} In a similar memoir, written in 1998, *perhaps* one could consider his views ever so slightly more positive when he writes that it continues to be an "exciting scientific challenge."¹¹⁸ As the extensive earlier discussion¹¹⁹ indicates, most scientists now accept the proposition that birds and many other species are sensitive to magnetic fields, in particular, the earth's, and likely use it for migration and perhaps other tasks. Receptors have been suggested, and are a current "hot" area of research, though not proven to everyone's satisfaction. Yet, Jim Gould contends that, given Don's skepticism, he still probably would not be convinced.¹²⁰

The "Witch" at RU (And Sounds in the Sky)

Meanwhile, during the early 1970s, the "Witch" was still at Rockefeller, and significant research with her continued.

Sounds Aloft

Among the investigations by Griffin and his team was the potential role of sounds in helping birds navigate correctly. Birds are known to rely on visual cues, but often, there are none, such as intensely cloudy circumstances. It appears that birds *do* try to avoid flying then. A summary of studies at the time indicated that "virtually all radar observations show that far fewer birds migrate in cloudy weather than when skies are clear."¹²¹ But sometimes birds do find themselves in severely overcast situations, a topic of intense interest to Don. (His "cloud experiments" will be discussed later in this chapter.) Are auditory cues possibly guiding them? But what can flying birds hear from ground level? In his usual inquisitive manner, Don had read reports and questioned balloonists. They reported "a wide variety of natural and artificial sounds audible up to 3,000-5,000 ft. altitudes where most birds commonly migrate."¹²² Might migrating birds be guided about a location from sounds such as a chorus of croaking frogs to suggest a marsh or the sounds of crashing waves to indicate a coastline? Do the sounds of other birds possibly lead them, or, in the case of alarm calls or predator's calls, deter them? Might they even be echolocating, using some particularly loud sounds in their repertoire? Echoes from such calls could determine the reflectivity of the ground surface beneath, yielding some cues as to the type of surface, particularly if water or land. Echo characteristics could also yield information about the bird's altitude. In fact, in the early 1970s, Griffin's lab was measuring both the acoustic properties of flight calls and the coefficient of sound reflection for various ground surfaces. Surprisingly, most vegetation reflects a very high proportion of flight calls.¹²³

Carl D. Hopkins and Frog Sounds in the Sky

Having completed his Ph.D. thesis (1972), Carl Hopkins was open to persuasion from Griffin to join him in a project. They would attempt to establish whether migrating birds in the sky could

hear those very noisy frog choruses on the ground, specifically those at the RUCFR Millbrook grounds. So, during the avian spring migration, in chilly April and May 1972, Don and Carl set off for the swamps and ponds at the Field Station. The “Witch” was nearby, to determine wind speed and direction from a helium-filled balloon with an attached “Susi ball.” The “Witch” likewise ascertained the location of a radio microphone suspended 30 feet below a helium-filled tethered balloon (a kytoon). The choruses being recorded on that microphone were produced mainly by the lusty “spring” or “leopard” frogs (*Rana Pipiens*) and spring peepers (*Hyla crucifer*); it was mating season and they were doing their loud best.

All this to determine what the birds flying above could hear; what intensity and frequencies from the frogs were reaching them? Just before Griffin and Carl were about to launch the balloon, Carl suggested they calibrate their measurements. On their truck, Don had an extremely loud foghorn alarm, typically used by boats to warn of their approach; most probably he had “borrowed” it from his own sailboat. Don held the meter next to the wireless (radio) microphone and Carl backed off in the truck and blew the horn, several times, at different locations. They now had a measure of decibels (loudness) as determined by the sound level meter and the corresponding recorded amplitude on the tape recorder. They now knew that a certain voltage of output corresponded to a certain sound level. This took all of 10 minutes and provided quantitative data for their intended study. An essential contribution by Carl.

Results of the experiments with the mike and balloon aloft indicated that the *Rana pipiens* mating croaks could be recorded up to 500 meters and, on especially favorable nights with light winds, even up to 965 meters, i.e., almost a kilometer. These heights were definitely within the range of migrating birds, as were the amplitudes of the recorded sounds. (Birds’ sensitivity and frequency range are typically quite similar to humans, except that some birds are less sensitive above 10 kHz.¹²⁴) In a subsequent study conducted primarily in the spring of 1973, with improved and extended measurements, Griffin achieved similar, though more refined results.¹²⁵

All these results suggested that other natural sounds, including those that continue over longer periods of the year, could also be heard by migrating birds. Such might be the stridulations of insects, of wind blowing through forest trees, etc., all potentially providing information about the terrain below.

Griffin was impressed by the fact that sounds through the atmosphere traveled farther than sound traveling overland. The intensities decreased more slowly than expected from the inverse square law. By this “law,” a physical quality is inversely proportional to the square of the distance from the source, be it electricity, light, gravity, or sound. But not for travel up through the atmosphere, where temperature differences, for example, affect the speed of travel. Sounds move faster at cooler temperatures. And there are refraction and scattering to consider. Recall that refraction or “bending” of the sound waves occurs as the waves enter a different or differently dense medium. Should there be a condition of “temperature inversion,” when temperature increases with increasing heights, the sound waves may be refracted downwards and so may be heard over longer distances.¹²⁶

The atmosphere also absorbs sound, more so as the frequency increases. Several hundred meters of air act as a low pass filter, i.e., allow more of the low frequencies to pass through. Thus, sounds are distorted. With experience, such distortions of familiar sounds could hypothetically

provide a bird with an altitude estimation. The matter is yet more complicated, for the amount of absorption depends on both the temperature and humidity of the atmosphere.

There were other concerns. Can a flying bird hear the sounds despite the noise it is generating, e.g., that due to air flowing over its surface or through its respiratory tract or past the ear canal? The latter might not be a problem, for birds have specially adapted feathers to avoid such turbulence. The issue of refraction due to temperature and other factors plagued Griffin as he struggled, over years, to determine a potential role of sound in avian migration. Similar issues of attenuation, etc. by the atmosphere were also of consequence for bats' ultrasonic echolocation.¹²⁷ But all the speculations and constraints, suggested Griffin, provide avenues for future research.¹²⁸

In Carl Hopkin's view, he did little with the research, and Griffin magnanimously added his name to the first paper. In fact, his suggestion to calibrate that night was significant in determining the final results, and Griffin appreciated Carl's contribution. Don was pleased to add a publication to a new academician's CV. This concern for promoting a young researcher's progress was quite typical of Don Griffin. Unlike many other lab heads, he frequently left his own name off publications produced from research conducted by members of his lab but typically aided with many of his suggestions.

Honking Geese ... and More

The "Witch" didn't help this particular project, though it might have, had the geese been more cooperative. "Somewhere between the Azores and Portugal" (June 4, 1973),¹²⁹ Griffin wrote a long letter to "Ed [Buchler], Joe [José Torré Bueno], Ron et al," the first of several letters to Ron Larkin back at Rockefeller. Don exhorted Ron to ... record honking geese.

Why honking geese? Don was traveling with Jocelyn but had also been reading some papers. He raised the issue of "echolocation of the ground or water by flying birds?" He included some detailed tables of expected echo intensity under different atmospheric conditions. In particular, he detailed the percent of expected sound reflection for different initial sound pressure levels and different distances the initial sound and its echo must travel. He noted that in addition, absorption, which depends on frequency and humidity, must also be taken into account. Don concluded, "I believe ... a really loud bird might well hear echoes. Obviously, low frequencies would be better ..." He cited Swan's "speculative" article that suggests geese may be echolocating the Himalayas.¹³⁰ "...Pretty vague but certainly geese are good candidates with loud and fairly low frequency calls."

Again, a few weeks later,¹³¹ Don was writing to Ron, this time from Pisa, Italy. (Don was there, collaborating on studies of horseshoe bats with Jim Simmons, then at Washington University.)¹³²

In his letter, Don was again, in his gentlemanly way, exhorting Ron to record honking geese: *The more I think about it, measuring sound levels of flight calls via the slaved Witch is a good idea – also geese in daytime without radar – just sound level meter at distance measured by the Rangefinder, or even just estimated. We would probably need to take the calls along with known intensity steady tones or bands of noise.*¹³³

[The "slaved Witch" is the radar unit working in tandem with another instrument such as an acoustic tape recorder or computer or sometimes, an intense searchlight to illuminate the target. The proposed set-up would permit the recording of flight calls while simultaneously gathering the bird's location information with the Witch.]

Ron made attempts at recording the geese in what are truly earnest, if laughable, exercises. He even managed to inveigle Ed Buchler, a Griffin post-doc, into assisting him. At first, the “common” geese (*Branta canadensis*) simply couldn’t be found. Then, on some other days, they were. The two researchers would sneak up on them, recording equipment at the ready. The geese would have none of it. They flew or simply went off; Ron and Ed ran stumbling after them. No goose sounds recorded. After several attempts, the two young men quietly abandoned this particular focus of Don’s interests.

Ron Larkin responded to Griffin’s letter on July 24. He included many details about cables and equipment and mounting techniques for the Witch ... and finally reported quite briefly and simply ... on the failed goose attempt:

*Ed and I tried the goose recording plan one day. We managed to do the same thing wrong several times in succession, got stuck in the mud, forgot the notepad, then got all set up. Rush the geese and they waddled into the water, without as much as a quack. Ed's laughter was all we managed to record.*¹³⁴

On July 28, 1973,¹³⁵ an empathetic response from Griffin in “Roma,” Italy on the difficulties of recording geese, but he continued to push. He specifically indicated several sites in Dutchess County, N.Y. [where Millbrook is located] with many migrating geese in the fall and those that overwinter. “... the problem is to be there and ready at the right moment.” [i.e., with the migrating geese flying within range, and the tracking radar and acoustic recorder operating, or, for geese waddling along the ground, just the necessary acoustic recording equipment and distance estimations] Griffin’s concerns for thriftiness are also evident as he thanks “Joe” for digging into surplus possibilities for needed lab equipment.

That seems to be the end of correspondence about recording honking geese. Again, however, in 1986, over a decade later, Griffin wrote a postcard from India to Ron at the Illinois Natural History Survey. Griffin was still convinced of the likely significance of sound, maybe echolocation, in guiding avian migration:

*Look where Jocelyn has taken me now. This trip has been mainly to places where she has duly “confronted originals” in sculpture from Jaipur to Sanchi. ... I saw about 50 Birds in one of the sanctuaries including **bar-headed geese** [*Anatidae indicus*] **that had flown over the Himalayas.** [Bolding by CR]*

[Note that Jocelyn was working on a Ph.D. at NYU in Art History, received in 1991; she had a passion for visiting “original” sculpture sites.]

A Long Letter from Kathmandu¹³⁶

No papers were ever published by Griffin and/or Larkin about geese honking. However, Griffin kept urging Ron to undertake studies of birds’ responses to various avian and natural sounds broadcast from the ground. In a handwritten letter of July 17, 1973, from Kathmandu, Nepal, Don muses,

You may wonder why I scribble so much from here. We find we are saturated after a few hours and Jocelyn works over galley proofs while I scheme away.

[The galleys were for her magnum opus, *Fiddler Crabs of the World*, decades in the making.]

I shall quote extensively from that long, five-page letter to give a sense of Don as a mentor, as the scientist mulling over ideas, and, finally, also as the researcher who was so deeply immersed in his work that it dominated any “vacation” of the usual sort.

The “mentor” Griffin emerges immediately after that first sentence. He is concerned that the fledgling academic, Ron, follow along the path to a successful future.

Dear Ron,

First, let me reiterate the hope that you are not neglecting the paper(s) from your thesis work. Do get that done before getting too involved with fall migration.

[Alerting Ron to future research plans]:

I have promised myself and NSF to have a go at human echolocation during the current year. I had hoped that Glenis¹³⁷ would join in such an effort, but she is obviously not going to.” I am not urging you to, but warning that I may draw on some audio electronics into that effort, but probably not actively until after migration season.” ...

[Griffin does undertake explorations into human echolocation, to be described in Chapter 15, “Before the Revolution.”¹³⁸]

[After expressing several technical concerns about audio recording and the “Witch,” he continues. (**All underlining is Griffin’s.**)]

My notions about sound fields audible to migrants are obviously pointless unless birds can and do listen. How can we test that? My trials with sounds from the ground showed that a very ordinary speaker and power amplifier can generate Circa 40 Db SPL at about a thousand. Hence, we don’t need to tie up the slaved acoustic horn to generate sounds of this level.¹³⁹

[Don then raises the issues of birds’ responses:]

Now the point I have in mind is that migrants being tracked might respond in various ways we could observe: they might change flight path, turn toward or away from speaker, hesitate, circle, drop, climb, etc. or they might change their own sound output. If we are gathering synchronous tracking data and sounds from slaved acoustic horn, we might note vocal changes - increase, decrease in output or change in kind of sound emitted. This seems fairly easy to try and worth trying.

What sounds to broadcast? A) Playback of birds’ own emission if any, B) recorded flight calls commonly occurring, such as ones recorded a few minutes before, perhaps filter to compensate for atmospheric absorption, C) sounds thought likely to attract, or D) repel – hawk or owl calls, mobbing calls, sounds that might be expected to have a plus or minus significance. What might these be? [DRG inserts in red pencil:] Joe’s [José’s] nose blowing. Sounds characteristic of bad conditions, rain, thunder, turbulent winds in vegetation, gunshots! [JCG [Jocelyn Crane Griffin] suggestions) (In July, all birds may be alert to those) frogs, insects, wave sounds, breakers on beach meaning perhaps “you’re crossing shoreline, better turn back!” Frogs or insect sounds expectable further south, signifying maybe “Gee we’re there, let’s land now” etc., etc. (Several of above suggestions from Jocelyn who seems glad of excuse to neglect galley proofs.) After all, Hunters use various kinds of calls to lure birds – not ordinarily at night of course. Tape-recorded calls are effective enough to have been legally proscribed. “False Echo” playback of any flight calls made by birds in question are another obvious possibility, they might signify approaching a cliff or hillside!

This whole area is quite Virgin Territory. if nothing happens, only a little effort would have been wasted. If response did occur, even if only sometimes, it would be behaviorally interesting. If responses were consistent enough to measure thresholds by varying gain of sound generating system, we could get at least a "response threshold" from birds in actual migratory flight - wind noise of own flight included.

All these ideas are additions to basic plan to measure emitted intensities, not in any sense to deflect you (or us) from that primary goal.

... [Brief discussion of Sony recorder channel usage.]

Your June observations that light caused birds to be lost to auto tracking must of course be followed up. Did you get long enough tracks in any cases to see whether the radar track itself showed turns? Even if not, this might be worth trying to do in fall. Migrants in June are usually small and quickly lost in any case. (I've suspected many of being insects!)

[CR: The comment about the targets possibly being insects has special relevance because of intense discussions/arguments about interpreting the data from the Atlantis II bird migration studies. At this point, the Griffin team would still have been in the midst of that data analysis. Recall that Ron Larkin was the holdout, arguing that a subset of the data, the very slow targets, were actually insects. After much, much work once he had left RU, with additional data and better radar, etc. he did demonstrate that to be the case.]

Talk these notions over, of course, with Joe and Ed. [José and Ed Buchler.] ...

How about scouting for other locations at least for acoustic probing? After ethology conference I'll try to do some of this, but that may be a bit late.

[CR: Don is presumably referring to The International Ethology Conference, held late summer 1973 in Washington, D.C. It was still an invitation-only meeting, which finally changed in 1983. Then Griffin writes about possible sites in New York State for acoustic probing.]

I fully realize that these things I can talk or scribble about in a few minutes take days or weeks to do. Don't let them interfere with Mainline activities (such as first item page one!)

[CR: As Ron's mentor, Griffin is again urging him to write the publishable papers from his thesis work, which he did, if not immediately.¹⁴⁰]

Time now to see whether local Tibetan handicraft store has my yak wool winter jacket ready - you'll see it come fall in the radar cab. I meant to express appreciation for fiber glassing and painting efforts, and only hope the change in [delta symbol used] thickness won't keep radar from re-entering the barn come November.

Very best wishes to all, DRG

Griffin has laid out a very full potential research program for his team. Ron did undertake a radar study of the reactions of migrating birds to sounds broadcast from the ground. In the "Acknowledgments," Griffin notes that the data were collected and analyzed with the collaboration of Donald Griffin, Pamela Sutherland, and David Thompson.¹⁴¹ [David Thompson was Griffin's Research assistant who was "lent," with Dave's agreement, to various of us as we needed extra help on a field research project. He not only assisted with the radar work but collaborated extensively enough with Ron Larkin to be a joint author on some studies.]

The calls broadcast by Ron were not of local honking geese, but instead, were more conveniently retrieved from sound recordings at the Cornell Laboratory of Ornithology Library of Natural Sounds. Included were alarm/distress calls and avian predator (hawk) vocalizations, calls

of birds either commonly heard at night or not, a control sound of a clicking alarm clock and, finally, thunderclaps. For most birds, the reaction was a turn away from the sound source, the thunder being especially effective on totally overcast nights rather than partially cloudy or clear times. So, importantly, at “normal/natural” amplitudes of sounds on the ground, the migrating birds *could* hear the sounds while flying in the air and did react, doing so quickly. Disappointingly, except for the thunder, the responses did not reveal any further discriminations.

They Don't Like Bright Lights!

A small flying plane piloted by Charles (Charlie) Walcott helped gather data showing migrating birds' avoidance of bright lights as Ron had earlier noticed. The plane data were collected at Millbrook, Don having persuaded his good friend Charlie Walcott to fly his private plane down from Cornell University one night. A very bright searchlight was mounted on the “Witch” and switched on briefly to illuminate the target (a bird), as the “Witch” tracked the bird. Walcott, like Don, was a fellow scientist fascinated by avian navigation. Enthusiastically, he flew his plane repeatedly over the “Witch.” Taking care to fly generally parallel to the birds' direction of migration, he had the bright landing lights on, while observers tracked the bird's flight. About 80% of the time, the birds evaded the plane. They flew away from it, at a distance of 200-300 meters, as they did for the bright searchlight. Reacting with a sudden sharp turn, they either maintained altitude, rose steeply or dove down.¹⁴²

Thus, light and sounds were proving to be likely effective means to avoid avian-aircraft collisions, a matter of concern for both passenger and military planes. Ron continued related studies, thereby gaining access to military funding. Over the years, the grants also permitted him to explore other matters related to avian migration. (Grant getting is *not* an easy matter.) Recall that the Williamses also studied the issue of military aircraft collisions with flying creatures, though, in their research, the flying animals turned out to be bats rather than birds.¹⁴³

Marilyn Louise Yodlowski (Do Pigeons Hear Infrasound?)

Finally, a student came to RU (1975) sufficiently interested in the problem of “sky sounds” to pursue the topic for her Ph.D. thesis (1980). Marilyn Yodlowski had conducted undergraduate research with ornithologists, Melvin L. Kreithen and William T. Keeton, in the Neurobiology and Behavior section of Cornell University, investigating pigeons' (*Columba livia*) sensitivity to infrasound.¹⁴⁴ Could such sounds heard by flying birds, in this case, homing pigeons, help guide them? Infrasound, that is, acoustic waves below frequencies of 10 Hz, are common in the atmosphere. Many sources generate such sounds: ocean waves, earthquakes, wind, thunderstorms and approaching weather fronts, as well as human's various mechanical devices. The sounds are often of high amplitude but unheard by humans, for the sounds are outside the normal range of hearing. Results of the work at Cornell showed that pigeons could detect infrasound as indicated by conditioning experiments in the lab. The birds did so at intensity levels comparable to those possibly encountered during their homing flights.

Because it is such a low frequency, infrasound can travel thousands of miles in the atmosphere, without much attenuation. Theoretically, the birds could detect approaching storms or the infrasound component of thunderstorms still hundreds of miles away.¹⁴⁵ (This ability is

presumably the basis for birds' "mysterious" ability to react to a storm before it appears locally or to an earthquake "before" it occurs.)

Marilyn continued this work with Griffin. In a description of her ongoing research, he notes that she "perfected an approved apparatus for measuring the thresholds of pigeons to fluctuations in atmospheric pressure at infrasonic frequencies (3 to 20 Hz)."¹⁴⁶ And in a letter about her final thesis to Fernando Nottebohm, Nottebohm presumably being a member of Marilyn's dissertation committee, Don writes

*"...it has been a pleasure to have Marilyn working with me for these past five years, and her thesis research, while perhaps not as extensive quantitatively in the neurophysiological area as would have ideally been desirable, does impress me as a solid and significant contribution. I hope to continue further experiments along the lines which she opened up."*¹⁴⁷

Unfortunately, I am unable to find any more complete description of Marilyn's dissertation research.

Before this point, Marilyn had decided to apply to medical school after completing her Ph.D. (1980) and Griffin had, by September 1979, written nine letters of recommendation for her; she attended Harvard Medical School and received her M.D. there in 1984.

Understandably, there is probably some regret among mentors when their "academic offspring" choose not to follow the path in which they have been trained. Yet, many, if not most, researchers do change their field of interest along the way. One RU graduate expressed a feeling, perhaps held by others, implying a certain resentment towards those who received "full RU fellowship stipends," but then went on to become physicians, a not infrequent career change, or into "the corporate world." A sense of "wasted opportunity" and "training" and "not using their background." A few of Griffin's RU Ph.D.s did become physicians, Marilyn Yodlowski and Mike Brines, and, also, Beverly Greenspan, she, after a position on the Bowdoin College faculty. Yet in creating his "150-word introduction" to be spoken, then published for the Ph.D. graduation ceremonies, Griffin sent the following to the RU admin for inclusion in his piece about Marilyn Yodlowski:

*I should like very much to include the final sentence... "We shall all miss her cheerful and sensitive company as she takes up the study of medicine and joins the distinguished company of physicians whose concern for basic science allows them to contribute to the good of humanity far beyond the specific service of caring for the sick."*¹⁴⁸

In Marilyn Yodlowski's case, she later joined the faculty of Harvard and Tufts Medical Schools and conducted both animal neurophysiological and human medical research, publishing numerous research papers. Later, she moved to the northwest USA and apparently concentrated on patient care and teaching in the general field of orthopedics. Not a "waste," I think, just a different direction. And Griffin was indeed supportive of persons in their new fields, new passions.

There is, however, a note from him to her a year after her graduation, asking if *Science* had responded about a short paper,¹⁴⁹ presumably her Ph.D. research. There is no *Science* report, nor is any other correspondence or relevant published article about her Ph.D. available to me.

Beverly Greenspan (Bats, then Fiddlers¹⁵⁰)

For Beverly, Don's lecture on echolocation at Brown University convinced her ... about both

the scientist and the fascinating subject. Upon graduating from Brown (1969), she *did* become his RU grad student and began working with bats.

Bats Study Requirements: Slithering, Carpentry, Climbing and Buzzes

She has a most vivid recollection of her first “batting” expedition; it was with Don, a trip to an old mine tunnel with hibernating bats that they intended to collect. She was a “city girl,” and the only bat she had ever seen close up in the wild was as a child; it was just one, under the eaves of a cabin at camp. The trip with Griffin was in the wintertime and cold, perfect for catching bats, for they would be hibernating. First, to get there. “I am sure we had no permission to be there. The owner of the abandoned mine in Hibernia, New Jersey did not give permission for anyone to enter, for fear of liability. ... I actually think he [Griffin] got a little bit of a kick about doing something unsanctioned by legal permission.”

Over the entrance was a solid piece of sheet metal. That was the vivid part, slithering headfirst, on her back in the dirt, under the metal wall to enter the dark space. Don had been to the mine before and led the way; he was a slim person, so he too could fit under the metal. Griffin “quite enjoyed things like that;” he was most enthused. Once inside, the tunnel was high enough to stand up. They lit their way with headlamps, battery-operated ones, not the dripping carbide lamps of Griffin’s younger days.

And so, they found the bats, hanging upside down, with frosted fur. Some awoke, due to the disturbance. Some were making “creaky” sounds. Some flew about, but most stayed put. Fortunately, the tunnel wasn’t reeking with foul odors, for when bats are hibernating, they are neither eating nor defecating. A very different story in the summertime when the bats are breeding. So, Beverly simply plucked the needed bats and placed them in the wooden carrying cage, not bare-handed; she did wear sturdy gloves. And they all slithered out the entry again, humans through the dirt, bats in the box.

Beverly was to use the bats both in the wind tunnel, then located at IRAB at the Bronx Zoo, and in a flight cage on the RU Manhattan campus. With some pride in the matter, she had managed to construct that cage herself in an upstairs room in Smith Hall, fastening large pieces of black plastic to the ceiling and securing them between pieces of wood. The bats were trained to fly to a platform to get a mealworm. The research interest was to compare the bat’s more usual echolocation calls used in navigating with the distinctive terminal buzzes made as the bat approached the target for landing. For the critical moment, as the bat neared the mealworm, it would cross the beam of a photocell which would trigger a photograph. Beverly was constructing the wooden photocell holder ... but she was not a carpenter. She knew almost nothing of tools, of screwdrivers, of saws. Don watched her fumbling. Smiling, he asked, “Beverly, do you think tool use is inherited on the Y chromosome?” Presumably, he then demonstrated the intricacies of such tools.

Gradually, however, Beverly grew less interested in the bat enterprise and far more fascinated by fiddler crabs.¹⁵¹ Officially, Jocelyn’s position was a researcher with the Bronx Zoo, specifically the Wildlife Conservation Society, but she was frequently present in the Griffin lab on the RU campus. Though a very social person, she tended to keep in the background; she was, at that point, writing her book, *Fiddler Crabs of the World*. Beverly noted, as did others, that she had “a certain reserve,” but was very happy to talk about her research and offer any requested advice. Conversations with Jocelyn were enthusiastic and enlightening about the fiddlers.

Beverly began reconsidering her field of research. Working on bat echolocation, Beverly realized, required much expertise with electronics and maybe even rather athletic field abilities, such as tree climbing, neither of which was her interest nor her skill, (She'd witnessed Jack Bradbury's bat field studies, including that daunting tree activity.) However, the Animal Behavior African Field Trip course had convinced her that she *did* want to do fieldwork. (Notably, she was the first *female* student to participate in such an RU field trip; more on RU women scientists in Chapter 16, "Revolutions."¹⁵²

Lekking Fiddlers?

Beverly was also intrigued by the "inspiring" research of another graduate student, Haven Wiley, a member of Peter Marler's lab, studying the phenomenon of "lekking behavior" in sage grouse.¹⁵³ Sage grouse, specifically *Centrocercus urophasianus*, are disbursed throughout the sagebrush prairie, but the males gather in traditional areas or "leks" for mating. There they "strut" spectacularly, their heads flashing specialized feathers that appear during the breeding season, their tail feathers fanned, their white chests filling to display their brilliant white feathers and dazzling yellow air sacs bulging and contracting rhythmically. From those sac and wing movements, one hears the most peculiar sounds, a "swish-swish-coo-oopink." All this to attract females who have gathered in large numbers on the lek. Only a few males consummate most of the mating, and hence father almost all the offspring. But that display and their sperm are the only resources that the males provide for the females. They offer no help building a nest, sitting on the eggs, or feeding her during incubation or the young after hatching.

Could that same system have evolved in a very distant species, an invertebrate, specifically the fiddler crabs? Jocelyn and Beverly pondered the possibility. The fiddler males, too, displayed, in large groups, to females. Waving a huge claw, a male crab sent specialized signals in elaborate displays to females or used that claw in aggressive displays and encounters with other males. The claw was too large to be used for feeding; the smaller claw made do. In *Uca rapax*, "Beverly's crab," the male made "ratchety" movements, namely, jerky little moves upward and then a grand sweep down. Each species had its distinctive stylized patterns, a matter that had intrigued Jocelyn Crane Griffin and later inspired her Ph.D. in art history exploring human communicative gestures in Medieval paintings.

But Griffin was not particularly thrilled about Beverly going off in that direction, theories of mating systems. He felt it would be difficult, probably impossible, to do experiments on the evolution of such systems to test hypotheses. But "he supported me and helped me as much as possible." Thus, officially, Beverly remained a Griffin grad student, since Jocelyn did not have an RU faculty appointment, though Jocelyn was her primary mentor, with Don's advice and assistance as well.

Exploring potential field sites was next, with the usual and unusual setbacks. For logistical reasons, it was preferable to be near a field station. Trinidad was no longer a reasonable option, given the declining, then severed relations between IRAB and the William Beebe station. Puerto Rico had the Caribbean Primate Field Station in the southwest, and both Griffins accompanied her on her initial visit. With water level changes, however, the intertidal area for the fiddler crabs had become subtidal. Next was Florida, where the Mote Marine Lab proved to be most feasible, working on one of their sites in Placida. Beverly lived on an old yacht belonging to the Cornell ornithologist

Oliver H. Hewitt. [Another “academic connection” via Griffin?] It was no longer fit for sailing, quite dilapidated, but seemingly habitable, until ... it sank. As the water poured in, Beverly simply gathered her belongings and left. Subsequently, she lived in a local motel, cheap, for no one came to Englewood, the “bigger” nearby town, in the hot, humid summer. Research continued.

The results of Beverly’s field study indicated that, like the lekking sage grouse, male fiddler crabs’ role in reproduction was skewed. For sage grouse, a few males produced most of the offspring. Not quite so extreme for the crabs, where some males produced more offspring than others. As with the sage grouse, this did occur directly with a few males having more than one sexual partner. But there was also an indirect route. The largest fiddler crab males tended to mate with the largest females, and those females, Beverly showed, produced the most eggs.

Unlike a true “lek” system, the male fiddler crab *did* provide resources for the female; he had a burrow into which he enticed a female. After mating, she lived there, protected, while the fertilized eggs developed until ready to hatch. Then she left and the eggs hatched in the nearby water.¹⁵⁴ Beverly had made an interesting addition to the growing knowledge about the *Uca* genus. Later, continuing research by others has shown lekking behavior to be widespread, occurring in other bird species, in some mammals, even bats, in some amphibians including certain frogs, and even in various fish and insects.

Faculty, then Medical Career

After her Ph.D., Beverly Greenspan was a faculty member at Bowdoin College in Maine for several years. She finally opted to pursue a medical degree and became a neurologist for the rest of her career. Although she said she always did feel a bit guilty not continuing in the field of her RU Ph.D. (1975), she did recognize the positive impact of her training in animal behavior field studies. At the start of her medical work, no MRI (Magnetic Resonance Imaging) equipment was available;¹⁵⁵ very careful, very detailed, observation was essential in any neurological diagnosis. Such was an essential part of animal field research. And of course, such detailed attention helped even after utilizing an MRI.

James (Jim) L. Gould (And Bees That Lie)

How it Began: From Bees to Griffin

Jim’s career choice began in an Animal Behavior course with Seymour Benzer at the California Institute of Technology (Cal Tech). Jim was, at that time, majoring in Molecular Biology. From his undergraduate research in that field, he had, already, been co-author of a publication.¹⁵⁶ Prof. Benzer advised him that there were “lots of smart people in molecular biology,” but not so many in behavioral biology. He suggested that Jim take a year off and think about his future direction. And then, amid any ruminations, Jim was almost immediately drafted into the U.S. Army Signal Corps (1967-68); it was during the long era of the Vietnamese war. Returning afterward to complete his college degree, Jim leapt into undergrad research on the ongoing controversy over the communicative significance of the honey bees’ waggle dance. As described originally in 1948 by Karl von Frisch,^{157,158} honey bees, after finding food, return to the hive and perform a waggle dance to the other hive members. Their dancing indicates both the direction and distance of the food source from the hive. The angle the dance makes to the vertical hive surface specifies direction with

respect to the sun. The bees dance in a figure “8,” with the central portion constituting the “waggle” part of the dance. The duration of that waggling denotes the distance to the food.

As previously noted,¹⁵⁹ Griffin had been delightedly astounded when he first heard of this work, suggesting, to himself, possible symbolic communication by the lowly honey bee. Taking it as his *mission*, Griffin publicized Von Frisch’s work, engaging the assistance of Cornell University, and even organizing an academic lecture tour for von Frisch around the United States. Others, such as Wenner (1967),^{160,161} claimed the dance had no such communicative function. In their view, bees were finding the food via odors or possibly other cues. For his undergraduate study, Gould and his fellow researchers conducted detailed experiments that controlled for cues other than the dance itself. The recruited bees found the food source designated by the dances, and not the food of a non-dancing “decoy” bee, emanating odors of that different food source. The work was published as the lead article in the very prestigious *Science* journal,¹⁶² where Wenner had himself published his anti-bee dance hypothesis.¹⁶³

What next? Upon Prof. Benzer’s suggestion, Jim Gould applied to Rockefeller University for graduate studies, and, given his interests, was, of course, interviewed by Donald Griffin (December 1969). As Jim was leaving, hurrying to catch a plane, and as the Smith Hall elevator doors were closing, Griffin asked him, “Do you think honey bees know what they are doing?” Jim, astonished, replied, “I hope not.”¹⁶⁴ (Jim was accepted as Griffin’s graduate student.) In a later remembrance, Jim recalls wondering if his possible future mentor was slipping into early senility (a common hypothesis around that time) or if “ethology was ignoring many of the most important questions about animal behavior.”¹⁶⁵

A While with Whales and Roger Payne and Katherine (Katy) Boynton Payne

Whales were next, at least briefly. As noted, part of the mentoring system at Rockefeller University entailed students spending some weeks working on others’ endeavors. Importantly, this process also provided much-needed “free” assistance in fieldwork and other research projects. Roger Payne was then a faculty member in Griffin’s lab and also affiliated with the New York Zoological Society. With his wife, Katy, they had an ongoing study of whale communication.^{166,167} A most fortunate prospect: Jim believed the research opportunity offered his wife, Carol, and himself, the southern hemisphere, right in the middle of the frigid winter of Northeastern USA. The site was Patagonia, Argentina in South America.¹⁶⁸

The research required many hours of underwater audio recording, hoping to capture the times when the Right Whales (*Eubalaena australis*) were singing. For many times more hours, the researchers created sonograms of the vocalizations.

Jim and Carol went to Patagonia in 1971. It was not so balmy: they all tented on the beach in severe wind storms. The Payne’s four young children were part of the group, charming to many adults, but sometimes delighting in pranks tormenting folks such as Jim, not yet a parent. (Grown up, the Payne children have become lively, creative, accomplished individuals. One, Laura, was my assistant in my early field research with plovers.¹⁶⁹ I learned a great deal from her, identifying flora and fauna, based on her long experience in the field with her parents and others.) However, Jim realized that the whale communication work was not likely to yield much information without a huge input of time. So, he opted for other research.

Bees Again – Make Them Lie

While Jim was not enjoying the whales, he was thinking about bees. The most convincing way to eliminate the possibility of odor as a cue in the honeybee dances would be to have the bees *lie* about where they had been, i.e., where the food source was located. In such circumstances, the forager bees would never visit the food site; they could carry no odors from it. How to do this? Devising an ingenious, complex set of experiments, Jim became impatient to leave the whales and begin the bee work back at the RU Field Station in Millbrook. The research became the basis for his 1975 Ph.D. thesis and was rapidly published in both *Nature* (1974)¹⁷⁰ and *Science* (1975),¹⁷¹ rather impressive!



Jim Gould at Millbrook, 1974 (From RU, 1975, p.3)
(photographer unknown)

their hive. If, however, there is sunshine or a bright enough artificial, concentrated light inside the hive, they will interpret the light as the sun and dance with respect to that light. In each case, the angle of the dance allows the bees to determine the direction of the food source with respect to the plane of the sun as the bees leave the hive.

The artificial “sun” Jim used was a bright 650-watt quartz lamp. Definitely bright enough, but ... so hot that it melted the hive. The bees set to work repairing the hive and Jim fitted a heat-absorbing filter over the lamp.¹⁷³ Ready to begin again.

Jim deviously manipulated the intensity of light. At “medium” intensity, but sufficiently bright, returning normal bee foragers would orient their dances with respect to the light, but the ocelli-covered forager bees would not; those bees would still orient their dances relative to gravity. At still higher light intensities, both the normal and ocelli-covered bee danced, oriented relative to light.

Gould then cunningly changed the location of the “medium” light every 30 minutes, at predetermined angles, some to the right, others to the left of the vertical. Bees had an array of

To conduct the experiments with proper controls and establish the “lie,” Jim Gould painted over the three ocelli of some honeybees. These are small visual receptors located between the two larger compound eyes of the bee and are used to monitor the level of illumination. Covering the ocelli makes the bees six times less sensitive to light. Thus, the bees are still able to forage and dance successfully but require higher levels of light.¹⁷² Since all the bees were individually identified with extremely small, numbered stickers, the behavior of each could be recorded, including videotaped records of the dancing.

Usually, bees dance with respect to gravity, i.e. the vertical, in the dark of

feeding stations available, but, with very few errors, recruited bees chose the one designated by the dance information. Notice that the dance information was accurate about the location of food when performed by “normal” bees, but misinformation when performed by the ocelli-covered foragers. Those ocelli-covered foragers, dancing in the medium-light condition, were orienting relative to gravity. The recruited “untreated,” normal bees were *interpreting* the dances with respect to a different cue, the artificial light. Thus, they flew in the “wrong” direction, not the direction of the food, and their choices were recorded by Gould and his apparatus.¹⁷⁴ The ocelli-covered bees had been “set up” to *lie* to their sister bee recruits. By changing the location of the light every 30 minutes, he could change the location of the foraging station indicated by the dancing of the ocelli-covered foragers; i.e., a new and different *lie* every 30 minutes. The experiments proved conclusively that the bees were determining food location by the information contained within the dance.

More About Bees at Millbrook

In other work, Gould verified the specific *distance* information conveyed by the dances.^{175,176} In one set of experiments, *recruit* feeding stations were placed *along a line*, at different distances from the hive. Another straight line of feeding stations to be used by the ocelli-covered *forager bees* was set at the same distances but at an angle to the recruits’ line. *One forager station* was baited, and then after 20 minutes, the baited station was changed to one at a different distance. The labeled, ocelli-painted foragers would find the food, return to the hive, and dance to the light, their performance filmed on a videotape. The recruited bees (interpreting the dancing in terms of gravity) then flew to the feeding station of their choice and their decisions were recorded. Few recruits flew to an “intermediate” station between the two lines of stations. The bees’ preference was for the station indicated by the *dancing*, *not* the station the foragers had actually visited. The *distance* of that station in the recruits’ line of stations corresponded to the *distance* of the forager bees’ baited station for that experiment.

To conduct these experiments, Gould invented various marvelous gadgets for recording events and establishing control conditions (clearly an affinity between two gadgeteers/inventors: Griffin and Gould). To attract the bees to the plastic pails serving as feeding stations took some doing. Among the “enticing” bits and pieces were sun-dried dead bees to attract other bees, for bees tend to forage at sites where there are other bees. Other inducements included a funnel painted to be a flower, with ultraviolet-reflecting paint duplicating the “paths” often found on flowers to guide bees toward the nectar and pick up pollen.

Since experimental conditions were changing every 20 minutes, it was necessary to keep track of just when recruited bees arrived at feeding stations. A bee’s entry time to a station was recorded by her breaking a red photobeam which was transformed into an electrical signal and transmitted to an event recorder. (Bees don’t see red.) Whiffs of carbon monoxide anesthetized the bee while feeding, and she thereby tumbled peacefully into a funnel, where the order of comatose bees in the narrow neck of the funnel revealed the arrival order. The bees could be matched to the arrival times indicated on the event recorder. (The bees were rendered unconscious, and thus temporarily unable to return to the hive to control which bees could relay information via dances to other bees.) Experiments were conducted in the early morning, when the dew at Millbrook was still heavy, restricting competing odors from naturally growing flowers and grasses.

These experiments certainly demonstrated that the bee dance conveyed information about the location of food, but did that mean that the “odor” hypothesis was completely wrong? Other elements of Gould’s work indicated that bees can use *both* odor and dance information. When one abundant crop dominates, as is the case on a monoculture farm, Gould suggests that the crop’s fragrance might overwhelm the hive. This could cause the bees to rely on odor information from a returning forager and eliminate dance language recruitment. [The dance might still serve a function to “energize” and recruit bees to go out foraging.] The dance can determine a general location with some error, while the odor allows the bee to hone in on the very specific site when the bee has reached the area.

In Jim’s words, “... the dance language is a real and very significant phenomenon.”¹⁷⁷

In his view, the ideal experiment would entail a robotic bee, whose behavior could be controlled entirely by the experimenter. He attempted to create one while at Rockefeller, but that effort was not successful. Later, as the research advanced, others engineered a model honeybee that “danced” and caused recruits to fly in a direction determined by the scientist, without providing any goal-directed odors.¹⁷⁸ An even more advanced “RoboBee” was later created,¹⁷⁹ to be discussed in Chapter 18.¹⁸⁰ Gould conducted many further studies about the honey bee dance and cognitive capacities of the bees, which are too extensive to discuss here. I suggest the book, *The Honey Bee* (1995) co-authored with his wife, the science writer, Carol Grant Gould,¹⁸¹ and relevant sections in their more recent book, *Nature’s Compass* (2012).¹⁸² Other scientific issues likewise engaged him: avian navigation, diverse species sensitivity to the earth’s magnetic field,¹⁸³ and the evolutionary basis for these various phenomena.

Anomalies and International Disputes: Bees and Avian Navigation

Gould views his scientific approach as dissecting the component of a phenomenon, the honey bee dance as a case in point. He enjoys finding “inexplicable” anomalies and explaining them. As an example, he demonstrated that *both* the odor and dance hypotheses are correct; it is not “either-or.”

Gould also investigated discrepancies in homing pigeons’ and other avian species’ sensitivity to magnetic fields while navigating. Their sensitivity, he found, depended on the bird’s age and experience. After fledging at about six weeks, the homing pigeon relies on a magnetic compass, while flying about and gathering cues about the site. By twelve weeks, the sun becomes its primary compass. Researchers often mixed pigeons together, not sorting by age, leading to confusing experimental results. This age-dependent use of cues was critical in Bill Keeton’s extensive magnetic cue research with homing pigeons at Cornell.^{184,185}

The role of odor cues in pigeons’ navigating became an international dispute. That matter was resolved by examining how pigeons were raised in the labs. Typically, notes Gould, a whole school of Europeans doesn’t allow the birds to fly around in the grounds outside their loft. Thus, odor becomes a highly salient cue, for fragrances waft into the loft as the breezes blow. The controversy reached its peak with the Italians, or more precisely, with Italian olive groves. In numerous experiments, conducted by Italian researchers, an olive grove grew on one side of the lofts, making that cue particularly dominant in the pigeons’ homing, to the exclusion of other cues often used by pigeons.^{186,187,188}

Age and experience also impact migration, the white-crowned sparrow (*Zonotrichia leucophrys*) being an example. It flies “vectors” the first year, meaning it is genetically programmed

to fly in a specific direction.¹⁸⁹ Thus, in experiments, it flew due south from Vancouver, British Columbia to reach its destination in Baja, California. When brought east to Princeton, New Jersey, it flew due south and never reached Baja. By the second year, it has learned enough to deal with translocation. Researchers, however, often did not distinguish between migration during the first and second years.

Birds, like bats, like bees, turn out to be extraordinarily fascinating ... and complicated beings.

Michael (Mike) L. Brines

Others in Griffin's lab, besides Gould and Griffin himself, were intrigued by the honeybee. Mike Brines had come with a B.S. degree from the University of Notre Dame, graduating in May 1973 "with highest honors," He was yet another Griffin student with a considerable "techy" background, a physics major.¹⁹⁰ Working together with then grad student Jim Gould, they were intent on understanding the *sensory* components underlying a bee's ability to determine the *direction* of a food source. The bee incorporated that info into the "waggle dance."

Sky Maps for Bees (and Others)

As had been shown by von Frisch decades before, in 1948,¹⁹¹ the bees use the sun, if visible, to orient their dances. On cloudy days, they also manage to communicate correctly, using patterns of polarized ultraviolet (UV) skylight. However, the biologically relevant information in the patterns had never been accurately measured. What might the bees observe in the sky and why did UV light become the band of light favored by evolution?¹⁹² That was the task that Mike set himself for his Ph.D. thesis, with Jim's help, and, of course, Griffin's advice.

At their disposal was the honey bee colony Jim had established in Millbrook. For a while, bees were also kept in Griffin's Smith Hall lab space on the RU Manhattan Campus, but ... problems. A worried letter arrived from Don, in Italy at the time. At this point, Gould, having completed his Ph.D., was to begin his Princeton faculty appointment in the fall, so Mike Brines was fully in charge of the bee project. The letter to Ron Larkin (August 23, 1975):

*... I hope the Bee leakage problem was indeed solved and that the Smith Hall sociology is in good shape on that front. If Mike [Brines] gets back before I do, which is likely as I recall his dates, do urge him to keep that activity in good shape so that there are not even any excuses for complaints.*¹⁹³

One can imagine the annoyance of the totally lab-based scientists on that floor. They were largely unsympathetic to any studies remotely like "fieldwork," much less "fieldwork" with "bees on the loose" brought into their domain. Presumably, the matter was settled.

For their studies, Mike Brines, collaborating with Jim, had created a very complicated device for mapping the sky to determine the exact patterns of polarization. With the instrument, they measured the intensity and degree of polarization and the direction of vibration (aka E-vector orientation).¹⁹⁴ They then constructed sky maps for both UV (350 nm.) and visible wavelengths. These were created under a variety of atmospheric conditions, ranging from clear skies with full sun through uneven overcast to complete cloud cover.

Under totally overcast skies, no wavelengths yielded useful polarization information. In other conditions, the polarization patterns turned out to be vastly different in different parts of the

sky, except for the relatively stable and predictable E-vector. Surprisingly, in the experiments, the accuracy is better for the visible wavelengths the researchers used¹⁹⁵ than for the ultraviolet. Most insects, however, detect only ultraviolet polarization patterns. Why should they better detect the *less* accurate wavelengths? The authors surmise that, with large areas of blue sky, any polarized wavelength, visible or ultraviolet, is adequate, but the situation changes in more difficult circumstances. When sunlight is obstructed and reflected, due either to partial cloud or extensive foliage, the interference to UV light is less than that to visible wavelengths.^{196,197}

The mapping work also led to a seeming paradox. In some circumstances, two places in the sky yield identical polarization patterns, but the bees consistently all make the same correct decision about the direction implied by the pattern. Brines and Gould suggested that the bees are following “rules” to arrive at their correct interpretations. Likewise, the investigators recognized there is sufficient information in the polarization patterns, theoretically available to the bees, to allow the bees to determine not only the sun’s position but also true North. Whether the bees and other animals do use this information was unknown then.^{198,199}

Since that time many insects and other invertebrates have been shown to use the info to determine “North,” as do fish, birds, reptiles and amphibians. More specifically, these animals can use the polarization pattern to “calibrate” other sensory cues for orientation and navigation. Finally, even mammals ... maybe. Bats were the first mammalian species that appeared to be responsive to polarization patterns, but the evidence was rather weak and somewhat problematic.

Mysteries abound, particularly concerning the mechanisms involved. For the other species, specially adapted photoreceptors (bees) or structures in the cones of the eye are thought to contribute to the sensing of polarized light, but these do not exist in bats. Surprisingly, humans are responsive to polarization, though its function is unknown and its mechanism(s) unclear.^{200,201,202}

After his RU Ph.D. (1978), Mike received an M.D. at Yale University, continued his residency there, and then became a Yale faculty member in the Dept. of Internal Medicine. Over many years, he conducted research on mechanisms of nervous system injury and therapies for neurodegenerative diseases, finally leaving Yale and founding a pharmaceutical company. Again, a different, but positive use of RU graduate scientific training.

Wanted: Birds Inside Clouds

To further explore the sensory basis of bird migration, Griffin wanted to examine the flight of birds in cloudy conditions, intense enough so that visual cues were eliminated ... all of them, from the sky above and the ground below. As noted, birds generally avoided those conditions, when possible, but it was not always possible. In fact, up through the late 1950s, scientists believed birds avoided starting long migrations when overcast. At the time, it was impossible to determine whether birds could maintain oriented migration if they were stuck in such conditions. Finally, radar provided such data,^{203,204} but it seemed to reinforce the idea that the migrating birds’ orientation depended on the sun, moon or stars. Griffin wanted more definitive data. Ideally, to gather such data, he wanted the birds to be flying either within a dense cloud or between thick cloud layers so that neither ground cues nor those from the sun, moon or stars were visible. In most previous research, such cues were available at least some of the time.

Chilly Nights in the Radar Shack

Thus, on miserable, chilly fall (or spring) days, with gray clouds to dampen spirits, across the lunchtime RU cafeteria, one would see Don Griffin, smiling gleefully, engaged in animated conversation with his lab members and others. It promised to be a fine night for the “Witch” to track migrating birds for the “cloud experiments.”

There were many “volunteers” to help with the tracking ... with varying levels of enthusiasm and “volunteering.” Ron Larkin (literally) “moonlighted” while a grad student with another professor. During the day, he was, in his view, “stuck inside” in a lab, doing brain surgery with rats. During the night, he was delighted to “get away.” To him, it was being “lured off to mountains with fascinating radar equipment, dogs along, stars at night. Wonderful to be out at night.”²⁰⁵ For the Griffin students and even for others within the Animal Behavior Program, it was an “expected” enriching experience with other research projects. As Jim Gould termed it, “We were free labor.” In the world of mostly male RU graduate students, the young wives helpfully joined their husbands over the many nights. Susi Torre Bueno worked with the Ford Foundation during the week for about a year, volunteering for radar work on the weekends; then Griffin offered her a position as a Research Assistant. It was, she said, “A great job. I loved working for him. He was an excellent boss. Very kind, very patient with me.”²⁰⁶

Working on the radar meant driving to the Millbrook area from the Manhattan RU campus or from the rented communal house near Millbrook. Until the Research Station was established, the “Witch” was dragged to various locations, generally around Millbrook. (Some trips, recall, were purposeful attempts to persuade the wealthy landowner to donate one of these locations for a field station.)

In Susi’s memory, the nights were dark and cold, and hopefully not raining. But it was hard to launch the kytoon.²⁰⁷ (The kytoon is to be distinguished from the weather balloons that were set free with an attached metal-covered “Susi ball,” tracked by the radar and used to measure wind speed. The kytoon was tethered, and shaped more like a dirigible, with four “fins” at the end to help guide it into the desired position. It typically held some measurement instrument. Photo of a kytoon later in this chapter.)

“So hard to manage,” noted Jim Gould, and more so in the rain, so little tracking was done then. Notepad in hand, one ran outside to observe the ascending balloon, presumably helping the radar operator inside the cabin point the radar in the proper direction to “capture” the balloon on the radar. (Recall that the “Witch” was a tracking radar, not a search radar, so it had to point in the correct direction to pick up an intended target.)²⁰⁸ Then back into the small, enclosed wooden cab. In the 1970s, that cab or “shack” was “a plywood box in which two people could fit only by sitting down and in close proximity.”²⁰⁹ Here one faced a large panel of instruments with knobs and dials, a relatively small radar screen, and dots that appeared and disappeared. One tried to keep track of the dots and jot down the data in the notepad’s columns: coordinates, altitude. Track this bird for 17 seconds, another for 1.5 minutes, another ... The task required intense concentration and attention to detail, looking at all the dials ... and accurately recording. Much the same scene as on Atlantis II, but there could be so many more birds to follow at Millbrook. (As on the Atlantis II voyage, the manual entries were backups to the automatic acoustic recording.) To Susi’s amusement, she recalled the results of a high school “Aptitudes Test” which assessed that she would be a “good radar operator.” She never imagined that, in six years, she would be doing exactly that.²¹⁰

Carol Gould was another “helper-wife,” a brand-new wife. She and Jim had taken a camping honeymoon, just before arriving at RU for Jim to begin his graduate studies with Griffin. That experience, she thought, helped prepare her for the rigors of the radar fieldwork, often accompanying Jim, when he “volunteered.” To her, the situation was excruciating and grim. In her view, the birds migrated in the worst weather. When the experiments were conducted, preferably under heavy cloud cover, it was likely damp, and the chill made the conditions even more miserable. Up all night, many nights ... so cold. Attempting to study for her own upcoming Ph.D. exams, she read the necessary novels, flashlight in hand, in the tiny cabin. As to other “necessaries,” the men just walked outside into the woods, not so easy for women. Griffin kindly provided food, but it was typically hamburgers bought early in the day from the Millbrook Diner. By “dinnertime,” as the bag was opened, it revealed plain buns and meat ... no condiments, just plain hamburger ... and it was all cold.

Sometimes, Jocelyn came along to the tracking. She was, to Carol, a good model, which Carol felt she never achieved. But for Jocelyn, as for Griffin, it was all for science; one does what is necessary, end of conversation.²¹¹

I do find it amusing that not a single male interviewee chose to make mention of the cold, miserable conditions, that they, being human, faced as well. Jim Gould *did* offer the comment that it was “so hard.” José didn’t remember it being especially cold or difficult. He also recalls that Ron and he had climbed Mount Kilimanjaro while they were RU grad students, so he figured they were probably quite “tough” then.²¹² (CR: I guess it’s difficult being male and always “strong,” even in these times of encouraging human empathy to counteract much else going on in society.)

How Foggy the Cloud?

To conduct the intended “cloud” experiments required that one knows if the cloud was truly dense enough to prevent vision of the sky, the earth or possibly other structures that might serve as cues or landmarks for the birds. And not only on the ground, where researchers may be seeing fog, but at the height the birds are flying. How to do this? Jim Gould came to the rescue. With a B.S. from Cal Tech, he had a considerable engineering background and constructing devices was one of his strong points. Don had a similar appetite for gadget/instrument making; Jim thought that was a significant part of their getting on so well, over so many years.

So, Jim built a cloud detector. To prove there was a cloud, the detector measured its density. How? A light flashed 50 times per second, while a photocell looked for the returning signal. The thicker the cloud, the greater the backscatter, and hence more signal reached the receptor photocell. This resulted in a changed radio frequency that was sent to a receiver on the ground, producing an audible sound. The entire unit (sans receiver), weighed only 300 grams; this included batteries sufficient for several hours of use. But how to get the detector up to the birds? Again, a form of kytoon was used, this one tethered, with the detector attached. As Gould described it, “Nice work, but everything was very hard.”^{213,214}

Has Anyone Seen Birds Enter Clouds?

To strengthen his case that migrating birds *do* fly into dense clouds, Griffin reviewed *every* incident he could find of observations during the daylight of birds flying into opaque cloud. To do

so, he delved into published reports, initiated personal conversations and wrote letters.²¹⁵ While flying a plane in 1947 to observe homing gannets, he had seen at least one of those birds soar directly into the base of a stratocumulus cloud.²¹⁶ However, these various observations did not provide evidence for *directed* flight, which was Don's interest in the sightings.

Experiments Inside Clouds

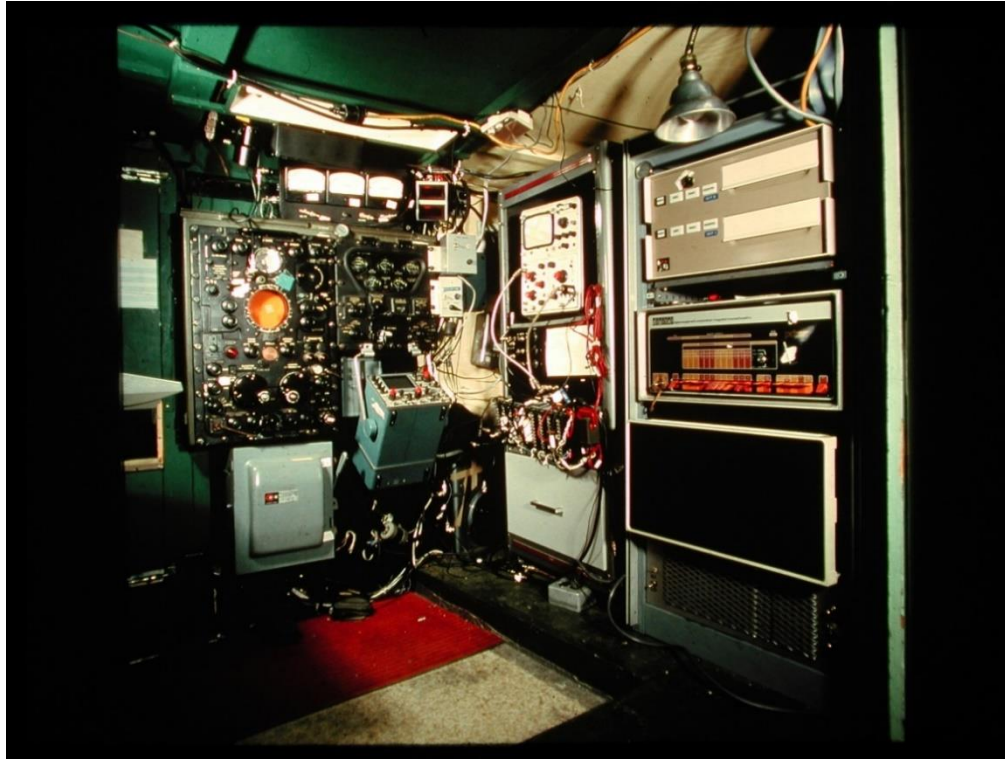
Once again, the "Witch" was employed, this time to look for evidence of directed flight. Griffin conducted the radar tracking during migration seasons, primarily when expecting low clouds (i.e. during rather miserable conditions for human scientists). Two published papers (1972 and 1973) offer extremely detailed descriptions of the methods, data and results of the work conducted during migrations between April 1970 to June 1971.^{217,218} I have access only to the second, the 1973 ms.²¹⁹ During the data collection period, about 1600 birds were tracked over 29 nights of observations. (Imagine the work entailed!) Several hundred birds were flying under clouds sufficiently opaque as to prevent any views of the stars or moon. But do recall, Griffin wanted visual cues of *both* ground and sky to be unavailable, so only birds flying within or between dense enough clouds could be included in the data set. The best meteorological data obtainable were from NASA, based on infrared photographs from satellites, revealing approximate altitudes of cloud tops by their radiation temperatures.²²⁰ But these data were subject to uncertainty, so he concentrated on only five nights of definitive data ... after *all* those long nights of data collection.

Griffin also had available "an electronic 'cloud detector' that was being perfected during the spring of 1971." (This was Jim Gould's invention, previously described.) It did provide "useful, though qualitative data" for May 30-31, 1971,²²¹ the very last day of their set of usable data. In short, at that point of its creation, the "cloud detector" was helpful, but not yet all it might be. Griffin separately discusses two other nights for which *their* radar gave evidence of thick cloud near the birds, but, worryingly, the meteorological data available from nearby airports provided weaker evidence of the cloud.²²² Keep in mind that the cloud's radar echoes²²³ were helpful here as indications of cloud thickness, but, but, but the birds were quite tiny and, like the clouds, were also returning very minimal echoes. One must always distinguish between reflections from the birds and those from the clouds. On some occasions, the cloud echoes were so strong that no birds could be tracked.²²⁴ Wind speed and direction were determined by radar tracking of free balloons or those with an attached, lightweight aluminum foil-covered "Susi ball."

By measuring echoes produced by different sizes of such balls, a reference was obtained that could be compared to the echoes produced by the size and motions of a bird. Thus, hopefully, wing beat patterns and other distinctive movements could be ascertained, helping to identify the species observed.²²⁵ I include all this detail, only a part of the complexities involved, to emphasize the incredible amount of labor and meticulous technical considerations that the research required.

The results indicated that a few birds' tracks curved gently or zig-zagged slightly, but most were as straight as the low-power radar could measure. The radar tracking of the balloon before and after bird tracking yielded reliable estimates of the wind speed in the area, at the level the bird was flying.

A "Shack," a "Witch," a "Kytoon" and Puttering



**Inside the
Radar Shack
(1977 version)**

The two standard instrumentation racks contain a PDP8/F computer and its peripheral equipment.

The shack could fit two persons only if they sat down and kept close together.

(by R. P. Larkin)



The "Witch"

This is a later version of the radar used with an attached camera. Sometimes a telescope and heavy-duty lights were also attached. Ron Larkin added the cuff to reduce recording echoes arriving laterally.

The decal portrays a witch sweeping aircraft out of the sky, the job of military radar. The "Witch" had originally been built and used in the Korean War.

(by Ronald P. Larkin)



Don Griffin “puttering,” 1970s

The tackle box contains BNC connectors (popular electronic connectors of the time) and various other cable fittings.

(by Ronald P. Larkin)



Left to Right:
Krikor (“Gregory”) Tomain and Larry Eisenberg of RU Electronics Shop, early 1970s

They are repairing some of the “Witch” electronics, a frequent necessity.

(by Ronald P. Larkin)



A Kytoon Ready for Launching, 1970s

Left to Right:
Ed Buchler is hauling the Winchmobile, a homemade cart to haul in the high-strength nylon line that attaches to the kytoon.
Griffin with Kytoon. Griffin’s steady companion, the green Rambler station wagon, is on the right.

(by Ronald P. Larkin)²²⁶

Combined with radar information on the bird's location and ground speed, the heading and airspeed of each bird's flight could be calculated. The net trend of migration observed was, as expected, northeast in the spring and southwest in the fall. Significantly, that direction was maintained even when the birds were within or between opaque cloud cover. When subjected to wind drift, the birds apparently were attempting to correct for it by flying in a direction that would bring them closer to a northeast (spring) and southwest (fall) orientation.²²⁷

How are birds accomplishing all this ... correctly oriented migration even in an opaque cloud? Griffin considered several possible theories. Among them were olfaction,²²⁸ the earth's magnetic field, inertial orientation, acoustic information from the ground, and patterns of atmospheric "fine structure" (including asymmetrical patterns of turbulence). (The RU computer center was assisting Griffin in "testing novel hypotheses" about the birds' use of the air turbulence information to determine orientation.²²⁹) He concluded there was, at that time, little conclusive evidence for *any* of these factors as significant for *migration*, though some, such as odor cues, might be locally significant in homing. Warning against the "current trend" in emphasizing the role of multiple cues, he advised that we mustn't be lulled into an "unjustified feeling of understanding," when we don't have "even *one* adequate explanation."²³⁰ Yet, Don was also wary of the existence of a "silver bullet," the *one* cue to explain all migration mysteries.

Griffin's Acknowledgments (The "Backstory")

Published scientific papers have an "Acknowledgment" section. But, at least in this instance, there is something of a "backstory." Griffin took care to acknowledge and thank the many who had helped,²³¹ noting the "infinite patience" of Larry Eisenberg and Mike Rosetto in adapting and maintaining the "Witch," the RU computer Center and José Torre Bueno, Jim Gould and Ron Larkin for both extensive radar observations and computer programming. He expressed his gratitude to Susi, as well as others, who gave "indispensable assistance" in radar observations and data analysis.

Don thanked the NASA Wallops Island Radar Station for their helpfulness. Wallops Island's much more powerful Spandar radar system was capable of tracking birds up to 100 km or more away, while the "Witch" could handle only far shorter distances. For two nights, the Wallops Island Station also generously provided a plane so the researchers could concentrate on observing cloud conditions near the bird being tracked. It was difficult for all concerned to schedule a time that had to depend (reasonably) on other NASA operations. Not weekends, holidays, etc. (that a NASA stipulation, not the ever "at-it" Griffin lab during migration seasons). Likewise, the weather impacted, requiring conditions when Griffin's cloud experiments could sensibly be conducted and when the planes could be dispatched safely.

On one of the occasions, the volunteer observer was Charles (Charlie) Walcott from Cornell University. On another occasion, the observers were José Torre Bueno and Don. Then still an undergraduate, but accepted at Rockefeller for his graduate studies, José had been invited by Griffin to accompany him on the observation flight. Presumably, this was Don's "wooing" José to join his lab's research activities for the longer term. But regulations and scientists' needs collided. Griffin and José were not permitted to follow the one bird they were tracking: the Wallops Island crew was fearful of a collision. Don tried to argue that, logically, that would be the bird most likely *not* to be hit, since Don and José were tracking it. All the other nearby migrating birds were far more probable accidents. The crew was not persuaded.

Though the crew's reluctance might seem unreasonable, Timothy Williams knew the groups at Wallops Island. Over the years, he had worked with them, while conducting radar studies of migrating birds, and was impressed with their overall support and helpfulness. Scientific explorations, such as bird-following, were certainly not part of their mandate. To bypass safety protocols, "on the spur of the moment for a scientist, politician or anyone else" would certainly result in someone's dismissal. To Don, at the time, this was all bureaucracy, once again, bureaucracy holding sway over any reason. He fumed, but did not lose his temper; no one has ever seen him do so (though as cited in instances throughout this book, he has come close to such expression). He was just about always "the gentleman." But it was clear that great restraint was being exercised.²³² Tim suggests that very likely Don may not have realized that *the* primary NASA mission was studies of aircraft safety in the skies. Planes and birds, even in the same sentence? Red flags, not going to happen.²³³

Griffin's restraint and his published acknowledgment and thanks were wise choices; scientists did continue to receive assistance from Wallops Island. His encouragement of José to join his research group did not immediately materialize, as José first spent time in the Marler lab. Then, as we know, he found more kindred interests in working with Griffin.

Finally, Don thanks the National Science Foundation (NSF) which provided most of the funding and also the Cary Trust of Millbrook; recall the extensive "courting" of the philanthropists to engage their assistance. Even the "Acknowledgments" section of a publication can afford some amusement and insight, provoking memories of people, places and incidents buried within a few words.

The Broad and Narrow Views (Bureaucracy #&*%!)

A "Big Radar"?

The title is a reference simultaneously to the range and width of the radar views, the research options available, and the levels of bureaucracy involved. The "big radars" that were used both in Europe and the Americas had a far, far larger range and much greater "volume of surveillance" as they rotated than did Griffin's ancient "Witch." But the "Witch" had a different function; it latched onto a target and tracked it closely. The "big radars" (weather, tracking and surveillance) used by the Williamses at Bermuda and Antigua, and by others at different sites, can often detect birds at ranges of 30-70 km. (about 25-45 miles), depending on the radar and the birds in question.^{234, 235} The "Witch," however, had a range of only 1,500 meters (almost a mile) for small birds. That comparatively short range missed migrating birds flying at the very high altitudes, which were many.

Tim Williams raises the issue of why Griffin, with all his contacts at the Navy and Air Force, didn't use the big radars. Tim used them, even without all of Griffin's connections and international status. For example, Don had received military funding and assistance for several projects. Not only did NASA's Wallops Island base aid Griffin's studies, but during WWII, when he was a Harvard grad student, Griffin had conducted research for the Army. He had been funded in his early Cornell days for his Alaskan avian orientation studies, and he participated in the ill-fated "bat bomb" efforts for the Air Force.

Williams muses further: He, Tim, was able to get the National Science Foundation (NSF) to pay for his own, fairly new, very *mobile* tracking radar. Why didn't Griffin? At least part of the

answer must have been the huge investment of time and effort and frustration that had been expended on the “Witch” and its “slave” components,” adapting them to Griffin’s specific research needs. Any thought of redoing the entire enterprise was anathema.

The answer to the more general issue, in the view of both Timothy Williams and myself, was probably two-fold and intertwined. The big radars could be used only during “left-over” time, when not required for “mission work” or some “emergency” use. Stringent safety protocols had to be observed, as in the Wallops Island episode. All this could severely constrain a scientist’s research needs. The Griffin radar team worked *every* night during the migrating season when conditions were appropriate for data collecting; forget weekends, forget holidays or personal events, forget miserable circumstances in the radar shack. Science would be conducted.

And importantly, bureaucracy! Griffin did not suffer bureaucracy gladly, bureaucracy in all its manifestations, constraints of any sort. Such might not have been obvious to the casual observer. There was Griffin, in changing times, still following the protocol of the “once necessary and appropriate” jacket and tie at the university, though also happily trekking in rugged, worn clothes in the field. On a personal, but more trivial level, as Beverly Greenspan remarked, he seemed to get “a certain thrill” from illegally entering an abandoned mine shaft for bat collecting. His most happily remembered phase of early education was the free “wandering in the marsh” of Barnstable, Cape Cod, but then again, wouldn’t we all like to do that instead of school? (well, many of us) And by leaving Harvard’s Biology Department’s chairmanship for Rockefeller, Griffin was freeing himself from the attitudes and constraints constantly facing him. He was to be free to undertake his professional life “his way.”²³⁶

Back to the military and bureaucracy. Not to forget that the world of science and that of bureaucracy were two different realms: Tim Williams recalls an event from his own research history working on the previously described ELF project with the Office of Naval Research (ONR). The scene occurred just before the start of an approved and long-planned project to determine the impact of ELF on the behavior of migrating birds. Merely a week before they were to leave for the site, Janet and Tim were called by their ONR rep to Washington, D.C.

[He said we had to have] ... a conference with the admirals in charge of the project. We entered the high security conference room at ONR. They shut the safe-like security door, and the admirals explained that they could not approve the proposal, because the whole point of the ELF system was that when it was operational, it would ALWAYS be ON, and so we had to do our little science project with it always ON. We asked how they thought we could have a control condition [i.e. the birds’ behavior at that site under natural conditions with no activated ELF.] They asked, “What is a control condition”. It is two different worlds (Our ONR rep had to get a higher-ranking navy officer to explain the concept of a control and over-rule the Admirals.)²³⁷

The military’s influence extended as well to the distribution of experimental results. As Griffin was retiring from Rockefeller, and clearing out his files, he showed me old publications about bats’ use of sonar; they were from military-funded research. On them, in bold capital letters, was stamped “SECRET.” Since, to this day, some bats have skills that far surpass our contemporary human inventions, military included, perhaps bats could teach us and our foreign adversaries some secrets. (The “SECRET” designation on that research had long been rescinded by more open and advanced scientific findings, not funded by the military.)

Publicity (More #&%@!)

Publicity was yet another impact on Griffin's research progress. Program directors wanted publicity for any successes. Williams notes institutions' keen awareness of publicity's benefits: NASA, WHOI, Rockefeller University, the New York Zoological Society (NYZS). NASA and WHOI ultimately received funding from Congress, whose members read the newspapers, not scientific journals. NASA and WHOI had spare time and unused equipment; a good trade for positive publicity from research about migrating birds or other topics that fascinated the public.²³⁸

NYZS and RU wanted their joint research institute (IRAB) to be in the eyes of the public, the philanthropists and the members of granting boards and committees; later, the same aim for RU and its new Millbrook Field Station (RUCFR). For RU, this led, as we have seen, to journalists' jaunts to Griffin's Trinidadian research site, much to Don's exasperation. It also led to the RU concept of "Open Days" at the Field Station, where potential and past philanthropists and other members of the public were invited to visit Millbrook. At the Field Station, researchers gave guided tours of the facilities, led bird-watching excursions around the grounds, created bat encounters, and exhibited ongoing research efforts by the Griffin, Marler and Nottebohm labs. This included interactions with the "Witch" as well, which hopefully was in a mind to perform well that particular night. And of course, beverages and snacks for all attendees ... of good quality. Griffin complained. He enlightened Rodney W. Nichols (an RU Vice-President) of the fact that a recently held event took a *month* of his lab's faculty time in preparation, a month obliterated from research. "No More!" Nichols agreed and that was that. The "cost-benefit analysis" did not support the undertaking. "There may well be occasional small group visits – one or two visitors plus a money-grubber or two ..." ²³⁹ (Years later, Peter Marler, as RUCFR Director, re-instituted occasional, sometimes annual, weekend-long Millbrook Open Houses, with much effort expended, particularly by junior faculty, postdocs and students.)

Research Style

Back to radar equipment. Aside from publicity needs, use of the "big guys" equipment required long lead times for the proposed research. Don's research style, though having long-term overall goals and some specific highly focused projects, could also be variously described as "opportunistic" or as "flexible," constantly building on the latest bit of scientific data he'd collected. His ideas were free-ranging. An example of this approach is certainly evident in the previous quotations from the long letter to Ron Larkin and the lab from Kathmandu.²⁴⁰

In short, although Griffin was sometimes funded by various branches of the military, he entered such relationships fully cognizant of the potential limitations on the freedom of his scientific investigations. I do not mean, however, to dissuade young scientists from future work with military funding. The military *was* generous to Griffin and other bat and animal researchers, as well as to scientists in diverse fields. One must also recognize that some, even "high-up" military personnel, may not be familiar with scientific concepts. They are trained in other matters, not scientific experimentation. Within the military ` are also persons with excellent scientific training. So, scientists, yes, the military remains a potential significant funding source for your efforts.

Unanswered Questions and New Technology

Even today, we remain ignorant of many aspects of avian migration, both globally and within the region of the Atlantis II voyages. This deficiency is particularly salient, given the challenges to be faced by birds and us, in the accelerating climate change. Unknown is the proportion of nocturnal land birds that fly the overwater route to their warmer destinations. Do they find these sites accurately? Which species favor or avoid the overwater route?²⁴¹ Globally, we recognize huge losses of birds each year; we need to understand why. The answers may reveal useful information about avian physiology and adaptability, their required learning experiences, and their risk assessment in both an evolutionary and individual sense.

Since Griffin's investigations, research has been greatly aided by technological advances in radar and the creation of tracking mechanisms, such as geolocators, PITs (Passive Integrated Transponders), and new radio and satellite telemetry. More land-based radar stations exist, with larger air space surveillance and other advancements. BIRDCAST, in particular, is a massive research effort coordinated by Cornell University's Laboratory of Ornithology, with hundreds of radars collaborating together.

On a much smaller scale, a Geocator, the size of a shirt button, can be placed on a migrating bird. Inside the tiny device are an inbuilt electronic calendar, a clock, a battery, and a light sensor that constantly monitors the daylight against the clock and the calendar and stores that data. Upon recapturing the bird and device, the entire flight path and timing can be determined ... but ... only one in five birds are usually recovered, so there is much loss of data, time and funds.

Facing no need for avian recapture or a battery, tiny PITS can be positioned on a bird's leg band, or under the skin, or even injected. Via a microchip, location information and ID are taken as the bird passes close to a system antenna, and then transmitted to a computer. The constraint is the need to pass close to the antenna, inches or maybe a few feet away. Thus, PITs are not very useful for migratory information. During the breeding season, however, they can be placed under a nest, recording parental foraging departures and returns, etc.

Radio telemetry is yet another available technique. Electromagnetic waves (radiofrequency in this case) emanate from a transmitter on a bird. The frequency modulations send location and ID info to an antenna and are transformed into beeping by the receiver. By "homing in" to louder signals, the scientist can find the bird or, alternatively, several individuals can triangulate their information to locate the bird. In this case, the weight of the transmitter's battery is the limiting factor on its lifespan and transmitting range; currently, no sufficiently small battery can last for an annual cycle. The Williamses, recall, were among the very first to use radio telemetry to follow the flights of bats for their research in Trinidad.²⁴²

Finally, satellite telemetry, namely the familiar GPS (Global Positioning System) and also Argos tags. On our "smartphones" or in our cars, a GPS yields highly accurate latitude, longitude and elevation above sea level. Originally used by the US Air Force in the 1970s, GPS was, in the 1980s, permitted into public applications. (At that time, inaccuracies were intentionally introduced to prevent terrorists' use of the information in an attack.) The devices access some orbiting GPS satellites from an array of at least 31. Receiving information from the satellite system, archival GPS tags store information. Thus, to access the data, a bird with such a tag must be recaptured. The "tag" is heavy, battery life again a limiting factor, or, with a bird large enough, attached solar panels can be used. Cost is prohibitive at \$3,000 to \$5,000 per device.

Instead of receiving information *from* a satellite, Argos tags send information *to* a designated system of satellites, accessible to researchers' computers worldwide. The tags are currently placed on numerous animal species. Again, prohibitive costs.²⁴³

But notice how many fields of knowledge are already and potentially interconnected! Engineers, ornithologists, botanists, agriculturalists, demographers ... and that just begins the process of musing about possibilities. How prescient was the intention of Rockefeller University and indeed Harvard and other institutions, at least during certain periods of their development, when they strove to integrate not only fields of science but of knowledge generally? Likewise, having a socially positive, constructive working environment and the inclination to share a cup of coffee or tea, or glass of wine or beer with "the other" can lead to unknown, better understandings.

Odds and Ends: The Humorous Bits

I shall end this chapter with the various bits that seemingly *must* be told but appear not to fit anywhere.

Bats? – Lucky You!

As Ron Larkin recalls a tale about Don,
*Several times I was in his office when some nice lady would call him, distressed about bats in her attic. He'd ask about how big they were, how many, were there little ones, and thank her for telling him, exclaiming about how wonderful it was.*²⁴⁴

The Day the Lights Went Out

And an example of Don's teaching:
*His favorite way of illustrating the fallacy of confusing correlation with causation was his terrible guilt one day when he was a child. He was walking along to school, idly slapping fence posts with a stick. He got to a fence post, smacked it, and the electrical grid in that whole area of Massachusetts went dead.*²⁴⁵

The Licorice Connection

Just who exactly *did* the deed was unclear. José, telling the story, claims merely to be an onlooker. Ron, José and Susi were in the lab in Smith Hall, RU Campus, working with an elaborate set of BNC cables. These are cables, popular then, not so much now, used to connect electronic equipment. Some bit of equipment had malfunctioned. Griffin would soon be checking the cables. With her, Susi happened to have a long piece of black licorice ... same size and color as the cables. Hmmm. So, "they" crimped BNC connectors to two ends of a string of licorice and placed the licorice "cable" into a critical part of an elaborate instrument setup.

Then, off to lunch; Don would join everyone in the cafeteria in a few minutes after he finished some testing himself. The threesome waited expectantly, smugly. Griffin arrived. No comments. The group was flummoxed. Back in the lab, there was the licorice "cable," hanging from the special hook for "bad cables." The three giggled; they'd "had" Griffin. I wonder. To me, that is exactly Don's sort of humor; he'd figured out what they were up to, but wouldn't give them the satisfaction of knowing for sure whether he'd been "had."²⁴⁶ Or ... maybe not. The details are

blurred over time and, as Don recalled the incident, he's not so sure he ever recognized why it was a bad cable.²⁴⁷

The Hippo is With Him ...

As Ron Larkin tells the story:

For at least a year or two in my grad student years, [when Ron was "moonlighting" with the Griffin lab], the "Witch" was based in the Bronx Zoo. We would haul it and the other gear to Dutchess County (no Mary Flagler Carey research station yet); [i.e. no Millbrook station]] and back on long weekends to take data. Hard work, fascinating science, fond memories. The vehicles (except DRG's green rambler) were forest green with "New York Zoological Society" logos on the doors.

One Friday afternoon, I was driving the truck towing the heavy radar. A carry-all carefully packed with instruments and equipment followed me and DRG took the rear, towing a boxy forest green wooden DRG-inspired contraption of a trailer made of 1/4" plywood with big swinging doors to deploy the kite balloon [aka "kytoon"]. Its load was about zero, of course. I pulled into the toll booth on the New York State Thruway and the attendant gaped at the logo on the Witch trailer and asked, "What's in there?" I said, "This one's just equipment" and, pointing back at the Rambler's rig, "The hippopotamus is back there." Everyone kept a straight face when we got to the field site. I never learned how DRG handled the questions the attendant must have peppered him with, but he did give me a knowing expression. ²⁴⁸

Jim Gould's Trials and Tribulations

Last year in grad school, the tensions. Would one find an academic position, what sort, where? Jim, after applications and interviews, was offered a position as an Assistant Professor at THE Princeton University. He proudly told Griffin. "Good first job," was Don's "laissez-faire" reply.²⁴⁹

And then, the actual day of Rockefeller University graduation ceremonies, June 1975. Since each year, only five or ten grad students complete their Ph.D.s, each advisor has time to address the gathered assembly to describe the work of his student. Jim had been in Griffin's lab for five years. On the day of the event, en route to the auditorium, Don took out a pen and pad of paper, peered at Jim, and asked, "Remind me, what was it that you did?"²⁵⁰

Yes, occasionally, Don's humor can be hard on one. But, perhaps, in Jim's case, it might have been deserved. On his office door at RU, Jim had a most official-looking sign. It was a large arrow, pointing toward Griffin's office door, and labeled "Mere Phenomenology."²⁵¹

And later in this book: "Phenomenology?" or actually "Revolutions" and "Animal Consciousness!"

ENDNOTES

NOTE: All letters from Donald R. Griffin to Ronald Larkin and from Larkin to Griffin are from the private collection of Ronald Larkin.

¹ I (CR) was then a Post-Doctoral Fellow in the Rockefeller University laboratory of Peter Marler. Afterwards, I was affiliated with other institutions and returned to Rockefeller University, again with Peter Marler.

Beginning in 1980, I was a Research Associate in the laboratory of Donald R. Griffin, until he left in 1986 and I continued at RU as a Guest Investigator with Fernando Nottebohm.

² Timothy C. Williams et al, 1977, p. 251-2. Included on these pages is a review of evidence from numerous studies, including those by Drury and Keith, 1962 and Drury and Nisbet, 1964.

³ William H. Drury, Jr. and J. A. Keith, 1962.

⁴ William H. Drury, Jr. and I. C. T. Nisbet, 1964.

⁵ W. J. Richardson, 1976 conducted radar research and reviewed the radar data for autumnal migration across the Western Atlantic and Puerto Rico.

⁶ M. B. Casement, 1966.

⁷ Numerous scientists contributed to this project. Among them were Leonard C. Ireland and John M. Teal, co-authors with Timothy C. and Janet M. Williams of the 1977 paper presenting the results of the efforts by many.

⁸ Williams et al, 1977, p. 252. The RV Knorr voyage utilized marine radar which “probably did not detect birds flying above 600m. Range 2 km.”

⁹ Timothy C. Williams et al., 1972.

¹⁰ Timothy C. Williams, personal communication, November 19 and December 5, 2020, E-mails. Williams has helped me to clarify the difference between the two types of radars.

¹¹ Ronald P. Larkin, personal communication, November 22, 2020, E-mail. Larkin provided the description of the “Witch’s capacity.

¹² Williams, personal communication, December 5, 2020, E-mail.

¹³ Williams et al, 1977, p. 260, 264, 266.

¹⁴ Larkin, personal communication, November 22, 2020, E-mail.

¹⁵ Timothy C. Williams, personal communication, November 19, 2020, E-mail.

¹⁶ Williams, personal communication, November 19, 2020, E-mail.

¹⁷ Bertram G. Murray, Jr. 1965, p. 122.

¹⁸ Timothy C. Williams, personal communication, November 19, 2020, E-mail.

¹⁹ Timothy C. Williams, personal communication, November 5, 2020, E-mail.

²⁰ Williams and Williams, 1978.

²¹ Larkin, personal communication, November 22, 2020, E-mail. Larkin provided much of this summary information, though any errors in interpretation are mine.

²² Susi Torre Bueno, personal communication, February 17, 2021, E-mail.

²³ Larkin, personal communication, June 8, 2019, E-mail.

²⁴ Larkin, personal communication, June 14, 2019. Telephone interview #2.

²⁵ Ronald P. Larkin, Donald R. Griffin, José R. Torre-Bueno and John Teal, 1979, p.227.

²⁶ Larkin, personal communication, November 22, 2020, E-mail.

²⁷ W. J. Richardson, 1972 is a radar study and an example of the research investigating weather factors impacting on migration. I thank Ronald Larkin for suggesting this publication.

²⁸ Note that wind direction is described in terms of the *origin* of the wind. Thus, a northwest wind blows *to* the southeast.

²⁹ Timothy C. Williams, personal communication, November 19, 2020, E-mail.

³⁰ Williams and Williams, 1978, p. 169.

³¹ It is likely that birds can anticipate coming storms, for some species have been shown to be sensitive to infra sound, that is, very low-pressure changes associated with storms. This sensitivity is discussed in the section about Marilyn Yodlowski.

³² Larkin et al, 1979, p. 246. Unless a front had slowed or stalled, birds were observed on the ship’s radar every time after a front had passed the coast.

³³ Larkin et al., 1979, p. 227. Both the information and quoted material in this paragraph are on p.227.

³⁴ As of 2021, Carolyn A. Ristau has possession of the tapes, having “saved” them from the NYC Sanitation Department when Griffin was about to discard them upon his retirement from Rockefeller University.

³⁵ José Torre Bueno, personal communication, December 4, 2020, E-mail.

³⁶ Volume 3 - Chapter 16, “Revolutions,” Part 1, “The ‘60s Revolution - Musically, Culturally, Politically,” subsection titled “Women in Science - At RU and Beyond.”

³⁷ Susi Torre Bueno, personal communication, February 17, 2021, E-mail.

³⁸ Susi Torre Bueno, personal communication, April 19, 2019. Telephone interview.

³⁹ Larkin et al, 1979, p. 262.

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- ⁴⁰ Larkin, personal communication, June 8, 2019, E-mail.
- ⁴¹ José Torre Bueno, personal communication, April 16, 2019.,telephone interview And December 4, 2020, E-mail. The information in this paragraph is from the preceding two Torre-Bueno sources.
- ⁴² Larkin, personal communication, June 8, 2019, E-mail.
- ⁴³ José Torre Bueno, personal communication, April 16, 2019. Telephone interview.
- ⁴⁴ Susi Torre Bueno, personal communication, April 19, 2019. Telephone interview.
- ⁴⁵ Donald R. Griffin to John Teal, 28 December 1972. Projects, Folder 151, Woods Hole Oceanographic Inst, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 14, 2018.
- ⁴⁶ Donald R. Griffin to John Teal, 13 December 1971, Box 15, Projects, Folder 151, Woods Hole Oceanographic Inst, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 14, 2018.
- ⁴⁷ Donald R. Griffin to John Teal, 15 May 1973, Box 15, Projects, Folder 151, Woods Hole Oceanographic Inst, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 14, 2018.
- ⁴⁸ Larkin et al, 1979, p.254. Several pertinent references are included in their discussion.
- ⁴⁹ Timothy C. Williams and Janet M. Williams, 1978, p. 166.
- ⁵⁰ Bermuda is located in the Sargasso Sea.
- ⁵¹ Williams and Williams, 1978, p. 166.
- ⁵² Williams and Williams, 1978, p. 174.
- ⁵³ Williams, personal communication, November 19, 2020, E-mail.
- ⁵⁴ R. P. Larkin and R. E. Szafoni, 2008.
- ⁵⁵ Williams, personal communication, November 19, 2020, E-mail. These data were gathered with the Antigua radar.
- ⁵⁶ Larkin et al, 1979, p. 228.
- ⁵⁷ The earlier radar studies, particularly Drury and Keith (1962), had identified species, but not via the radar information; that allowed only stipulations of “large birds” and “small birds.” Species identification was done by identifying which birds were seen to leave from the northern sites (southeastern New England, USA) and which species were visually observed in the various southern regions where the birds landed.
- ⁵⁸ Timothy C. Williams, personal communication, November 5, 2020, E-mail.
- ⁵⁹ Larkin et al, 1979, p. 228, 232, 233.
- ⁶⁰ David W. Masch, obituary, retrieved November 17, 2020.
- ⁶¹ By airspeed, I mean relative to the air itself. The speed relative to the ground is a separate measurement.
- ⁶² Larkin et al, 1979, p. 260, p. 262.
- ⁶³ Roger and Katy Payne’s important work on humpback whale communication has been discussed earlier in this chapter, Volume Two – Chapter 12 - Part 4, “The RU Animal Behavior Group: Their Research,” in section, “Roger Searle Payne (RU Assistant Professor) and Katherine (Katy) Boynton Payne (Scientist).”
- ⁶⁴ Larkin et al, 1979, p. 257-258. This section is a discussion of the issue with several relevant references.
- ⁶⁵ Larkin, personal communication, June 6 and 14, 2019. Telephone interviews.
- ⁶⁶ Griffin’s ideas about Cognitive Ethology are discussed primarily in Volume 3-Chapter 16- “Revolutions,” Parts 2, “Revolution in Ethology and The Birth of Cognitive Ethology and Part 3, Evidence Supporting Animal Consciousness (Griffin’s and Later)”
- ⁶⁷ Larkin, personal communication, June 8, 2019, E-mail.
- ⁶⁸ DRG, 1998,p.87.
- ⁶⁹ DRG to Ronald P Larkin, personal communication, July 7, 1982, letter. Letter from the personal collection of Ronald P. Larkin. Griffin was at Rockefeller University and Larkin was at INHS.
- ⁷⁰ Larkin, 1991, p.221.
- ⁷¹ José Torre Bueno, personal communication, April 16, 2019. Telephone interview. José Torre-Bueno offered the description of Carl Hopkins’ research site, and their visit during the interview.
- ⁷² Susi Torre Bueno, personal communication, February 17, 2021, E-mail
- ⁷³ Susi Torre Bueno, personal communication, February 17, 2021, E-mail. Susi described the incident in the email.
- ⁷⁴ Susi Torre Bueno, personal communication, February 17, 2021, E-mail. This is Susi’s description of the event.
- ⁷⁵ Volume 2 - Chapter 12, Part 2, “A Tropical Paradise, Bucolic Field Station, And Early Years At RU, section on “Carl D. Hopkins, Rockefeller University Graduate Student.”
- ⁷⁶ Carl D. Hopkins, 1972, January 1.

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- ⁷⁷ Carl D. Hopkins, 1972.
- ⁷⁸ José Torre Bueno, personal communications, April 16, 2019, telephone interview and December 4, 2020 -E-mail.
- ⁶⁶ José Torre Bueno, personal communication, December 4, 2020 -E-mail.
- ⁸⁰ Larkin, personal communication, June 6 and 14, 2019. Telephone interviews.
- ⁸¹ Adrian M. Dokter et al, 2018.
- ⁸² Williams, T. C. et al., 1977, p. 260.
- ⁸³ Timothy C. Williams and Janet M. Williams, 1978.
- ⁸⁴ José R. Torre-Bueno, 1978.
- ⁸⁵ José R. Torre-Bueno, 1975.
- ⁸⁶ José R. Torre-Bueno, 1976.
- ⁸⁷ Laybourne, 1974, cited in Torre-Bueno, 1976, p. 471.
- ⁸⁸ José R. Torre-Bueno, 1976, p. 471.
- ⁸⁹ José R. Torre-Bueno, 1976, p. 471.
- ⁹⁰ Specifically, the starlings kept their beaks closed with ambient temperatures below 10 degrees C, very slightly open between 10 and 15 degrees C, gradually opening more as the temperature increased further and gaped fully above 30 degrees C, thus affording maximum cooling.
- ⁹¹ José R. Torre-Bueno, 1976, p. 479.
- ⁹² Asmussen and Bøje 1945 as cited in J. R. Torre-Bueno, 1976, p. 480.
- ⁹³ José R. Torre-Bueno, 1975. As far as José recalls, that research was included in his thesis, but not separately published.
- ⁹⁴ José R. Torre-Bueno and J. Larochelle, 1978.
- ⁹⁵ James L. Gould, J. L. Kirschvink, K. S. Deffeyes, and Michael L. Brines, 1980. Although there are no published accounts of Gould and Brines demonstration of magnetite in bees prior to Torre-Bueno and Larkin's pilot studies in the wind tunnel, Gould told me about their work in an in-person interview of May 29, 2019. The earliest related publication is the multi-author publication of 1980 cited here.
- ⁹⁶ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.
- ⁹⁷ José Torre Bueno, personal communication, December 4, 2020, E-mail.
- ⁹⁸ DRG, 1998, in Squire, p. 87-88.
- ⁹⁹ José Torre Bueno, personal communication, April 16, 2019. Telephone interview.
- ¹⁰⁰ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA. Griffin meant by his curt remark, if the birds actually have such magnetic sensitivity, they should at least *try* to use it for something.
- ¹⁰¹ Ronald P. Larkin and Pamela J. Sutherland, 1977.
- ¹⁰² Timothy C. Williams et al, 1977. Their work was part of the "Seafarer Project."
- ¹⁰³ The essential difference between "searching" and "tracking" radar in this usage is that "searching" radar, typically with a broader radar beam was used to find some target "item" or "items" such as a plane or flock of birds. A "searching" radar sometimes can have a narrow beam. The "tracking" radar with a narrower beam follows a specific object and can give quite precise data about range, azimuth, etc.
- ¹⁰⁴ Larkin, personal communication, November 22, 2020, E-mail. Larkin described the "Witch's" range data. The "Witch's" maximum tracking range for small birds (at least during the Atlantis II work) was up to 1500 meters.
- ¹⁰⁵ Larkin and Pamela Sutherland, 1977a, p. 777.
- ¹⁰⁶ Williams et al, 1977b, p. 1, 19.
- ¹⁰⁷ Larkin and Pamela Sutherland, 1977b, Part II of Williams et al, 1977b, p. 12. This part of the paper (p. 5-9) contains data and interpretation of tracking data obtained from the "Witch" by Ronald P. Larkin and Pamela J. Sutherland.
- ¹⁰⁸ Williams, personal communication, November 19, 2020, E-mail.
- ¹⁰⁹ Larkin and Pamela Sutherland, 1977b, Part II of Williams et al, 1977b, p. 9. Data are also displayed in Figures 3 and 5.
- ¹¹⁰ Larkin, personal communication, November 22, 2020, E-mail.
- ¹¹¹ Timothy C. Williams et al, 1977b, p. B-C.
- ¹¹² Larkin and Sutherland, 1977a, p. 777.
- ¹¹³ Williams, personal communication, December 7, 2020, E-mail.

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- ¹¹⁴ Larkin, personal communication, June 6 and 14, 2019. Telephone interview.
- ¹¹⁵ Larkin, personal communication, November 22, 2020, E-mail.
- ¹¹⁶ DRG, 1985, in Dewsbury, p. 139. Griffin briefly summarizes his views, unconvinced about avian magnetic sensitivity; he also references a longer discussion in Griffin, 1982.
- ¹¹⁷ DRG, 1982.
- ¹¹⁸ DRG, 1998, p. 88.
- ¹¹⁹ Volume One - Chapter 9, "A Flying Professor At Cornell: Early Years," Part 2, Part Two - Griffin's Early Research At Cornell And Later Developments By Others, in section, "Avian Magnetic Sensing."
- ¹²⁰ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.
- ¹²¹ DRG, 1973, p. 117. Griffin notes that in the 1950s, it seemed reasonable to state that birds would avoid beginning long-distance migrations when it was cloudy, or climb quickly above such clouds. Later radar data showed this not to be the case, though there were many fewer birds flying in such conditions.
- ¹²² DRG, 1972b, in Rockefeller Annual Report 1971-1972, p. 14.
- ¹²³ DRG, 1974, in Rockefeller Annual Report 1973-1974, p. 1.
- ¹²⁴ Mark Konishi, 1969.
- ¹²⁵ DRG, 1976. This is the *Animal Behaviour* journal article of that date.
- ¹²⁶ B. Truax, 1999.
- ¹²⁷ DRG, 1971a.
- ¹²⁶ D. R. Griffin and Carl D. Hopkins, 1974.
- ¹²⁹ DRG to Ron Larkin, June 4, 1973, letter.
- ¹³⁰ L. W. Swan, 1970.
- ¹³¹ DRG to Larkin, June 26-29, 1973, letter from the private collection of R. Larkin.
- ¹³² Their European horseshoe bat research is discussed in Volume One - Chapter 11, Part 2, "Echolocation Research By Griffin And Others," in the section, "Hans-Ulrich Schnitzler's Work at RU." Other research with horseshoe bats is found primarily in the section, "Detecting an Insect and the Perplexing Doppler Shift," but also in other sections.
- ¹³³ DRG to Larkin, June 26-29, 1973, letter.
- ¹³⁴ Ronald P. Larkin to DRG, July 24, 1973.
- ¹³⁵ DRG to Larkin, July 24, 1973, letter from Rome, Italy.
- ¹³⁶ DRG to Larkin, July 17, 1973, letter from Kathmandu, Nepal.
- ¹³⁷ Beverly N. Greenspan, personal communication, November 14, 2020, E-mail. Beverly recalls that "Glenis Raewyn Long was a researcher in behavioral acoustics. She was interested in echolocation and briefly worked with Griffin." [Long then continued a career in psychoacoustics, studying both humans and other species.]
- ¹³⁸ Volume Two - Chapter 15, "Before the Revolution (Griffin Lab Life And His "Non-Cognitive" Research)," section titled "Human Echolocation (Griffin Research Onsite at Rockefeller University)."
- ¹³⁹ DRG to Larkin, July 17, 1973, letter from Kathmandu, Nepal. Don continues with some specific possibilities: "We could improve on this with a very roughly hand aimed horn for speaker. I even have it: the 4-foot aluminum horn can be fitted to that heavy tripod; I used it for a while as a way to listen for flight calls. All it needs is an E-1 and A2 scale."
- ¹⁴⁰ Larkin, 1975.
- ¹⁴¹ Larkin, 1978.
- ¹⁴² Larkin et al, 1975.
- ¹⁴³ Timothy C. and Janet M. Williams, 1969.
- ¹⁴⁴ Marilyn Louise Yodlowski, Melvin L. Kreithen and William T. Keeton, 1977.
- ¹⁴⁵ Yodlowski, Kreithen and Keeton, 1977, p. 726.
- ¹⁴⁶ DRG, 1978, in RU Annual Report 1977-1978, p. 1-2. Description of M. L. Yodlowski's ongoing research at Rockefeller University.
- ¹⁴⁷ Donald R. Griffin to Fernando Nottebohm, 19 May 19 1980, Box 14, Correspondence, Folder 139, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 11, 2018.
- ¹⁴⁸ Donald R. Griffin to Judith Schwartz at Rockefeller University, 27 May 1980, Box 14, Correspondence, Folder 139, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 11, 2018.

- ¹⁴⁹ Donald R. Griffin to Marilyn Yodlowski at Harvard Medical School, 9 June 1981, Box 14, Correspondence, Folder 139, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed December 11, 2018.
- ¹⁵⁰ Beverly N. Greenspan, personal communication, May 9 & 16, 2019. Telephone interviews. Unless otherwise specified, information in the section about Beverly Greenspan derives from the two interviews.
- ¹⁵¹ For a description of fiddler crabs and Jocelyn Crane Griffin's research with them. see Volume 2 - Chapter 14, "Behind The Man: Significant Women," section, "Jocelyn Crane Griffin ...", subsection, "A Worldwide Traveling Scientist."
- ¹⁵² Volume Three – Chapter 16, "Revolutions," Part 1, "Cultural And Scientific Revolutions (1960s And '70s)", in section, "Women in Science - At RU and Beyond."
- ¹⁵³ R. Haven Wiley, 1973. This article is derived from his Ph.D. research.
- ¹⁵⁴ Beverly N. Greenspan, 1980. This article is derived from her Ph.D. research.
- ¹⁵⁵ The first MRI machines were produced in the early 1970s but did not become commercially available until the 1980s.
- ¹⁵⁶ R. B. Kelley, Gould, J. L. and Sinsheimer, R. L., 1965.
- ¹⁵⁷ Karl von Frisch, 1948, reprinted 1951.
- ¹⁵⁸ Karl von Frisch, 1967.
- ¹⁵⁹ Griffin's strongly positive response to von Frisch's research on the honey bees' dance is discussed further in several chapters, including, for example, Volume 1 - Chapter 9, Part 1, "Settling in at Cornell" and Volume 3 - Chapter 16, "Revolutions," Parts 2 and 3.
- ¹⁶⁰ Adrian M. Wenner and D. L. Johnson, 1967, *Science*.
- ¹⁶¹ Adrian M. Wenner and P. H. Wells, 1990. A review of the bee dance language controversy, concluding that the dance does not convey distance and direction information. Instead, they claim that the flower odor on the returning forager is the cue used to locate the food source.
- ¹⁶² J. L. Gould, M. Henerey, and M. C. MacLeod, 1970, *Science*.
- ¹⁶³ Adrian M. Wenner and D. L. Johnson, 1967, *Science*.
- ¹⁶⁴ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA. Jim Gould described his graduate school interview with Griffin during our conversation.
- ¹⁶⁵ James L. Gould, 2004, p. 1. Gould writes about this incident in his obituary of Don Griffin.
- ¹⁶⁶ Kathryn B. Payne and Roger Payne, 1985. This article compiles and analyzes the whales' songs over 19 years, including the early work.
- ¹⁶⁶ The Paynes' projects studying whales and whale song have been discussed in Volume 2 - Chapter 12, Part 4, The RU Animal Behavior Group: Their Research," section, "Roger Searle Payne (RU Assistant Professor) and Katherine (Katy) Boynton Payne (Scientist)."
- ¹⁶⁸ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.
- ¹⁶⁹ Carolyn A. Ristau (1991b). Ristau's research with plovers is briefly described in Volume 2- Chapter 15, Part 1, "Home in the Griffin Lab" section, "Preparing for Fieldwork -The Plover Example" and in Volume 3- Chapter 16, Part 3, "Evidence Supporting Animal Consciousness (Griffin's And Later)," in section, "Manipulating Beasts – The "Injury-Feigning" Plover."
- ¹⁷⁰ James L. Gould, 1974, *Nature*.
- ¹⁷¹ James L. Gould, 1975, *Science*.
- ¹⁷² Martin Lindauer and B. Schricken, 1963.
- ¹⁷³ Rockefeller University, 1975, p. 4.
- ¹⁷⁴ Donald R Griffin provides a good summary of Gould's experiments in *The Question of Animal Awareness*, 1976, 1st edition, p. 27-28 and also in the 2nd edition, 1981, p. 50-52.
- ¹⁷⁵ James L. Gould, 1974, *Nature*.
- ¹⁷⁶ James L. Gould, 1975, *JCP*.
- ¹⁷⁷ James L. Gould, 1975, p. 692.
- ¹⁷⁸ Alex Michelsen et al, 1992.
- ¹⁷⁹ Tim Landgraf et al, 2018.
- ¹⁸⁰ Volume 3- Chapter 18, "The Return: Bees, Beavers, Bats, Elephants ... and Consciousness in Barnstable," Part 2, "Bees (*Apis mellifera*)."
- ¹⁸¹ James L. Gould and Carol G. Gould, 1995.
- ¹⁸² James L. Gould and Carol G. Gould, 2012.

¹⁸³ The phenomenon of magnetoreception is discussed in Volume 1 - Chapter 9, Part Two, sections “Avian Magnetic Sensing” and “Contemporary Magnetic and Quantum Theories of Avian Migration [WONKISH!].”

¹⁸⁴ William Keeton’s work is discussed in Chapter 9, Part One, section, “Entomology and Bill Keeton.”

¹⁸⁵ William T. Keeton, 1971.

¹⁸⁶ Most of the information in this section about Gould’s approach to science and birds’ age-dependent use of cues for navigation derives from CR’s personal interview with James Gould on May 29, 2019, in Princeton, N. J.

¹⁸⁷ Florino Papi et al., 1972.

¹⁸⁸ Florino Papi, 1990.

¹⁸⁹ Frank Bellrose, 1958a; Donald R. Griffin and Timothy H. Goldsmith, 1955. Avian vector orientation had been shown decades earlier, but many species’ chosen “vectors” did not bear any relation to the appropriate direction for migration. The vectors were probably related to other destinations, pertinent to the bird at some point in its life, e.g. place of rearing, breeding grounds, etc.

In work conducted in Cape Cod, Massachusetts, Griffin and Goldsmith (1955) had found directional flight for displaced common terns (*Sterna hirundo*), that direction being southeasterly. The explanation proffered was that any bird who happened to be inland could, by flying southeast, reach the coast, which the bird might recognize and/or could follow to more familiar areas. Bellrose also displaced mallards (*Anas platyrhynchos*) at various times of the year, including migration seasons, but the vector the birds chose did not bear any relation to the appropriate migration direction. As with the terns, a correct vector depended on clear weather, such that the sun or stars were sufficiently visible; during overcast conditions, the chosen direction was largely random.

Neither Griffin, Goldsmith nor Bellrose investigated any dependence on the ducks’ age and experience, as did Gould’s lab. I thank Timothy Williams for alerting me to the Bellrose publication.

¹⁹⁰ University of Notre Dame Commencement Exercises, 1973, p. 40, p. 60, p. 62.

¹⁹¹ Karl von Frisch, 1948. This first publication about the work was in German

¹⁹² Michael L. Brines and James L. Gould, 1982, p. 70.

¹⁹³ DRG to Larkin, August 23, 1975, letter.

¹⁹⁴ Michael L. Brines and James L. Gould, 1982, p. 72-74. These pages contain a detailed description of the device.

¹⁹⁵ For the visible light, red (650 nm.) and green (500 nm.) wavelengths were used.

¹⁹⁶ Michael L. Brines and James L. Gould, 1982, p. 90.

¹⁹⁷ Mike Brines also conducted behavioral experiments with honeybees demonstrating the extraordinary accuracy of the waggle dance directions. They were accurate to within + or- 5 or 10 degrees of arc, but only if the light provided in the experimental apparatus was rich in ultraviolet light. These are experiments in which bees are cajoled into dancing to a bright light in the hive instead of orienting their dances with respect to gravity.

¹⁹⁸ Michael L. Brines and James L. Gould, 1979.

¹⁹⁹ DRG, 1978, p. 1. Description of M. L. Brines’ ongoing research at Rockefeller University.

²⁰⁰ Natural Environment Research Council, 2014.

²⁰¹ Stefan Greif, Ivailo Borissov, Yossi Yovel, Richard A. Holland 2014.

²⁰² Timothy C. Williams, personal communication, November 17, 2021, E-mail. Williams notes that among problematic experimental aspects is the fact that the bats were put into magnetic fields for use in other experimental work. The researchers used the “vanishing point” rather than tracking the entire journey of the bats after release. As discussed in earlier chapters, Griffin, himself, noted how the final direction observed (aka the “vanishing point”) can be misleading. Data from one of the two release sites were especially scattered and unconvincing. (See particularly Volume One - Chapters 7 and 9.)

¹⁹⁶ Ernst Sutter, 1957a, cited in DRG, 1973, p. 117.

²⁰⁴ Ernst Sutter, 1957b, cited in DRG, 1973, p. 117.

²⁰⁵ Larkin, personal communication, June 6 and June 14, 2019. Telephone interviews.

²⁰⁶ Susi Torre Bueno, personal communication, April 19, 2019. Telephone interview.

²⁰⁷ The kytoon is further described in Volume Two - Chapter 12, Part 3, “The “Rock,” The “Witch” and The Field Station” and also in Volume Two - Chapter 15, “Before the Revolution ...” , Part 3, “The Trip to “The Middle of Nowhere,”” in section, “High Flyers (Bats and Kytoons).” Photographs of Griffin with a kytoon may be found in Chapter 12, Part 5 and in Chapter 15

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- ²⁰⁸ José Torre Bueno, personal communication, December 4, 2020, E-mail.
- ²⁰⁹ Ronald P. Larkin, personal communication, November 23, 2020, E-mail.
- ²¹⁰ Susi Torre Bueno, personal communication, April 19, 2019. Telephone interview. Except for the short quote by James Gould, the description of the radar work in this paragraph is provided by Susi Torre Bueno.
- ²¹¹ Carol G. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.
- ²¹² José Torre Bueno, personal communication, December 4, 2020, E-mail.
- ²¹³ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.
- ²¹⁴ DRG, 1973, p. 122. The description of the “cloud detector” derives from both CR May 29, 2019 interview with James Gould and from Donald Griffin’s 1973 paper.
- ²¹⁵ DRG, 1973, p. 118.
- ²¹⁶ Donald R. Griffin and Raymond J. Hock, 1949, Incident #320, cited in DRG, 1973, p. 118.
- ²¹⁷ DRG, 1972a. This study includes observational data collected from April-May 1970,
- ²¹⁸ DRG, 1973.
- ²¹⁹ DRG, 1973. The observations in this paper were made between November 1970 and April-May 1971.
- ²²⁰ DRG, 1972b in RU Annual Report 1971-1972, p. 13.
- ²²¹ DRG, 1973, p.122.
- ²¹⁴ DRG, 1973, p. 123, p. 135.²²³ Timothy C. Williams, personal communication, November 19, 2020, E-mail. Williams notes that, strictly speaking, the radar is detecting large water droplets or rain which comprise the “cloud.”
- ²²⁴ DRG, 1973, p. 136.
- ²²⁵ DRG, 1973, p. 120-121.
- ²²⁶ Ronald P. Larkin, personal communication, November 23, 2020 and November 13, 2021, E-mails. The five photos were included in the 2020 E-mail. The photo descriptions derived from both the 2020 and 2021 communications.
- ²²⁷ DRG, 1973, p. 139-140. This is a summary of the results.
- ²²⁸ Florino Papi et al, 1972.
- ²²⁹ DRG, 1971b in RU Annual Report 1970-1971, p. 15.
- ²³⁰ DRG, 1973, p. 140.
- ²³¹ DRG, 1973, p. 139.
- ²³² José Torre Bueno, personal communication, April 16, 2019. First telephone interview.
- ²³³ Timothy C. Williams, personal communication, February 13, 2020, E-mail. The views and information contributed by Williams are paraphrased from several emails of that date.
- ²³⁴ Timothy C. and Janet M. Williams, 1978.
- ²³⁵ Timothy C. Williams, personal communication, December 22, 2020, E-mail.
- ²³⁶ Timothy C. Williams, personal communication, November 19, 2020, E-mail. The opinion about Griffin’s wish to conduct matters “his way” was expressed by William in the E-mail, and I heartily agree.
- ²³⁷ Timothy C. Williams, personal communication, February 13, 2020, E-mail.
- ²³⁸ Timothy C. Williams, personal communication, February 13, 2020, E-mail.
- ²³⁹ DRG papers to Larkin, personal collection. This was DRG’s mid-1975 “List of Planning Questions,” noting Rodney W. Nichols’ agreement to forego future Millbrook “Open Houses.”
- ²⁴⁰ DRG to Larkin, July 17, 1973, letter from Kathmandu, Nepal.
- ²⁴¹ Larkin, personal communication, November 22, 2020. Larkin suggested the currently unanswered questions.
- ²⁴² Timothy C. Williams, 1975.
- ²⁴³ National Zoo, Smithsonian Institute, n. d. Retrieved December 2, 2020. The information in this section about various methods of determining location information is from this website.
- ²⁴⁴ Larkin, personal communication, June 8, 2019, E-mail.
- ²⁴⁵ Larkin, personal communication, June 8, 2019, E-mail.
- ²⁴⁶ José Torre Bueno, personal communication, April 16, 2019. Telephone interview.
- ²⁴⁷ Carolyn A. Ristau, 1991c, p. xvii. The details of the remembered event have indeed changed over time. As recalled in the “Reminiscences” section of this 1991 book, there were only two participants, José Torre-Bueno and Beverly Greenspan.
- ²⁴⁸ Larkin, personal communication, June 8, 2019, E-mail.

²⁴⁹ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.

²⁵⁰ James L. Gould, personal communication, May 29, 2019. CR in-person interview, Princeton, New Jersey, USA.

²⁵¹ Larkin, personal communication, June 8, 2019, E-mail.

CHAPTER TWELVE

A TROPICAL PARADISE, A BUCOLIC FIELD STATION, AND EARLY YEARS AT ROCKEFELLER

[Chapter 12 has five Parts: Part One - Move to The Rockefeller University; Part Two – Trinidad - A Research Station In Paradise ... Muddy Roads And Many Bats (both in this file); Part Three - The “Rock,” The “Witch” And The Field Station; Part Four - The RU Animal Behavior Group - Their Research (Griffin, Marler And Nottebohm Labs) (both in same file); Part Five - Griffin Lab Research: Early RU Years (separate file)]

PART ONE

MOVE TO THE ROCKEFELLER UNIVERSITY

Overview

Facing administrative bureaucracy and especially hostility from the newly dominant cell biologists, both E. O. Wilson and Griffin decide to leave the Harvard Biology Department. Wilson retreats to the Harvard Museum of Comparative Zoology and Griffin is invited in 1965 to form a new institute at The Rockefeller University in New York City. Griffin brings his Harvard grad student with him, Timothy Williams, and quickly gains another grad student, Jack Bradbury, to work on bats. But even at RU, animal behavior field research struggles to be accepted as “real science.”

He and Jocelyn Crane marry. I portray life, both academic and social, at the RU campus urban oasis. That life is both egalitarian in its goals and hierarchical with attendant formalities. At RU, a student might well lunch beside a Nobel Laureate, but receive “a word” from the RU President for inappropriate attire at an RU concert.

The Move

It was all quite opportune. The Board of the Rockefeller Institute of Medical Research in New York City had, in 1953, voted to become a graduate university instead of an institute. By 1968, the institute’s title was officially changed to “The Rockefeller University.” In 1959, the first Ph.D. s were awarded and President Detlev Bronk was strengthening the biomedical faculty. Importantly, he was also expanding and seeking to enhance Rockefeller’s already well-recognized status by developing other academic domains that he considered part of the intellectual and practical world of a broadly educated scientist. To this end, he hired not only biochemists (e.g. Nobel Laureate Fritz Lipmann) but also physicists, mathematicians, philosophers and even behavioral scientists. Carl Pfaffman, the physiological psychologist, became, in 1965, both a professor and Vice-President of Rockefeller University.¹ In the view of Detlev Bronk, a biological scientist needed to be conversant with all such areas: physics was the basis of chemistry; physics needed mathematics, biologists needed the instruments of physics: electron microscopes, X-ray crystallography; many disciplines

could be enhanced with mathematical formulations and with the deep thinking of philosophers; and all these operate within a whole organism, hence knowledge of behavior.²

At the same time, back at Harvard, Don Griffin was becoming increasingly exasperated with his position as Chair of the Biology Department (within the larger Zoology Dept.) There was less and less time for his fieldwork, as had also been the situation at Cornell. At Harvard, his research time was being reduced as he dealt largely with administrative duties plus the usual refereeing of scientific journals expected by an academic scientist, particularly one as esteemed as Griffin. But likely most significant was the growing hostility of the cell biologists toward Don Griffin and Edward O. Wilson. In the view of the cell biologists, they themselves were the “real scientists,” not the behavioral biologists. (Recall the incident, initiated by a disgruntled cell biologist, making spurious requests for Don’s early, early paper about seal stomach contents.³) The cell biologists seemed determined to take over the department. As Chairman, Don had not been able to get a single program he suggested passed that year by the department (approx. 1964-1965). (A Chairman is quite different from a Head. As Department Head at Cornell, Harold Adelman was able to make sweeping changes at his own initiative.) There seemed to be a move to get rid of both Griffin and Wilson.⁴ But these were internationally recognized scientists; their removal was not easy.

Harvard was not the only “takeover” site by cellular and molecular biology in those times. Even respected “small” liberal arts colleges with a very strong emphasis on undergraduate teaching experienced those forces, e.g.

“Swarthmore and Haverford were under pressure to dump ‘old-fashioned biology’ for ‘modern biology.’ Animal behavior/ethology was attacked from both the biological and psychological sides. ... E.O. Wilson ‘took refuge’ in the Harvard Museum of Comparative Zoology in the 1960s” ⁵ [and stayed on for the rest of his career, becoming a Harvard Emeritus professor upon his retirement.]

For Griffin, the choices were different. He felt he was unable to have a productive career at Harvard any longer. The Museum was not an option for him. Personally, as is further discussed in a later chapter,⁶ his life was changing. William Beebe had passed away in 1962. Griffin had obtained a divorce from his first wife. In 1965, he accepted a position at Rockefeller offered by Bronk and married Jocelyn Crane, relocating to New York City. They moved into the sumptuous apartment in the Hotel des Artistes on the Upper West side of Manhattan, given to Jocelyn by Beebe.

Organizing and Directing IRAB

Griffin was much relieved to be out of the Harvard departmental war.⁷ Likewise, in 1965, at the invitation of Detlev Bronk, he began organizing the new Institute for Research in Animal Behavior (IRAB), a joint enterprise with the New York Zoological Society (currently known as the Wildlife Conservation Society).⁸ Griffin would be the Director. As described in the prestigious journal, *Science*, the enterprise “will clearly be involved in a sector where many scientists expect a major ‘breakthrough’- behavioral biology.”⁹ Among the facilities of this joint venture were not only the Bronx Zoo and the New York Aquarium in Coney Island, but also the William Beebe Tropical Research Station in Simla, Trinidad, where Jocelyn had worked with Beebe over many years. (The Simla station was officially a part of and “under” the NY Zoological Society). Simla was also where Griffin had first met Jocelyn while conducting bat echolocation research there.

After persuasion by Bronk, Pfaffman and Griffin, the British ornithologist Peter Marler would also be joining the enterprise, arriving in Fall 1966. Marler was already a well-recognized researcher of avian song learning, drawing significant parallels to human children's language learning.¹⁰ Among the modes of influencing him was a jaunt aboard Detlev Bronk's yacht; a photo in the Rockefeller Archives labeled "Moment of Decision" reveals a pensive Peter Marler aboard that yacht.¹¹ Not a simple persuasion, for Marler and his family were seemingly happily ensconced in California, Marler, a professor at the University of California, Berkeley.

Allures of The Rockefeller University, Including Student Junior Colleagues

But Rockefeller offered stimulating possibilities for both Marler and Griffin, including ample funds for research, and the opportunity to select scientists to join them at the new Institute. Further, there would be significant relief from most teaching duties, for the Rockefeller graduate students were selected to be very bright, "independent," young scientists capable of "self-directed study," becoming "junior colleagues" and "learning through daily mentoring in the laboratory."¹² Rockefeller had no undergraduates, only graduate students. They had almost no required courses ... and extremely few were offered. For those who entered without adequate training in biochemistry, however, a most intensive Rockefeller University short summer course was required before beginning graduate studies in the fall.¹³ An additional "required course" was part of the program, at least during the early days of Griffin's appointment at Rockefeller. As described by Griffin's grad student Timothy Williams, it was "a triumphal parade of 'The Rock's' famous, and it was great to hear lectures from Nobel Prize winners, one after another. I loved it."

Assignment to a laboratory was two-way, based on the wishes of the student and those of the lab director. Over time, as Rockefeller funds no longer flowed quite so generously, the choice depended also on the ability of each to find grants. In reality, the "self-directed study" and "no course requirements" worked variably, depending on both the personality of the lab director and the student. In some labs, the student's research project was assigned by the laboratory head according to his interests, as were those of any post-doctoral fellows. In others, the situation was far more flexible. Likewise, some students flourished with no or few courses; others regretted the lack of the more formal and structured learning experience provided in a lecture course. Without such, a student was often left meandering through the literature, largely on his own.

I recognize that I have been using the masculine pronoun and that is indeed purposeful. Few women were part of the student or post-doctoral ensemble, fewer yet among the faculty. But more on that later.

Life at The Rockefeller University

The Bucolic Rockefeller Campus

Even though "at the edge of Manhattan's bustling Upper East Side," life on The Rockefeller University campus was both strangely bucolic and yet quite disciplined and formal. The 14-acre private oasis, is described on the RU website, as one of New York City's most "spectacular and soothing landscapes," and, in the NY Times, as a "musical composition of light, shadow and shades of green." Shading the grounds stand century-old London plane trees. Azaleas burst into bloom each spring,¹⁴ so stuffed full of blossoms, one couldn't imagine finding a space to squeeze in an extra flower.

We used to joke among ourselves that the gardeners were out early each morning before we students and faculty arrived to pick up, by hand, any stray leaf that dare fall upon the lush green lawn. In fact, it wasn't a joke; they did, and, indeed, early in the morning, so as not to be an intrusion upon the idyllic scene.

And the tulips were splendid, that is, in the days before the major budget economies of the '70s, when the tulips were all supplanted by easy-care perennials. Tulips, though they may continue to grow from one year to the next in our own gardens, often without all their initial vigor and glory, did not do so in the Rockefeller Gardens. Fresh new ones were planted to bloom the next spring, one could be certain of this, because the color of the bright inner circular garden could vary from year to year, one time a brilliant red, another, a bright yellow. How we cheered the errant tulip ... the time when a single red tulip dared bloom in the round, compact sea of yellow. It did so in a most prominent place, through the august wrought iron Main Gate, up the drive into the circular garden at the foot of Founders Hall, the main entry point for visitors to the campus.

To the side of the campus flowed the East River; breathtaking views were afforded from the better quality apartments for faculty and students in the Rockefeller Tower building, the high-story dining area and even from the smallest, older offices of Gasser Hall and various other sites. As one peered out from such a small dingy office, commercial vessels would float by, but also sailboats, or rather, yachts with sunbathing passengers, meandering who knows where in the vast world.

There *were* amenities at Rockefeller University. In the spacious Faculty and Students Club, one might sit before a fire in the fireplace come winter and sip a cocktail made by one or other of the familiar barmen who remained at Rockefeller for eons, it seemed. And the drinks were the cheapest in all of New York City. No cash, no tipping permitted; the costs were added to one's accumulated monthly bill of University charges. From within the club's walnut-walled room, one looked out, through floor-to-ceiling windows, on the gardens at the same ground level. And in a part of the landscape, in the frigid NYC wintertime, an outdoor space, (had it been extra parking, a shallow pool?) was converted into an ice-skating rink; that was in the pre-economy years. The bar was likewise the scene for "post-lecture" hors d'oeuvres, intended for those who'd attended said lecture, providing an occasion to socialize and discuss the talk. But there were other attendees, typically non-lecture-attending students and postdocs for whom free, seemingly endless shrimp and other canapes were beyond resistance. The repast was decidedly less luxurious as the years went on.

Cultural Events ... and their Requirements

And there were cultural opportunities. Both in Abby Aldrich Hall near the Caspary concert/lecture auditorium and by the top floor Faculty dining room, one encountered works of Modern artists: Alexander Calder, Chuck Close, and Frank Stella among others. As a founder of the Museum of Modern Art, Abby Aldrich Rockefeller was remembered by such choices. Much of the faculty, though, was not similarly inclined in their cultural tastes. Don Griffin once remarked to me, most politely, that he had a difficult time appreciating many of the works.

Attendance at New York City's theaters and concerts was encouraged by including a stipend for such tickets in the graduate students' financial support. Accomplished local artists performed in weekly noon concerts sponsored by the tri-institution group (Rockefeller University, Cornell Medical Center and Memorial Sloan Kettering). These events, however, were, most unfortunately, rather poorly attended, with busy students and faculty not taking the time to "disrupt" their day. Elderly folk from nearby old-age homes were sometimes taken in small groups by their "carers" and filled the gaps.

However, the approximately monthly Friday evening concerts were another matter. Often performers scheduled for the next evening at the famed Carnegie Hall or another noted NYC venue would be persuaded to play in Caspary Auditorium for an audience of Nobel Laureates (and others of course). “With its intimate scale, clear sight lines, and superb acoustics, Caspary provides an extraordinary musical experience.”¹⁵ In the ‘70s and ‘80s, it was a simple matter to obtain tickets, free or at very low cost to the grad students as I recall. Now, the six annual concerts in the Peggy Rockefeller Concert series require a subscription, and, as word spread, are preferentially available to members of the tri-institution group, rather than the general public. Back in the ‘70s, however, when Frederick Seitz was RU President, concert attendance was one of the formalities. Just as graduate students would wish to be “seen” attending the academic lectures offered, so, taking advantage of Rockefeller University’s cultural events *and* dressing appropriately was important. If a grad student was *not* wearing a jacket and tie, a “word” would be spoken to the unfortunate young man by Pres. Seitz, either before the concert or during intermission and said individual would promptly leave. He might or might not opt to return, but if he did, he *was* suitably attired.

Living and Eating

Accommodations were also provided at subsidized cost to students and faculty. The students dwelled in apartments in the Graduate Students Residence building on campus. The faculty had various choices, including an impressive tower of apartments overlooking the East River. Some of the lowlier faculty, such as Post-Docs, were initially housed in nearby Rockefeller University-owned 4th-floor walk-ups, but these options were gradually replaced by more secure and amenable facilities off-site and on an expanded campus, built over the East River Drive.

In the ‘70s and ‘80s, several options existed for casual eating or more elegant dining. For a special lunch with a visiting faculty member or a “date” among students or Post-Docs, one might reserve a table in Founders Hall, complete with linen tablecloth, overlooking the river or, in the warm spring, out on the veranda among the blossoming trees. The dark wooden hall with chandeliers and light pouring through the tall windows eventually became converted into a library. But in its stead was a fine faculty dining room on the top floor of the Research Tower building. The “long table” was an especial feature, intended to promote interchange between the faculty of diverse disciplines. Though not officially so designated, the table quickly became the domain of the most senior faculty, to which younger faculty might be invited by their lab heads. With some trepidation, invited by Don Griffin, I, too, would join the assemblage, in awe of Nobel Laureates and other world-renowned scientists beside me.

One might attend a reception or, with advance reservations, dine in the elegant Abby Dining Room open only in association with the Caspary concerts. One entered via the Abby Aldrich Rockefeller Hall which displays art from the Rockefeller Collection. A large Calder mobile dominated the entry hall. Views of the subtly lit gardens and candlelight complimented the fine cuisine. (In later times, the dining room was open more regularly for student and faculty dining, though some variant of “appropriate dress” was still required. The permitted sorts of attire grew less restrictive over time.)

Hierarchies

The Bass Dining Commons, a very spacious room with wide expanses overlooking the East River and walls of fine Italian ceramic tiles, provided a cafeteria of sorts, but obviously several notches above most so-named self-service restaurants. Divided into two sections, [at least in the ‘70s and ‘80s], one side allowed smoking, while the other, with a more glorious view, did not. Both

parts were open to staff, students and faculty, but soon self-segregated as most smokers were staff, while faculty and grad students were far less likely to be. Once the self-segregation began, it continued to develop, with non-smoking staff personnel enduring their companions' puffing to be with other staff friends.

And, yes, there was certainly a hierarchical order at Rockefeller, which became somewhat more egalitarian over the years. Initially, waitresses in the Founder's Hall dining room were all African American women; they wore tiny hats, and black uniforms with small, white aprons surrounded by lace. The superb Instrument Shop, which performed exacting work and devised with pride and good humor whatever strange bit of apparatus one might imagine, were all German, recommended by others working in the shop. Similar groupings of ethnicities and race were to be found in other staff positions that entailed cooperative work with each other. ... All these details are as I remember them, for I can find no reference to the social compositions. I also vaguely recall an explanation that similar groupings enhanced the friendly, collaborative nature of the joint tasks or, perhaps, I just imagined that reasoning. Matters *did* change as will be discussed in the Chapter on Revolutions.

Among the faculty and students, the Graduate Fellows (the grad students) brilliant though they be, were the "bottom." Heads of labs, I believe, all full professors, were the top academically, but those that were also Nobel Laureates, and there were more than a few, were obviously the "crème de la crème." Below were the Associate Professors, then the Assistant Professors, Post-doctoral Fellows, and Research Associates, in that order. Visiting or "Guest Investigators" typically implied that Rockefeller University was not paying their salary, but the individual had a Rockefeller University title and use of the facilities, likely even an office or space within a lab. Often, but not necessarily, such an individual had a position and salary from another university or was on Sabbatical leave from another institution and might be anywhere on the professorial ladder. As the years went by at Rockefeller University, and fewer funds flowed, there was more and more need for most faculty to obtain external funding to pay for needed equipment, "overhead" to RU and salaries of their lab personnel, including any technicians or research assistants, neither part of the "faculty."

Two New RU Griffin Graduate Students

Into this challenging environment entered two graduate students to work with Donald Griffin: Timothy Williams and Jack Bradbury. Both had been undergraduates at colleges that were excellent preparations for the idealized, independent, self-directed study intended for Rockefeller grad students. Williams had been at Swarthmore College and Bradbury at Reed. Except for Antioch College and perhaps Hampshire, there are few if any such well-regarded "independence training" undergraduate institutions in the USA. Both Reed and Swarthmore attracted and accepted only the most intellectually gifted.

Timothy C. Williams

After college (A. B. 1964), Timothy had been a first-year grad student with Don at Harvard. He had been recommended by Don Kenneth Rawson, Don's former Cornell and Harvard graduate student who had become a Swarthmore Professor. And Prof. Rawson had been Tim's academic advisor and more than that. Dr. Rawson had invited Tim to be his summer research assistant on a mouse homing project at the Rocky Mountain Biological Station in Colorado. That set Tim on his "lifelong study of homing and migration."¹⁶ Already, this "academic grandson" had become an "academic son." In the summer of 1964, Tim had been invited by Griffin to join him in research in

Trinidad on bats' homing abilities. Tim had asked if it was acceptable to bring along his brand-new wife of two weeks. "... Don said he thought that could be arranged, as long as [Janet] was willing to do research as well." She was employed by Don, helping his work, Tim's studies and Jocelyn's research. It quickly became apparent that Tim's work required two persons, so Janet was switched to work predominantly with him, and also with Griffin.^{17,18} Janet notes: "That decision of Don's shaped Tim's and my future life together, since we worked together as a husband-wife team of field biologists [for the rest of our lives], for over thirty-five years."¹⁹ We did our best to combine work and family. Our children, two sons, joined us on many expeditions, beginning when the first was yet unborn and continuing when still a nursing infant.

As Don was struggling through the final stages of his divorce, he would often come alone to relax and share dinner at the Cambridge home of Tim and Janet. Close bonds were formed among them all in those trying times. Invited to join Don at Rockefeller, and having just moved from New York City to Harvard, Tim considered resettling again. Would there continue to be some arrangement for Janet? ²⁰ Yes, again Griffin would hire her, though primarily as an assistant for Tim, since his work still needed two people.

But there was more to be tackled. Before acceptance into the Ph.D. program, Tim had a required interview with Detlev Bronk, President of The Rockefeller University. Bronk was a highly respected biophysicist. Tim reviewed relevant research, reexamined his own research plans and prepared for the event. And ... well, they mostly discussed operas they liked, with mutual hopes that Tim, now residing in New York City, could see more live opera. They both expressed their appreciation for Swarthmore's college program, where "Det" Bronk had also graduated and was later a faculty member for almost a decade.

Jack W. Bradbury

The other Ph.D. student, Jack Bradbury, had already been working for two years at Rockefeller as a graduate student with Prof. Alex Mauro, brilliant, warm and generous, and one of the most beloved persons at the university. Jack had entered the University with an interest that had begun in his earliest days, in animals, in whole organisms. His scientific hero had been William Beebe. From age 10 through high school, Jack had lived at the beach, Newport Beach, California. With his avidly interested buddies, he had collected, dissected, and learned about almost every marine-dwelling creature they could find or capture. (In this, Jack was most fortunate to have similarly inclined bright young folks (male) to join him. Griffin's enthusiastic nature interests had been primarily solitary experiences.) Jack's extensive collections and his knowledge of the organisms led to the high school biology teacher inviting him to be a student lab assistant. This was a paid position, so no more scrounging for yardwork earnings. And later, for three glorious summers at the Marine Biological Laboratory in Woods Hole, Massachusetts, Jack had the splendid opportunity to be the lab assistant for one of his Reed professors, Frank G. Gwilliam. In Jack's view, even his father's profession influenced his view of the complexities of animals, conscious, feeling animals; his dad was a Disney animator who drew rambunctious, manipulative and loving animals²¹ But the emphasis at RU was on neurobiology. After two years, Jack still deeply appreciated Dr. Mauro, but Jack's research seemed to be leaving the whole animals. Initially, he worked at RU with Horseshoe Crabs, his studies tending towards physics and membrane potentials. Animals used in the research had to be sacrificed; that act was more than difficult.

Then, a new lecture series. The newly appointed professors, Peter Marler and Donald Griffin, presented a set of talks introducing the field of animal behavior. Jack heard them and realized he had found a scientific approach that was just what he wanted to do. In Bradbury's view, *It was a field that focused on whole behaving animals (no crucified crabs). Scientists worked in the field and in controlled laboratory settings. Evolution, ecology and physiology all overlapped to generate different patterns of behavior in different species.*²²

Bradbury met with Griffin; they "hit it off immediately." At that time, Don was emphasizing comparative research into bat echolocation: how different bat species facing different environmental conditions and prey might vary their emitted echolocation sounds. To solve this puzzle "would require a mix of field and captive animal studies, seriously challenging mathematical physics and a fluency with technological devices."²³ Jack had solid proficiency in all these areas from his prior work and Don invited him to join his group in Trinidad the following summer. Like Tim, Jack had a wife who would not be pleased with several months' absence. She, too, had an undergraduate degree in science, specifically in psychology, and, for her senior thesis, had conducted experiments on young ducklings' imprinting process. Griffin suggested she could come to Trinidad as a Field Assistant.

PART TWO

TRINIDAD- A RESEARCH STATION IN PARADISE ... MUDDY ROADS AND MANY BATS



Simla, Trinidad: A View from A Window (by Julia Chase-Brand)

Overview – Part Two

Life at the William Beebe Tropical Research Station (aka Simla) of the N.Y. Zoological Society is both gritty in the experience of field research and verging on elegance in the lifestyle. For many researchers, the “hands-on” methods of their fieldwork involve trekking through the guano-mud bat caves. Others, no doubt enduring other adversities, study the glorious wildlife that abounded in Trinidad.

Visiting scientists, including Griffin, explore many aspects of bats’ abilities: What role might vision play in their navigation? Visual/cognitive maps? Pattern perception? Species differences adapted to the species’ niche? The mysterious fishing bats consume the attention of Don Griffin and his student Rod Sutherland. Other scientists are engrossed in fascinating problems in other species, particularly communication.

When opportunities arise, researchers happily engage in the local culture, learning the patois, exuberantly dancing.

Summer 1966 and Griffin's team set off for Simla, the William Beebe Tropical Research Station in Trinidad. Since the summer of 1964, Tim and Janet Williams had already been spending most of their time there.

The Simla field station figured importantly in Griffin's life, personal and scientific, from 1960 to 1969. Likewise, it was the scientific stomping grounds for many of Griffin's academic sons and grandsons. Yes, the masculine descriptor is purposeful; there were some women, but few that made it through the academic system in those days. Most of the women who came as visitors to the station were male scientists' assistants or wives/assistants. Beebe himself, however, was highly supportive of women professionals, had women on his professional staff, and received much flak from his colleagues for doing so.²⁴ And as shall be further discussed in Chapter 16 ("Revolutions"), when at Rockefeller University, Griffin, too, always seemed to have more women Ph.D. students and lab members than did most other RU faculty.

Chronologically, in 1960, Donald Griffin had first met Jocelyn Crane; that meeting was at Simla. She was then Associate Director of the station, Beebe being the Director. Griffin had come to Simla to study bats, particularly *Noctilio leporinus*, the fishing bat. Beebe passed away in 1962 and Jocelyn became Director, though she had, in effect, been functioning as Director in Beebe's later years. After Griffin's divorce was finalized, Jocelyn and Don were married in December 1965.

Exploring the Research Paradise

The William Beebe Tropical Research Station of the New York Zoological Society

Before the site in Trinidad, the field station was situated at the appropriately named "El Rancho Grande," located in Venezuela's cloud forest mountains. After much hassle and political turmoil, the site was moved, "never again in Venezuela," swore William Beebe, its head. Jocelyn Crane had discovered both sites and her searches, as well as her life and research, are detailed in Chapter 14.²⁵ Both locations were simply beautiful, besides being extraordinarily rich in flora and fauna for tropical research study. "Trinidad lies at the southern end of the chain of the Caribbean islands ... just ten miles off the coast of Venezuela. ... The island is about fifty miles long from north to south and about thirty miles wide ... A steep range of mountains, the Northern Range, runs east and west along the north end of the island and gets up to over 3,000 feet in altitude...."²⁶

When Trinidad was a British colony, much of the northern range was set aside as a preserve; this ensured a sufficient watershed for the large lowland population. Much of the protection remained when Griffin and his team were there.²⁷ The Research Station was high on a ridge of the Northern Range, approached by a steep road flanked by towering tropical trees, many bursting into masses of flowers: the Flamboyant, the Pui, pink or yellow, the Pomerac. Finally, one came to Simla, "an elegant house built by a past English governor of Trinidad as his summer residence." One entered into a most pleasing, large living room with one wall open to spectacular views overlooking the Arima Valley, running north to

south. “There were no windows with glass in the building nor screens for insects, just shutters to keep out the sun in the hot weather and wooden canopies over each window to shed rain during the rainy season.”²⁸ Within the station were several other rooms including a dining area; both the dining and living rooms served as focal areas for the many intense discussions over cocktails and superb dinners. Other constructions housed guests and scientific areas.

Only a few miles up the Valley was the estate and working cacao plantation owned by the widow Asa Wright. Asa was an intriguing woman who figured in the lives of various researchers and rented rooms to some. Her Foundation finally came to own and manage the Beebe station as it fell into hard times, years later.

And the sounds ... all the researchers marveled at the sounds. Stepping off the plane in Trinidad, a blast of intense humidity and the “roar of millions of insects.” In the night, the “chirps of gecko lizards ... hunting prey on the walls and ceiling” of their lodging. Sometimes, an incessant, repetitive “electronic” beeping, disturbing sleep at night, and concentration on data in the office during the day. Who was using the irritating device? No one ... just one of the insects.²⁹ Each morning, the day began with the sight of the lush wonderland.

The Wildlife

Avian: “The forest was full of birds, mostly colorful tanagers.” Down the hill, large blackbirds, Crested Oropendolas (*Psarocolius decumanus*) flew into a tall tree with hanging, giant (10-20 foot) oriole-like woven basket nests. Frequently, a male gave a most peculiar display: a “squeaky ... call followed by a ruffling of feathers and wing slapping,”³⁰ while its long black tail flashed brilliant yellow ends. Probably most irresistible to a female, especially a female Oropendola. The Great Kiskadees, colorful yellow and brown flycatchers, were a daily sighting near the station as were the Little Tinamous (*Crypturellus soui*). And there were other frequent station visitors: two species of Honeycreepers (*Cyanerpes*). The small birds entertained in their distinctive ways: During mating season, a male Blue-black Grassquit (*Volatinia jacarina*) would jump high (for him), about a foot in the air, from a well-exposed tree branch, simultaneously squawking and displaying his feathers flamboyantly. The aptly named yellow and black Bananaquits (*Coereba flaveola*), also aptly known as Sugarbirds, eagerly stole leftover jam or sugar from tea time, and nectar from flowers at other times. Higher in the mountains, one might hear the “beautiful, clear bell-like tones of the Bearded Bellbirds (*Procnias averano*),” but usually, like many topical forest birds, they were only heard, not seen in the dense foliage. Among the most strikingly beautiful birds were the Blue-crowned Motmots (*Momotus coeruliceps*) with a long, racquet-shaped tail. And most impressive of all, but a distance from the station in a swampy area of the West Coast, were the Scarlet Ibis (*Eudocimus ruber*), the national bird of Trinidad. Janet Williams recalls with pleasure a day trip there, invited by Jocelyn to join her as she searched for displaying fiddler crab species, accompanied also by Don Griffin and Tim Williams. The flock of brilliantly red birds was observed returning, after the day’s foraging, to the home site. Marine prey gave the Ibis their extraordinary color.³¹ And not to be forgotten were the

White-Bearded manakins (*Manacus manacus*) whose displays were studied by Alan Lill, to be described later. Dwelling in some caverns were the mysterious, echolocating Oilbirds (*Steatornis caripensis*), known locally as Guacharos, studied by Griffin and others.³²

In the evenings as the researchers gathered in the large Simla living room over rum punch and appetizers, Jack Bradbury remembers, "... we could watch flocks of parrots and egrets flying back to night roosts, and foraging flocks of swifts getting in one last meal before nightfall."³³ With the darkening night, hordes of bats filled the skies.

Insects: "There were insects everywhere including lovely butterflies, preying mantids, stick insects and every type of beetle one could imagine."³⁴ [CR: Let us not forget the cockroaches, as much as three inches long, encountered en masse as the "writhing floor" of the bat caves ... and most everywhere else, thousands, in the woods, in the houses.]

And, of course, the ants, many species, but three types were most typically encountered by the researchers: Tiny ones found in every morsel or giant-sized pieces of food. But the Simla kitchen had "rather" ant-proof cabinets, with fine mesh walls and doors, whose feet stood in dishes of water. Larger ants were the leaf-cutters that came by the millions to a tree, cutting the leaves into small bits which they carried back to the nest to produce a fungus garden. The fungus provided food for the larvae and some ants. And finally, the horrific army ants marched through the forest in wide columns, even two or three feet wide. "They bite viciously." At least once, they were most useful as they marched into the kitchen, and found cockroaches to eat, which satisfied everyone except the roaches.³⁵

Others: There were many other invertebrates and mammals, too many to mention, except to highlight the fiddler crabs, (*Uca*) subjects of intense study by Jocelyn Crane over decades. Her work culminated in a massive tome, *Fiddler Crabs of the World*, still regarded as a major reference source.

Bats and Caves

Multitudinous species of bats, over 60, inhabit Trinidad. For scientific reasons, most researchers selected one particular species, or, for comparative studies, several. Rod Suthers, with Julia Chase, conducted visual acuity tests on 40 different species, most from Trinidad. The fairly large Greater Spear-nosed bats (*Phyllostomus hastatus*) received particular attention from other researchers. The Williamses explored how these bats employed *both* vision and echolocation to return home after the scientists displaced the bats from their home roost. Tim and Janet used radio telemetry as one means to track the bats, being among the first scientists to do so.^{36,37,38} Jack Bradbury was especially interested in comparative social behavior and chose both *Phyllostomus* and Sac-winged Bats (Family: *Emballonuridae*) for his later postdoctoral work.³⁹ For his Ph.D. dissertation, Bradbury studied characteristics of the *Vampirum spectrum's* echolocating calls. These calls were specialized to locate, not flying, tiny insects, but animal prey such as rodents, birds, and even other bats in the dense forest; sometimes large insects such as beetles were eaten. (Though carnivorous, it didn't drink blood as did the other vampire bats, hence its common

name “Great False Vampire Bat.) Back at “The Rock,” Jack’s lab studies of target discrimination helped specify the precise nature of the bats’ abilities.⁴⁰ Another bat, *Noctilio*, the fishing bat, was a source of much puzzlement and investigation, initially by Griffin, and then Suthers, among others.

Though the bats lived mostly in caves, they could be found in various other, often most unappealing, putrid places. And worldwide, at night, they left their lairs in mind-boggling masses. Why so many? “If they came out too early, the hawks would pick them off. Came out singly? Owls and other carnivores would catch them one by one. So for most cave-dwelling bats, the strategy is to wait until late dusk and then emerge en masse ... in murmurations of bats ... There’s safety in numbers.”⁴¹

Of the caves, the huge Tamana Cave and the smaller Guanapo Cave were most often used by Griffin’s group. Tamana had several side chambers, each of which tended to hold only one or a few of the many distinctive species of bats. The bats numbered a half million to three million,⁴² making Tamana Cave both an excellent source for capturing diverse species of bats but a difficult site to attempt behavioral studies. Guanapo Cave was closer to the station and still difficult to access, but less so. So, with many, but not millions of bats, Guanapo Cave was a frequently chosen study site. More on bats and caves as we purvey the research projects.

To quote Jack Bradbury, “It was easy to see why Jocelyn and William Beebe had picked this forest for their work.”⁴³

The “Bat Researchers” and Others

David and Ada Pye

Recall from the Text Box in Chapter 11 that David Pye had invented the portable bat detectors used by many bat researchers over the years, including Don Griffin.⁴⁴ Don had first met Pye at an earlier time during a conference in the 1960s; Don Griffin was Pye’s “hero.” Planning to return to Trinidad in the summer of 1961 to continue his fishing bat studies, Don invited David and Ada Pye to join him. They were eager to accept the invitation and did all the complicated arranging needed to do so.

Pye’s project in Trinidad was inspired by picking up a moth that, so disturbed, made barely audible, very high-pitched sounds. When he suggested to Kenneth Roeder, the renowned moth researcher, that Roeder might want to find out how and why these noises were being made, Roeder responded, “The moths are *your* discovery; you find out.” The guess was that it all had to do with bats and bat sonar. Pye had a bat sonar detector. Roeder sent him tapes of high-frequency bat sounds to play to the moths, thereby, hopefully, “inspiring” the moths to respond by producing those strange sounds. And indeed, the moths produced very high-frequency broadband sounds, caught by the bat detector and recorded as evidence. But why? As Pye describes the reasoning: 1) Adding broadband sound to an approaching bat’s echo could distort that echo and make it difficult for the bat to locate the moth *or* 2) the moth’s sound could startle the bat. In either case, the moth is more likely to escape uneaten, but it is difficult scientifically to distinguish between the two possibilities.⁴⁵ These days, the generally accepted conclusion is interference with bat sonar.

The Summer of 1966

The summer of 1966 seems to be particularly special. Many scientists had passed through Simla. But that summer, the station was buzzing, filled with scientists each doing their “own thing,” but helping each other, sharing resources, then in lively conversations about it all over the communal dinner table and lunch too.

What was different? After the sadness of Beebe’s death in 1962 and tensions over management by a *woman* (Jocelyn Crane),⁴⁶ personal relations were generally stable. Not just stable, but happy, insofar as Jocelyn and Griffin were married and Griffin was there at Simla with two enthusiastic graduate students, and an equally enthusiastic undergraduate assistant, Ann M. Graybiel. Perhaps, the peacefulness and joy spread.

Non-Bat Research at Simla

There were, of course, many bat-unrelated activities carried on at the Simla field station that summer and over the years. That particular summer, Jocelyn was continuing her major studies of fiddler crabs’ (genus *Uca*) communicative claw-waving displays as well as recording male courtship sounds from various katydid species (family *Tettigoniidae*, related to crickets). Alan Lill was observing the flamboyantly colored male manakins (family *Piprinae*) make their exuberant displays to the female birds. He sat silently in the quiet jungle forest for hours, not daring to move and possibly disturb the birds. The mosquitoes and biting ants, however, moved freely over him, enjoying their ever-returning victim.⁴⁷ Neural recording from the brains of colorful *Heliconius* butterflies exposed to color stimuli was the work of Stu Swihart. John Alcock, later the author of a popular book on animal behavior, was working with his graduate advisor, Lincoln Brower. They were painting silk moths (family *Bombycidae*) with the colored patterns of toxic butterflies to determine whether birds would avoid eating them. But, a complication: the birds seemed to use more cues than distinctive patterns. Silk moths *flew* differently than any of the toxic butterflies.⁴⁸ Never underestimate a moth ... or other insect ... or any animal!

Roderick (Rod) A. Suthers (1937-2019) and Julia Chase

Among the “bat people” in the summer of 1966 was Rod Suthers, Griffin’s former grad student and postdoc. In 1966, Rod was a faculty member in the Physiology Department of the Indiana University Medical School, accompanied in Trinidad by his graduate student Julia Chase.

Fishing Bats

Suthers had conducted his Ph.D. research on fishing bats (*Noctilio leporinus*) primarily at Simla. When Griffin first investigated their fishing,⁴⁹ it was a mystery as to how the bats producing their high-frequency sounds *above* the water could possibly accurately detect the presence and location of fish *below* the water. The physical acoustics of the situation made echolocation of the underwater fish seemingly impossible. Only about 0.1% of the incident sound energy entered the water.⁵⁰ And then there is refraction: the sound

waves reflected off a possibly moving fish would have been refracted both entering and leaving the two mediums. Yet the fishing bats had been observed catching fish and analyses of stomach contents had revealed fish parts.

Flying low over the water, the bats dragged their disproportionately large feet with sharp, forward-pointing claws through the water ... but observations suggested that was only for a distance of a few centimeters or up to about a meter. Sometimes, they snagged a fish. Other times, they made do with insects, those flying or drifting on the water. The fishing did not seem to be random. Were the bats simply returning to known good fishing areas and trying their luck? Or were bats detecting ripples generated by the fish in the water? Don Griffin, Clarke Slater, a Harvard undergrad, and Griffin's then graduate student Alan D. Grinnell had conducted preliminary experiments in Trinidad in 1960 and '61 (constructing "Lake Slatell" to do so). They became convinced that the bats could not detect a target *through* the water, but the results were not absolutely conclusive.⁵¹ Griffin suggested to Suthers that he might like to follow up on this research for his Ph.D. project and, as Rod acknowledges, provided "stimulating help and criticism" throughout.

So, Rod was having another try with captive bats fishing in a 7-meter (21-foot) long pool enclosed in the bats' 15-meter (45-foot) long flight cage at Simla. Presumably, this is *not* the same pool and bat cage that has figured in the various anecdotes and cocktail-time malodorous fragrances that shall be revealed later. And among Rod's assistants was Ann Graybiel, a Harvard undergrad, who, to her delight, was invited to accompany Don Griffin and Rod one summer to Trinidad.⁵²

To ensure that enticing fish scraps were not presented to the bats at the same place each time, allowing the bats to learn to fish by location, a grid was laid; the target position was determined by a random number table. With the aid of highly sensitive microphones, each bat's sounds were recorded. In some experiments, a wire supported a target above the water while an attached piece of fish was below. The underwater piece of fish was supported by a tiny underwater balloon. With use of the grid, direct observation and strobe flash photography, a bat's position could be determined at the moment the microphone indicated a sharp increase in the bat's pulse frequency. This rate change indicated that the bat had just detected the target. Thus, the researchers could determine the distance over which the bat sensed a target.

In some of the trials, the target was a very small projection of wire above the water. The bats could regularly detect a wire only 0.21 mm. thick extending 5 mm. above the water and, above chance levels, even find a 1 mm. length of such wire. In yet other trials, the bats had to distinguish between two small shapes above the water, one of which indicated a fish piece below the water while the other indicated no fish. Trained to choose the shorter of two pieces of wire protruding above the water, the bats could learn to distinguish between a 9 mm high piece of wire and one 10 mm high. Once trained, it took only seconds for *Noctilio* to make its decision and choose the shorter target.⁵³ In summary, results showed that bats could not find fish below the water without a cue above the water. However, they could learn to discriminate between the above water shapes used and could locate extremely fine bits of wire extending above the water's surface.

Griffin and Flying Fishing Bats



Top: at "Lake Slatell" at Simla, Trinidad (circa 1960) (by Alan D. Grinnell)

Bottom: at a similar indoor flight cage and pool at Simla (1964) (by Nina Leen) in RU, 1985/1986, p. 4.

What of actual ripples? An ingenious invention with a bit of rubber hose under the water produced mini “upwellings” of predetermined size as water flowed out of the hose. Yes, the bats detected such tiny “ripples.” Was olfaction or sight involved? How to determine this? Smear a target indicating “no fish” with scrumptious fish bits and pieces and dribble freshly squeezed fish fluids in the nearby water. The bat ignored these enticements and picked the correct target indicating the underwater fish. Even a blinded bat with nostrils plugged with cotton and paraffin was successful.⁵⁴ Those results indicated that the fishing bats were not using either odor or sight to detect the underwater fish. The bats must be relying on their sonar which was capable of detecting the “artificial ripples” and the tiny above-water wires and shapes. Those above-water targets simulated some ripple characteristics, namely elevation above the water’s flat surface.

Under natural conditions, both fish and insects create millimeter-sized irregularities on the water’s surface which bats can discriminate from floating debris such as sticks, leaves or bubbles.⁵⁵ Recent studies have shown that *Noctilio* can use *either* hunting strategy: dip at a particular spot indicated by ripple information or trawl based on prior experience that the area is good for fishing. Once the bat detects the fish, it uses the pouch between its leg to scoop up the fish and its sharp, curved claws to catch and hold it.

Bats’ Visual Acuity

Also in the summer of 1966, Rod, with the help of Julia Chase, studied the visual acuity of various bat species. The basic test was to determine how fine a line a bat could see, a measure of visual acuity. The optomotor reflex (OMR) was used as a means of determining that ability. [The OMR is an innate reflex involving eye, head or body movements and is common to many species; it is an attempt by the organism to stabilize its visual field.]

Rod had a cardboard drum mounted on a bicycle wheel, which could be turned by hand, or, in later experiments, by a motor. A liner with vertical black and white stripes of equal width was inserted inside the drum. A bat was added ... inside a clear plastic cylinder. It hooked its feet onto a sturdy wire cover across the top. Or should we say, a rather upset bat was put inside the cylinder? The researchers would wait ... and wait ... and wait ... and finally, the bat would finish defecating, urinating, grooming, spreading pheromones around and then settle down.

Next Rod or Julia rotated the drum and watched to see if the bat moved. If it moved, one knew that the bat had seen a moving stripe. In control trials, the field was entirely gray or white and the bat did not make the movement it did with rotating vertical stripes. Using finer and finer stripes, at some point, the bat didn’t move, and the researchers had thereby determined the visual acuity of the bat.

The researchers knew the bat’s responses were based on its vision and not sonar, because the bat, inside the clear cylinder, could see, but couldn’t use its sonar through the plastic. Over the field season, they tested fifteen bat species with this experimental arrangement. The big-eyed species of bats had visual acuities of under 1 degree of visual angle, while the tiny-eyed insectivorous bats had a poorer visual acuity of about 10 degrees. The difference reflected the needed capacities of the species: The big-eyed bats fed on fruit and nectar or mammal blood and had faint sonar; they foraged at night with their sonar but

also used any available light. They are the so-called “whispering bats.” The insectivorous bats hunted moving, darting, small insects at night, relying more fully on echolocation abilities and less on vision. The summer’s and other work resulted in Suthers’ *Science* paper.⁵⁶

Stymied by a Sewing Machine!

A story from Julia Chase:

In 1966, my first summer in Trinidad, Rod had brought from Indiana University a fishing net with a telescoping aluminum handle. The 2-inch mesh net was appropriate for fish, but definitely not for bats. He also brought a length of finer nylon mesh fabric that was suitable for bats. Then he nonchalantly gave me my first assignment, to sew a new net and fit it onto the aluminum hoop. I was a girl, wasn't I?

The problem here was that Home Ec [Economics] was the only subject in which I'd ever gotten a C. ...

I went to the old-fashioned Singer treadle sewing machine in the corner of the great-room, lifted the cover ... and there was a tree boa coiled up inside.

Surprise! I'm not phobic about snakes but was stunned and fascinated.

Resentfully, the snake uncoiled and slithered away.

But then came the really difficult part, threading and using the sewing machine. I was never good at it. I was still struggling by mid-morning when Griffin happened by. Seeing my dilemma, he sat down and carefully threaded the machine and showed me how to use it. There was not a bit of condescension or humiliation in his words or behavior, and he never mentioned it again. I believe he never told Suthers either, for which I am eternally grateful. (J. Chase, August 28, 2020, personal communication.)

Visual Obstacle Avoidance

There were numerous other experiments in bat vision conducted by Rod or Julia or both over the years, based at least in part in Trinidad. Some explored the obstacle-avoidance abilities of a species of big-eyed whispering bats, specifically *Phyllostomus hastatus*, the Greater Spear-nosed bat, an apparent favorite bat subject among the Griffin team.

To do the study, a flight cage was hung with vertical strips of white cloth. Could the *Phyllostomus hastatus* successfully navigate between the strips and reach the other side without banging into the cloth? The bats were either in normal condition or wore goggles, preventing their vision, or earplugs, preventing their hearing, or both goggles and earplugs, blocking both sight and hearing. The researchers watched and scored the bats' behavior as a “miss,” a “touch” (lightly grazing the cloth), or a “hit.” A normal bat flew easily between the barriers, touching them lightly or not at all. A blindfolded bat did equally well. When the

bats were deafened with earplugs, the bats were “clutzy” and often brushed into the cloths with their wings. But a bat with both goggles and earplugs just bashed into all the cloth strips at random. Taken together, the work shows that this bat species *can* navigate in the light with vision alone, though not as well as when they are aided by their echolocation; they are at a loss if they can neither see nor echolocate.⁵⁷

After these experiments in the field facilities, Jack Bradbury and Fernando Nottebohm conducted visual obstacle avoidance experiments in the IRAB wind tunnel, to be discussed later in the chapter.

Bats’ Pattern Perception

In still other research, the bats’ pattern perception was tested, beginning with simple patterns, discriminating between a vertical and horizontal line or between a circle and a square. Big-eyed bats were subjects: the largely fruit-eating bats, *Carollia perspicilata*, and the predominantly nectar-feeding *Anoura geoffroyi*. They were chosen specifically because they did *not* have to precisely detect tiny flying insects, but had to find much larger stable fruit or flowers embedded in stable leafy jungle surroundings. Could vision be of particular use for them? After all, the ultrasonic cries and the echoes lose considerable intensity over distance, and these so-called “whispering bats” have fainter sonar than many other bats. Furthermore, these bats would not have any potential additional cues provided by the *movement* of their target as insectivorous bats would.

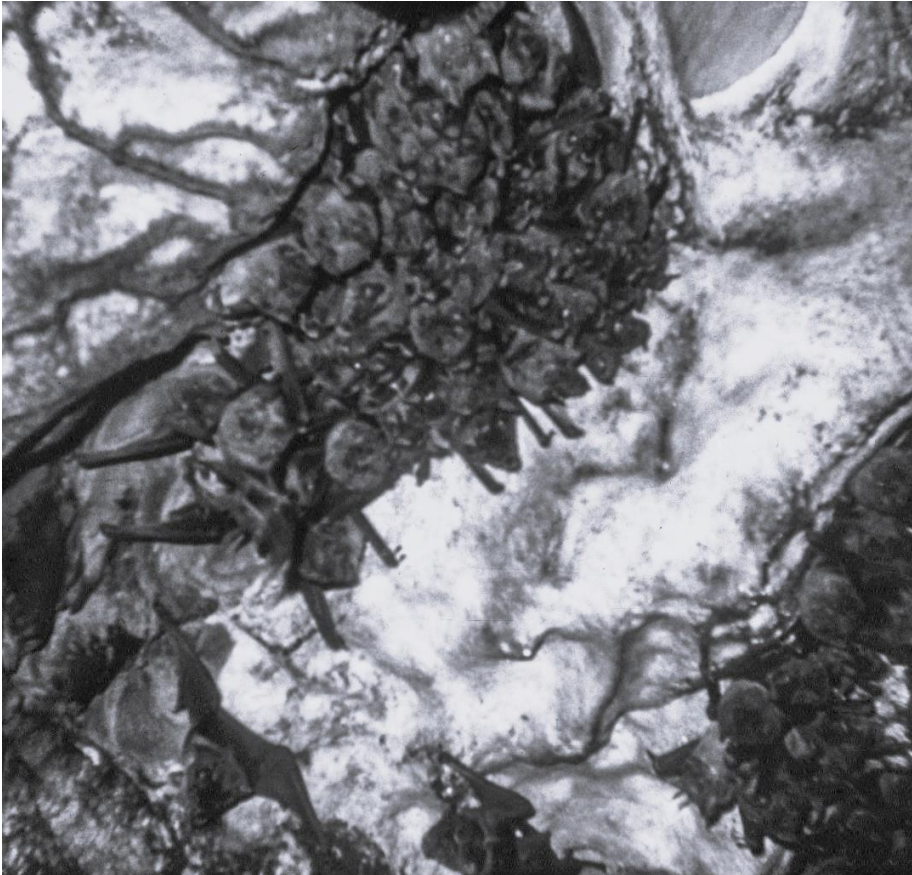
For the experiment, the bats roosted in a room closed off by a door to the test chamber. When the door was lifted, the bats flew into the test chamber and saw black shapes behind a plexiglass sheet. (Recall that plexiglass prevents bats’ use of sonar.) Behind one side of the sheet might be a cross with a spigot in the middle, while the other side had a circle with a spigot. One pattern was associated with sugar water from the spigot, the other with bitter quinine water. To be certain that odor was not playing a role, in some trials the bats were given sugar water from both spigots, and the experimenters expected ... what? ... that the bats would still choose the pattern previously associated with reward. But now the bats performed randomly; they went to either side. Why? Once again, we note the difficulties faced by human experimenters who have neither the senses nor the mind of a bat. Finally, the researchers realized that the sugar used was local Trinidadian sugar, which is contaminated with molasses and presumably had an odor that bats, but not humans, could detect. The bats happily chose the distinctive *odor* previously associated with reward. With “less smelly”/“non-smelly” reagent grade sugar from the local university (the University of the West Indies), the bats performed as expected; they chose the previously rewarded *visual pattern* in the control trials. In fact, the *Anoura* species, in particular, exhibited pattern discrimination comparable to or superior to that of a lab rat or mouse.^{58,59}

Tamana Cave and Its Inhabitants

For all the bat researchers, many expeditions and experiments included Tamana Cave. At Julia’s first visit, only twenty-four hours after arrival, she and Rod, with Dr. Bob Loregnard, expectantly approached the site. Every bat person was eager to follow Loregnard around. As a local biologist and head of the Trinidad bat rabies control crew,⁶⁰ he

knew the location of every bat species in Trinidad, for bats are a major reservoir for viruses. Bob brought researchers to the bats, whether it be to a cave, under leaves, on the path of a major bat “flyway,” or in “fetid hollow tree cavities.”⁶¹ This day’s site was a formidable hole in the earth: about 40 feet across and 40 feet down. Julia dreaded heights; Rod, snakes. Each got to face their challenges: Julia as she feigned no fear in front of the hearty men and climbed down the shaky ladder they’d pulled out of a knapsack. And during the course of the day, Rod met two 4-foot-long green snakes that tumbled onto, then ... off him.⁶²

It was quite a horror movie scene inside the cave as well, but, also, tremendously fascinating for the bat researchers. The ceiling of the entry chamber was full of potholes ... scratched out ... by the bats themselves. It was inhabited by a large species, the Greater-Spear-nosed bats (*Phyllostomus h.*). The cavities along the periphery of the ceiling held bachelor males, while further in, and thus more secure, each cavity held a male bat with his harem. The ground underfoot felt like coffee grounds but was actually an accumulation of centuries of bat droppings (guano).



Phyllostomus h.
Harem
Deep Inside
Tamana Cave
 (by Julia
 Chase-Brand)

Further into the cave, numerous side chambers tunneled off from the main cavern. Julia Chase-Brand has described the cave and its inhabitants very well in a memoir,⁶³ and I shall mention only a few dwellers. In one tunnel were the common vampire bats (*Desmodus rotundus*), the very social, little dumpy roundish bats with grayish-brown fur, staring with their big round eyes. They are only about 70-90 mm (2.8 - 3.5 inches) long, weighing only

25-40 grams (about 1-2 ounces). After a meal ... of blood, mammalian blood, they can almost double their weight. Upon returning to their roost after eating, they will check each other's tummies. Should one of their group have not had a good dinner, a full bat will regurgitate blood to feed the hungry one. These bats, like most of the others Rod and Julia collected, were among the subjects in the visual acuity experiments that have been described.

Still further into the cave in a yet darker area were some peculiar-looking species, such as the Ghost-faced bat (*Mormoops megalophyllia*) and *Chilonycteris rubiginosa*. They are tiny-eyed and insectivorous and depend solely on sonar for hunting their prey. In the moderately lit areas, near the walk-in chamber, roosted larger-eyed species such as Seba's Short-tailed bat (*Carollia perspiculata*) which was among the neotropical bats studied by Griffin back in the early 1950s.

In the deeper portions of the cave, the ground was covered with cockroaches, "3-4 inch long cockroaches, writhing wall to wall, an entire carpet of them." [Those cockroaches (*Blaberus giganteus*) impressed the various bat researchers, for everyone in some conversation or writing to me has mentioned this particular horror of their Trinidadian cave experience. They also note the other cockroach species, in lesser sizes and quantities, in their households.]

The various bat species created an entire ecosystem: Delicious, nutritious bat poop for cockroaches. Opossums (the black-eared opossum *Didelphis marsupialis*) meandered in to catch the bats. Researchers saw snakes hunting bats and were told snakes do eat bats, some snagging a flying bat on the wing, others grabbing a bat hanging from the ceiling. And nosing around the area were assorted frogs and beetles and spiders.

Outside the caves, other species, the *Emballonuridae*, lived on exposed places such as outer trunks of trees, on the sides of houses, or under bridges. Jack Bradbury later studied their intriguing social behavior. Julia was interested because, while these bats use sonar for nighttime insect hunting, they are often seen active in the late afternoon, earlier than other bats.⁶⁴ As shall be further discussed, their retinas turned out to be markedly different from those of strictly nocturnal bats.

Bat Eyes

After examining the eyes and retinas of 31 bat species, Julia concluded that the eyes could readily be categorized into three classes: tiny, medium and large. All the nocturnal species had densely packed rod receptors and their retinas were all highly convergent, meaning the rods from a comparatively broad area of the retina would pool their responses to achieve high sensitivity in dim light. The nocturnal species are further divided into tiny-eyed and medium-sized eyes. The tiny-eyed nocturnal bats hunt for insects using their loud sonar cries.

The medium-eyed nocturnal bats have eyes about six times those of the insectivorous bats. They are the "whispering bats," as Griffin termed them, such as *Desmodus*, *Carollia* and *Anoura*. The quite faint sonar, the "whispering," of *Carollia* and *Anoura* sufficed for finding their larger, stationary prey such as fruit and nectar from

flowers. Their faint, but directional, beams are believed to reduce extraneous echoes from foliage surrounding the targeted fruit or flower.

The other group of "whispering," nocturnal medium-eyed bats, *Desmodus*, are vampires, feeding on large mammals, such as sleeping cows. Their medium-sized eyes suggest use in the very faint light of most nights.

The third group, the *Emballonuridae*, roost in exposed sites, partially or totally in the daylight. They have eyes 16 times the relative size of the nocturnal insectivorous species. Their receptors are a mix of rods and cones, and the retinas are far less convergent than in the strictly nocturnal species. Field observations suggest that visual surveillance in daylight from the species' exposed roost sites may be an important concern for these bats.

Recall that Griffin, as far back as 1952 had found striking differences in the echolocating calls of neotropical bats that fed on insects, fruit, fish or the blood of large animals, including in his studies several of these very species.⁶⁵ Though Griffin was initially unable even to record the "whispering bats," Alvin Novick returned the following year with new, more sensitive equipment to begin a long series of comparative studies recording all the species mentioned and others.^{66,67} But Griffin and Novick's focus was on relating prey to sonar use, rather than considering also the role vision might play. In fact, from Griffin's and Galambos' early experiments, they believed "bats could scarcely use their vision at all since plugging their ears made them so helpless." Later, as a Cornell faculty member, Griffin found a graduate student, W. C. Curtis, who explored bat vision further and found evidence for at least rudimentary pattern vision.⁶⁸ Bat visual ability became a growing, though not central, interest for Griffin.

The "Mouse-Tossers"

Julia relates a tale of her assistance with some of Don Griffin's research, taken from her forthcoming book.

The most prestigious job I had my first summer (1966) was as the 'mouse tosser' for Dr. Donald Griffin. Griffin was 51 at this time and was world renowned not only for co-discovering bat sonar with Robert Galambos, but also for his endlessly creative approach to experimental field biology.

*... During that summer, Griffin was working with the biggest of the Trinidadian bats, *Vampyrum spectrum*, a carnivorous species with a whopping three-foot wingspan. ... It hadn't been studied much, [but Griffin had captured a specimen], and wanted to record the bat's echolocation calls as it hunted. Now this is no easy task because the bat's sonar emerges in a narrow beam of ultrasound, like the light from a flashlight, so the bat had to be induced to approach Griffin's recording instruments head-on. ... Griffin had set up a movie camera, strobe lights and a microphone attached to an ultrasonic tape recorder [all set to document an approaching, hunting bat. The critical bit was my tossing a dead mouse at the precise, optimal location for the recording. Fortunately,] *I used to play baseball and still had a good aim.**

One night, I was delayed after dinner. When I finally got out to the flight cage, the experiment had screeched to a halt, and everyone was convulsed in laughter. [A researcher, Roger Payne, had volunteered to be the tosser, but ... having tossed the

mouse, slipped, fell and the mouse fell too ... onto Roger's face.] *Totally unperturbed, Griffin kept the camera and tapes rolling, as the bat gently plucked the dead mouse off Roger's face.*

The next day, Roger built the world's first "mouse-apult" out of wood scraps, nails and an elastic band, and I was retired from my job as mouse-tosser. (And yes, that is the same Roger Payne who two years later became world famous for co-authoring with Scott McVay "The Songs of the Humpback Whale," [describing the ballads so painstakingly transcribed by himself, Mc Vay and Roger's wife, Katy Boynton Payne.]⁶⁹

Afterwards

Over the years, even when Griffin himself was no longer conducting research at Trinidad, Julia and Rod returned, she as his graduate student and field assistant again in 1967. Then she came solo in summers with her own grant and with her own students when on the Rutgers University and Barnard College faculties. For several years in the 1980s, Julia conducted echolocation studies as a Visiting Researcher in Griffin's laboratory, having access to Griffin's excellent ultrasonic recording equipment. This time her subject was rats!⁷⁰ Eventually, Julia decided on a career change, went to medical school, earning an M.D. at age 53, and began practice as a psychiatrist. All this was in addition to her pioneering success as a distance runner, competing first in 1961 when women were officially prohibited from such competition and celebrating the 50th anniversary by running again in 2011.⁷¹

Rod, too, returned to Trinidad, conducting further vision studies. After 1967, his new field assistant was his wife-to-be, Barbara Braford, an Indiana University Biology Dept. Ph.D. student, studying birds. In later years, Suthers' interests shifted from bat sensory studies to the physiology and neural control of bird song. His research is further described in the Appendix of Volume, Three.⁷²

Timothy C. Williams, Griffin Graduate Student, and Janet M. Williams, Collaborator⁷³

Tim was exploring the role of both vision and echolocation in enabling bats to return to their home roosts when displaced to small or larger distances. It was already known that by echolocation alone, bats could learn to recognize a large area, aka a "familiar territory."⁷⁴ Griffin was keenly interested in how much the bats used vision, if at all, when returning over long distances to their home. He was most pleased that Tim, too, was enthusiastic about such a project.⁷⁵

[Although Don and Tim were not using the term "cognitive map" at that time, a bat must be using the echolocation information to construct a map of a "familiar area." The ultrasounds produced by bats are absorbed by the air too rapidly to be effective beyond a few tens of meters. Thus the bats could construct a larger map of the "familiar area" by piecing together overlapping map segments tens of meters in diameter; the map could also contain distinctive features that were perceived via echolocation.]

Simla field station was the Williams' base of operations and Tim and Janet stayed in Trinidad much of the year, having begun while Tim was at Harvard. They returned to the U.S. every two to three months for Tim to take an RU graduate course and for them to do data analysis, write papers, deal with equipment, "recharge" and then set off again.

Over the three years that they lived in Trinidad, they much preferred working in the dry season rather than the wet, since searching for and displacing bats in homing experiments involved much travel over narrow, winding back roads, very muddy or worse in the rain. Mudslides slid; trees crashed across the road. Tales abounded of people stuck with their vehicles in the mud with no way to contact anyone; no cell phones and no wireless network existed. Not to exaggerate, there was also at least one *paved* rural road, that up the Arima Valley to the Research Station:

*Paved by hauling blocks of tar from the Tar Pits in the island center, pounding them to pieces on the dirt road, and then letting the sun melt the tar into a material that would shed water during the rainy season but had a slippery surface when the sun was out which made driving exciting all year.*⁷⁶

But there was a happily remembered bonus to those long, slow, rough, often hours' long drives, rumbling along, not in a sensible 4-wheel drive, but rather a little Renault, all that was available for rental.⁷⁷ The first year, 1964-65, Don, Janet, and Tim were together in Trinidad for several weeks without other Griffin students. Don Griffin would frequently join Tim and Janet, driving in the car with bats to release far from their roosts. "Don would regale them with wonderful stories. He was a marvelous storyteller."⁷⁸ Among Tim's favorites were those of Don's young days at Harvard working with Pierce, the physicist with the magnificent parabolic horn. Many of the tales have also appeared in Don's book, *Listening in the Dark*.⁷⁹ In other years, Don usually had to be "shared" with the many others at Simla, including the summer of 1966, a wet season Tim and Janet usually avoided.

Both Tim and Janet were much impressed with Griffin's agility during any cave explorations. Notwithstanding Don's apparent "non-athletic" youth,

*"he would climb up and down 'climbers' ladders (8" wide rungs held together with flexible steel cables) rapidly, while Janet and I, half his age, struggled with the swinging menace. He would crawl through caves rapidly, even in the tightest sections."*⁸⁰

(Years later, when Don was in his late 80s, Hope Ryden, the author and beaver enthusiast and researcher, would visit Don at his beaver lodge study site. "With the agility of a young man, he scrambled atop the lodge to view"⁸¹ [the video screen recordings of beaver activities below.]

Tim wanted to bring bats back to Harvard for study. These were *Phyllostomus hastatus*, the Greater Spear-nosed Bat, which featured in the homing studies. How to get them back from Trinidad? Simple, or simpler in those days. Says Tim, we brought the bats ... back to Harvard,

hidden in a little suitcase as carry-on so they would not die in checked luggage. ... We spent a miserable winter there trying to do operant conditioning to test their senses until the pest control people sprayed the bat room with DDT ... and killed all the bats.

[The spraying was totally] *unknown to DRG [Griffin] – he was furious. After that, we did all our work in the field in Trinidad which suited me fine.*⁸²

Most of the bats used in Tim's homing experiments lived in Guanapo Cave (officially the "Heights of Guanapo"), but many also came from Tamana Cave where so many of the bat researchers found a bat species of their choice. Both Tim and Janet grew to be quite fond of their study bats, *P. status*, as did the other researchers of their own species. Janet described them as "very attractive ... like miniature German shepherds ... with fur of black or dark amber red ... like a kitten's. The bats were easy to catch, easy to handle, and rarely tried to bite," though the researchers always wore gloves to protect against a bite and potential rabies. Handling the bats gently, they were never bitten.

Having captured bats, Tim and Janet initially marked them with plastic leg bands or colored ear tags. Later, they more simply used bright paint or reflecting tape on the bats' heads, allowing easier detection of a bat hanging upside down in a dark cave. Then they released the bats, one by one, near or far from the home roost. The plan was to displace bats 1, 5, 10, 20, 30 and 40 miles from their home, 40 miles being the furthest extent of the island of Trinidad.⁸³

Conveniently, Waller Air Field was situated about halfway between Guanapo and Tamana Caves, about 20 miles away, so that bats from both caves could be released at the old runway.⁸⁴ The airfield, an old World War II airbase, was located in an extensive flat area with swamps and sugar cane plantations. It had been used in the war as a refueling stop for Canadian and American flights en route to Africa or Europe. Strategically, it had also been intended as a bulwark against the Germans, whom the US government feared, might colonize South America and then attack the US mainland. For Tim and Janet's research, Waller field had different advantages. Multitudes of bats lived in the abandoned massive concrete buildings, the windowless ice storage sites left from the war days. Here was a source of additional experimental "subjects" for their and the others' research projects, if needed. But they used Waller Field only infrequently. The site had distinct disadvantages, namely as a "hang-out" for local Trinidadian gangs, a more human source of danger.

Initially, the Williamses were attempting to determine whether the released bats could return on the same night. They did, but that depended on the distance to the bats' home cave. By 10-20 miles distance, 55-60 % returned the first night, only 26% if 30 miles away and none at 40 miles distance. But they all returned at a later time. It didn't matter if the bats were released in groups or singly; the same results. Different terrains did not seem to matter, i.e. whether the bats had to "fly over mountains, up from the valley, or over open water. Nor did it matter if the weather was clear or rainy.⁸⁵

The displaced marked bats (*Phyllostomus hastatus*) were refound in their home caves, in Tamana Cave among the roosting hundreds and thousands, or in the smaller Guanapo cave. Sometimes a bat was lost for very long periods. This tended to occur if the displacement had been far and if a particular bat, maybe a younger one, was not familiar with much of Trinidad. But after a while, aided by the impressive wizardry of the RU Electronics Shop (described later in this chapter), specifically Larry Eisenberg, radio telemetry was created. The researchers could thereby track the bats in their homing flights and during their feeding trips. This time, unlike the unsuccessful attempts by Don Griffin

with radio tracking decades earlier, the apparatus was light, light enough for the bats to carry. The transmitters were less than an inch long and less than a tenth of the bats' weight, i.e. lighter than the young carried by a female. (*Phyllostomus h.*, unlike many other bats, did not leave the young in the cave when the adults left to forage. Instead, the mother carried the single young.)

The bats had been selected in part because they were large sturdy sorts, one of the largest species in Central and South America, about 4-5 inches long with a wingspan of 18 inches. They are, however, very light, only about 3 ounces. Thus, they are fairly easily seen but light enough so that any electronics they carry must be light too. The RU Electronics shop technology did what was needed. The Williamses' experiments were one of the first to use radio telemetry to track bats.

In the field, Peter Hartline was another resource; he had experience in making transmitters and using radio telemetry. Peter was the son of H. Keffer Hartline, an RU professor and future recipient of the 1967 Nobel Prize awarded for his research in vision. Peter had been Tim's roommate at Swarthmore and visited Trinidad one Christmas vacation to help them with techniques of using telemetry.

With a piano wire antenna trailing behind, the transmitters were tied to nylon mesh glued to the bats' fur and usually survived there for about 10 days before falling off. Typically, the transmitters were retrieved before then and re-used several times.⁸⁶ The recovery process was not meant to be a comedy routine or trauma drama, though it might seem so. Tim and Janet did not want to disturb the bats. Thus they did not attempt to catch a great mass of bats with a large net, upsetting them all and perhaps missing the very one they wanted. After arriving at their most frequently used site, Guanapo Cave, Janet would balance herself atop Tim's shoulders. He then plodded through the undulating muck of bat guano and cockroaches. The headlamps lit their way ... sort of ... while she identified their "subject." She reached high up to the ceiling crawling with bats and "...would gently bring down the one with a transmitter. She would pat the bat on the head with her hand which would calm it; she would untie the transmitter and return the bat to its place in the social cluster." [Then on to the next transistorized bat. It worked ... without mishap.]

Tim reflects: "I think her rapport with the animals and skill at handling accounted for the unusually high percentage of bats that returned to the cave and the very low level of disturbance to the cave from all our work."⁸⁷

The *Science* article⁸⁸ resulting from the studies describes radio-tracking data on homing from displacements as far as 10 km (6 miles) from the bats' roost, while other data indicate successful returns from distances even up to 28 km (17 miles).^{89,90,91} The researchers concluded that the bats used visual cues to orient correctly on their long homeward flight and reach familiar areas near home, while they echolocated to do finely detailed flight through the tangle of tropical vines and trees and the dark cave crevices near and at their home roost. These facts were determined by covering the bats' eyes with aluminum goggles, some opaque and others with clear plastic lenses. The researchers could thereby reversibly "blind" the bats without physically blinding the animals that they had grown fond of. Scientifically, any surgery creates questions of injurious side effects impacting performance.

Even initially, the bats with Janet's homemade blindfolds did not strongly orient in the homeward direction, while the bats with clear vision did.⁹² From fairly short distances of 5-8 miles or less, blindfolded bats did not seem to be hampered and returned home in one night. At distances of 15-20 miles, no blindfolded bats did, while about half the bats with vision managed to get home in the night. Many of the blindfolded bats who managed to remove their glued-on masks did return after 3-5 days, even at the greater distances. It was clear that vision was essential for the long-distance returns. To the researchers, it seemed likely that the cue for visual return was the distant mountain ridge, visible (at least to humans) even against a cloudy night sky. On shorter returns, the bats were apparently able to use their remembered echolocation "familiar territory" map.⁹³

After completing his Ph.D., Tim turned to work with birds, collaborating on the research with Janet. Bat research also continued, though initially thought to be birds. The military had problems with "bird"-aviation collisions, specifically in Texas. The "birds" became bats when an officer sent Tim a box of "remains." Tim recognized the bits as "furry" rather than "feathery" and so designed means to help avoid aircraft collisions with the Mexican free-tailed bats (*Tadarida brasiliensis*).⁹⁴

Tim became a Post Doc at Woods Hole Oceanographic Institute and conducted a radio-telemetry study of herring gull orientation, building on Don Griffin's prior work; John Teal and John Kanwisher were his mentors and collaborators. In subsequent research, Tim and Janet pursued long-distance migration studies, radar providing a useful tool. An extensive network of radar sites was in place to study birds, but not so for bats. Much of the rest of their life's work was focused on such avian studies, initially concentrating on bird migration in the Atlantic and then the Pacific. The investigations took them to exotic locations, typically with their two sons in tow. In the Pacific, they traveled to research sites, among them Hawaii, Alaska, Guam, the South Seas, New Zealand, Australia and the Indian Ocean. Adventurous side trips included the Galapagos Islands and Africa. Tim's academic career was based almost entirely at Swarthmore College, Pennsylvania; the students enthusiastically engaged in Tim's courses in animal behavior and related fields and participated in his much-appreciated ornithological fieldwork courses. In 2002, Tim Williams retired, he and Janet settling in the White Mountains of New Hampshire, still deeply ensconced in nature.⁹⁵

Jack W. Bradbury, Griffin Graduate Student⁹⁶

Jack's Summer of 1966 in Trinidad

Now that Jack had left Prof. Mauro's RU lab, he was tackling the issue of a new Ph.D. project. In that summer of 1966, Jack's first visit to the Trinidad station, Griffin was particularly impressed with excellent animal behavior researchers working there.

As Jack recalls the situation, Don thought what a superb opportunity was available for Jack to spend a little time with each scientist, seeing what they did and why, and, thereby, learn a set of perspectives from which Jack could then choose his thesis topic. Most of Jack's time would be spent working with Griffin and Inger, Jack's wife who had been hired to be Griffin's field assistant for the summer. On other occasions, Jack would take breaks to

work with other researchers when they felt they had time to include him. The plan seemed good to them both.⁹⁷

So about two days each week, Jack was free to join other researchers as convenient for all. Jack, Don Griffin, Rod Suthers and Julia Chase would share the bat lab and flight cage and join forces capturing as many bat species as possible, Jack and Griffin for their comparative sonar work, and Rod and Julia for vision experiments. Jack and Griffin had attempted to record while in the field, but high-fidelity recordings with fancy mikes were better made with captive bats.

Often with the help of Bob Loregnard, Jack accompanied other researchers and searched for bats. Jack was a “newbie” to the world of bats; he was flabbergasted by the diversity of the group. Within mammalian species, bats are second only to rodents in number of species. With the ability to fly and to detect objects and prey by sonar, they have invaded almost every available niche. Bats ate insects at every level inside and above the forest and below in the caves; they ate fish in the water, rodents, lizards, fruits, nectar, blood, and even other bats. Accompanying the Williamses, Jack visited some of the caves favored as well by Rod and Julia. He shared similar experiences of floors that were “a seething sea, feet thick, of dried bat droppings. ... full of beetle larvae and cockroaches ...”

The low-ceilinged cave in the Guanapo Valley (Guanapo Cave), was filled with dense clusters of *Phyllostomus hastatus* in ceiling cavities, with the occasional male angrily peeing in one’s face. These bats and this cave figured prominently in Bradbury’s later post-doctoral work. Over the summer, Bradbury became adept at mist-netting, not getting bitten as he extricated the bats in the net, recording them, and returning them to their habitat ... i.e., finding and recording the bats on Griffin’s comparative study “wish list.”

Searching for a Good Ph.D. Topic

After summer’s end, a decision about a Ph.D. topic. The grad students had been taking a lecture course with the new RU faculty hires: In Marler’s group were Thomas Struhsaker who’d just completed his Ph.D. on vervet monkey (*Chlorocebus pygerythrus*) alarm calls and Fernando Nottebohm with a dissertation on songs of canaries (*Serinus canaria domestica*). Griffin had hired Richard Penney, a researcher of Adelie Penguins (*Pygoscelis adeliae*), studying their social signals and navigation over the vast snow and ice of Antarctica. Don had also hired Roger Payne who had recently completed an excellent thesis on how barn owls locate their prey and was now starting to look at sound signals in whales. RU President Detlev Bronk had also added faculty studying taste and olfaction, not only the physiology of such, but behavioral aspects. RU’s interest in the “whole animal” was expanding.

A major impact on Jack from the lecture course developed from Marler’s term paper assignment on the new work of John Crook with African weaver birds (Family: *Ploceidae*). Crook’s theory was that mating systems and some communication were better predicted by ecology than by phylogeny. This was controversial. It was opposing the idea of animal behavior as a taxonomic tool, a means to examine phylogenetic relatedness by behavior. Konrad Lorenz had gained much attention for this view of animal behavior, through examples of duck mating displays across species. Crook, however, while agreeing that many

behaviors are inherited, proposed that they could change fast enough to be modified by ecological conditions.

Jack thought it a fascinating idea. He recalled the hints of different bat social systems he had seen the past summer. *Phyllostomus hastatus*, Tim Williams' study subject, would huddle in the ceiling either as all-male bachelor groups or as many females, apparently with a single male, i. e. a harem. The carnivorous bat, *Vampyrum spectrum* (aka Giant Spear-nosed Bat), did not seem to settle in large clusters. Like many carnivores which tend to live singly or in small bands, the *Vampyrum* seemed to live in pairs. The small sac-winged bats (*Saccopteryx leptura*) also seemed possibly to be living in pairs. Almost nothing was known of bat social systems. A Ph.D. thesis topic?

Both Marler and Griffin felt that for Jack to develop field methods and make sense of any discoveries would require far more time than Jack still had available as a graduate student. Reflecting on the challenges another graduate student had endured while Jack was helping him in Trinidad, Jack had to agree.

The Thesis Project: What Can *Vampyrum* Discriminate?

Griffin had another suggestion. Jack was three years into thesis work; Jack was good at math and physics. It would be more practical to continue the echolocation work, building on observations from the summer's work. After completing the Ph.D., then Jack could more reasonably pursue his interests in bat social systems. Don felt that such work was outside his own main area of expertise and his funding was committed to echolocation work. Jack needed to complete a Ph.D. and he had to be able to access funding that supported his thesis work.

But what might be an interesting Ph.D. echolocation project for Jack Bradbury? Perhaps *Vampyrum spectrum*, the largest neotropical bat and a top-level carnivore might be of particular interest? How does a hungry *Vampyrum* find a sleeping bird to eat or rodents? An impressive array of possible prey to be distinguished from inedible objects, mostly all located within a dense forest. Jack and Griffin had brought back two *Vampyrum spectra*; one turned out to be pregnant and had given birth successfully. The Bronx Zoo had another male of the same species. That was four bats to be housed in IRAB at the Zoo.

As Jack describes his work with these bats, he notes that monogamously paired mammals are rare. With these bats, while one left to hunt for the infant in the flight cage, the other stood guard. Jack provisioned them with some dead mice, but also let them hunt a few live ones as he filmed in infrared light in which they could not see. With or without light, they could find their prey. Don and he decided that Jack's thesis would be quantifying their ability to discriminate between similar objects and attempt to understand how they did it.

[Recall back in Griffin's early days on the Harvard faculty, his early, simpler experiments investigating the Little Brown Bats' (*M. lucifugus*) abilities to discriminate different shapes, namely edible mealworms from an array of other inedible items. Shape discrimination was a long and continuing Griffin interest.⁹⁸]

***Vampyra* in the Lab: One Smart Bat and Visits by Griffin**

Jack trained the adult bats to fly to one of two perches below which dangled plastic targets of different shapes and/or sizes. A choice mouse morsel was the reward if they flew in total darkness to the correct target using only sonar. Beginning with two very different shapes, Jack made the second shape increasingly similar to the rewarded one. With complex rigging, he could measure the intensity of the different reflections of specific sound frequencies. Both the echo intensity and spectral composition proved to be important determinants of the bats' discrimination.

One bat of the three adults managed to solve a difficult discrimination successfully while the others failed. Bradbury had contrasted a sphere with a more foot-balled shaped target, gradually making the shapes more similar. When the targets were more dissimilar, all three bats were successful, but with increasing similarity, only the one bat. Ultrared filming revealed that the successful bat had swooped to come at the targets from an angle rather than horizontally, such that one target gave a much softer echo. More construction as Jack built a barrier to keep them all flying horizontally. These bats proved to be very clever, but with the barrier, soon all three displayed a similar threshold of similarity at which they could no longer discriminate the targets. Nevertheless, the behavior appeared to be impressive problem-solving by the one bat!

Jack notes:

I needed a lot of instrumentation to do this thesis and had two racks full of electronic equipment to calibrate my targets and analyze the bats' sonar calls. I started to dread Don's visits as he would look at my racks, start wondering why this instrument was connected to that instrument, and pretty soon, he would have disassembled my entire rig. He loved to putter with equipment, and that was in fact a common propensity in both of us. But as the rig got more complicated, I had to start making a map of my working configuration so that I could put it all back the way I wanted after Don had disassembled it!

In essence, Griffin was always curious and wanted to know how everything worked.

Professional Socializing and Research

An invitation to the International Ethological Congress of August 1967 in Sweden provided Jack with an opportunity to gain a broader background in ethology. Furthermore, Griffin was able to introduce him there to various luminaries of the field to explore possibilities for a post-doctoral appointment. Now, attendance at the meetings is open to all, but not in those days; it was a form of scientific recognition and scientific "connections" to be invited. Jack was most impressed by the ease with which Griffin moved among all the major ethologists whom he knew and who knew him. Among those Jack met was Konrad Lorenz who was quite interested in Jack's Ph. D. *Vampyrum* study. Meeting John Crook, Jack discussed potential projects to test Crook's ideas. Of several possibilities, bats won. " ... the group was so large and diverse that [Jack] couldn't help but find some interesting comparative patterns" and anything Jack discovered would be new, whether or not Crook's ideas were supported.⁹⁹

Jack and Fernando Nottebohm were both at the Ethology Congress and spent considerable time together. Similarly, at Rockefeller, they and their wives shared many

occasions. That social part of science, as with other endeavors, is not to be underestimated. In Jack's last grad school year, over dinner in one of their homes, Jack had mentioned the rather large eyes on *Vampyrum* bats. They wondered how well these bats could see. Jack said he didn't know and didn't think that anyone had studied vision in echolocating bats very thoroughly. Fernando then suggested that he and Jack undertake a "short study on whether Little Brown Bats could see obstacles at all when flying." Not exactly what one wishes to do when attempting to complete a Ph.D. and also outside of Fernando's expertise. However, both of them were excited about doing a joint experimental project together and their wives agreed to supply the necessary strawberry shortcake after every night's trials.

They did conduct the studies, using Griffin's wind tunnel that had been erected at IRAB just next to the flight cage with Jack's *Vampyrum*. Some bats were temporarily deafened so that they couldn't use information from their echolocating calls. As the light levels were varied, the bats had to pass through obstacles of strings of different diameters. They could see the strings, at least under many light conditions, but there was no question that the bats' vision was fairly limited.¹⁰⁰ Jack and Fernando jokingly discussed trying it with the nearby caged *Vampyrum spectrum*, but that bat is so large, that it couldn't even fit inside the wind tunnel. They decided not to further interrupt Jack's thesis experiments. (Note that Rod Suthers and Julia Chase had conducted a similar, though less precise study, in the more rudimentary Simla facilities, using a species of big-eyed whispering bats, specifically *Phyllostomus hastatus*, the Greater Spear-nosed bat. Unlike the Little Brown Bat which is insectivorous, *P. hastatus* prefers fruit, but also eats pollen, nectar, insects and even small invertebrates. It appears to be somewhat more reliant on vision than the Little Brown bat.)

In the late fall of 1967, Griffin and Bradbury discussed his options for a post-doctorate, and Griffin offered to nominate him for the highly competitive Harvard Junior Fellowships; he thought Jack had a good chance. Griffin also suggested Jack speak to Peter Marler about working on bat social behavior. After examining the many possible complications, Marler offered Jack a fellowship for up to two years to do the work. Jack knew the bats to study, the sites in Trinidad to use, and now the funding. On to the next phase!

Finally, Ph.D.s!

Tim Williams¹⁰¹ and Jack Bradbury both graduated in June 1968 as RU Ph.D.s. But there were hurdles to jump along the way. Some were the obvious disdain the "real" scientists held for the animal behaviorists. As had been true at Harvard, the "serious" biological experimentalists included cell biologists, physiologists and those in related medical and neural studies. During lunch, faculty and students ate in the same large dining room. Tim recalls overhearing jokes about the animal behavior program being called "Bronk's Zoo"¹⁰² (a homophone to the IRAB animal facility at the better-known Zoo).

The matter extended beyond the dining area. As Tim Williams describes it, *We were ... among the earliest field behavior researchers at the Rock and dealt with the institution recognizing animal behavior. In my qualifying exam, one Rock Prof. stated that unless I did laboratory experiments, I could not be considered a scientist.*

*Griffin had to get Det Bronk to back him and Marler up that field experiments were science.*¹⁰³

“A 50-minute talk on ... [the thesis] work in Caspary Auditorium to the entire University faculty and graduate student body” was part of the graduating process, a fairly terrifying part. But it was done successfully by them both and Jack showed infrared movies of bats hunting mice as a dramatic supplement.¹⁰⁴

Tim’s career after his Ph.D. has already been briefly summarized and Jack’s is described in the later section about his work in the Marler lab.

Carl D. Hopkins, Rockefeller University Graduate Student¹⁰⁵

The Introductory Fall Seminar for new RU grad students inspired Carl D. Hopkins, as it had both Tim and Jack. Carl, a physics undergraduate major from Bowdoin College in Maine, began RU in 1966, slightly after both Tim and Jack. Many years later, he recalled the lecture by Donald Griffin that autumn. Having read *Listening in the Dark* as an undergraduate, Don was already “an amazing figure” for Carl. Besides Griffin giving the lecture about bats, Roger Payne had been nearby on the Caspary Hall stage. But Roger was inside a wire cage, a Faraday Cage, peering at something through a microscope, (The cage blocked electromagnetic fields, necessary for what Roger was up to.) Also with Don Griffin was a bat, the largest bat in South America, *Vampyrum spectrum*, with a wingspan of 30 inches, quite probably one that Jack Bradbury was working with for his thesis. But this bat was not in a cage; it had been released by Don and was flying: dipping and darting around the auditorium. Probably these very intelligent, but mostly city-dwelling grad students had never even seen a bat. Meanwhile, inside the cage, Roger was dissecting a moth sufficiently to be able to record action potentials from an auditory nerve, which were then amplified through a loudspeaker. Every time the bat flew near the moth, potential prey, a loud barrage of very rapid clicks, sometimes a buzz, would emerge from the speakers. The moth was detecting the bat’s ultrasonic calls and the loudspeaker was broadcasting the moth’s detections. To the young Carl Hopkins, this was “the most amazing thing I’d ever seen.” Griffin could be “quite a showman.” He’d given a lecture, but one with a man in a cage, a live moth and a huge bat flying around the audience. Effective!¹⁰⁶

Carl was hooked; he wanted to do that or something very much like it. At this point, he was doing biophysics in Frank Brink, Jr.’s lab with frog’s Action Potentials, then working with Haldan Keffer Hartline (soon to receive a Nobel prize in 1967). Griffin got Carl thinking about electric fish as a possible thesis project. The first electric fish (family: *Mormyridae*) had been discovered in Africa by Hans Lissman. Having read Lissmann’s papers, published in German, Griffin was most impressed and had actually met Lissman during Don’s Harvard faculty sabbatical year in Cambridge, England in the academic year 1961-62. (Recall that Don’s father, much interested in languages and history, had emphasized, in Don’s education, the importance of learning other languages.)

There were puzzles: Fish which produced pulses of electricity emanating from their bodies ... were they using the different voltages and frequencies for defense, predation, navigation, communication? As was later determined, all of the above, though not necessarily all functions in one species.

In brief, Carl began with an aquarium in Hartline's lab. Griffin advised Carl, impressed him with his knowledge about Lissmann's research, and offered Carl many ideas and suggestions, i.e., Griffin was exceptionally encouraging and enthusiastic. In a simple playback experiment through electrodes, Carl found the fish would actually approach those electrodes. He joined Griffin's lab.

When an RU Animal Behavior Field Course was offered in Trinidad and Panama in January – February 1969, Carl joined the group. (The Field Courses of 1969 and 1971 are discussed later in this chapter.¹⁰⁷) What might his aquarium-bound electric fish be doing with other fish out in their murky water natural environment? Might Trinidad harbor electric fish? Jack Bradbury was there, conducting his Post Doc with the grant from Marler. Carl shipped Jack a truly primitive amplifier he had built: a circuit board he'd bought from an electronics store, mounted in a plywood box, with wires sticking out in all directions. But ... it worked! Jack detected electric fish (family: *Gymnotiformes*), even in the river near the field station. And so began Carl's project and life research.

Griffin was most helpful to Carl with the technology needed for the electric fish research. Bat echolocation work, as has been described, especially in those days, required a literal ton of equipment: oscilloscopes, still and movie cameras, high-quality tape recorders, amplifiers, various other electronics, and very heavy batteries, and Griffin had it all. "He was ready for anything" and ready to help Carl set up for his project. Don helped create a battery-powered chart recorder, designed to go very slowly, plotting voltage as a function of time. The construction had a voltmeter and with it a motor that made a dot on a piece of paper once a second, so it produced a dot diagram of voltage over time. The apparatus could provide an all-night recording of the presence of electric fish in the river; no other recording equipment could do so for so long.

Carl was in awe of Griffin's technical prowess and off-the-cuff rapid technical solutions to problems. To record fish voltage production that was more detailed than the long-term dot patterns, again a voltmeter was used and an amplifier. The apparatus caused a needle to swing in proportion to the voltage and thus produced a mark on a paper tape. But, as Carl noted to Griffin, he also wanted discharge *frequency* recorded. "Oh, just make an integrator" "Hmmm?" "Get a capacitor, a filter, etc..." So, an accurate frequency measurement device was created and Carl returned in the summer of 1969 to continue his work.

Although Carl considers Don Griffin a very important person to him and has tremendous respect for Griffin, he did change his lab affiliation to Peter Marler; Griffin remained on his thesis committee. At that time in Carl's life, Griffin seemed intimidating, a bit "terrifying," and an "angular" sort of person, while Peter Marler seemed almost "Teddy-bear-like" in body and style. [Many have had quite different impressions of them both, since Marler could be welcoming, but have a strong temper and Griffin had a deep and sincere gentleness and kindness, though "protected" by tough, demanding scientific attitudes.]

Carl finally conducted his thesis research in Guyana, for many more species of weakly electric fish dwelled there. Marler lost Kathy, the lab secretary and manager, through Carl's effective courtship. Kathy quit her job and she and Carl went off to Guyana, where they worked together on the research. They made a most significant discovery, the

first case of electrical sex differences in a fish: Males had a low frequency and females a high, about an octave apart (e.g. 62 Hz and 125 Hz). Each pair of fish had its unique pair of frequencies. And, importantly, they were *not exactly* an octave apart. A male could not detect the signals if an octave apart. But if the male's signal was merely 1 Hz higher, the male *could* detect the female's presence; he was sensing the *beat* produced by the combination of the two frequencies. During the day, when the fish are resting, they rest their electrical signaling too; they produce, perhaps, 5 Hz frequencies. His dissertation research was reported as an article in *Science*.¹⁰⁸

Griffin continued to find Carl's work fascinating. Carl recalls how gratifying and exciting it was to continually receive letters from Don enthusiastically noting the parallels between Carl's work and bat echolocation.

Once again, technology may have influenced career research choices. In Carl Hopkins' words, "The technology was so overwhelming." With Griffin's radar "Witch," used for avian migration studies, "so many things could go wrong" ... and did. "It was a constant battle;" continual repairs were being made. [Further discussion of the "Witch" may be found in Part 5 of this chapter.¹⁰⁹] In the Hartline lab, recording from a single dissected axon required so much wiring, computers and other electronics, that an entire room was filled with a computer; an elevated floor was built so the wiring could lie below. [In current times, a "smartphone" has more computing power and storage than the huge computers of those earlier days.] Carl was enormously relieved when, doing his South American fieldwork, he had essentially just one instrument. It produced an audible sound (correlated with the fish's electrical signals) and that sound was recorded on tape. He "fixed everything with masking tape and epoxy."

Carl Hopkins received his Ph. D. in 1972, did a postdoc with Theodore H. Bulloch at the Scripps Institution of Oceanography in San Diego, California, and spent most of his career at Cornell University; fieldwork was in South America and Africa. His focus was neuroethology, the neural basis of animal behavior, specifically of weakly electric fish. Along the way, he and Kathy married and had a family. Now retired, they still live in Ithaca, New York, socializing and exchanging science ideas with the various researchers already mentioned, e.g., Jack Bradbury and Charlie Walcott, among others.

Fun and Frustrations in Simla Life

Life at Simla was not always engaged in research. There were conversations to be had, meals to be eaten, local people to meet, a new culture in which to engage, local patois to understand, annoying photographers and reporters to deal with, and dancing and parties to be held. On to all those!

Daily life with Fine Dinners

A most "civilized" lifestyle was followed at Simla. William Beebe instituted the tradition,¹¹⁰ continuing over the decades at El Rancho Grande and Simla, including the era when Jocelyn was clearly the one managing the station. Lunch and dinner were served at specified times, and all were expected to be present promptly at those times. All had freshly

washed off their field grime and guano “in the cold water bedroom sink and dressed for dinner. Men were obliged to wear a shirt and tie; women changed into dresses or a skirt and blouse.”¹¹¹

Before dinner, cocktail time! Flocks of returning birds provided entertainment as did the bats which dipped and swerved to catch insects. The researchers would vie with each other to identify the bat species. If Griffin were visiting, he would set up a bat detector, amplifying the bats’ ultrasonics to human audible levels. Sometimes, yet more entertainment: just outside stood a white Styrofoam wall. An ultraviolet light could be turned on, attracting numerous and varied insects for the group’s amusement and study.

The favored cocktail was a “Simla Special.” Tim Williams has shared the recipe, as directed by Don Griffin, the very first night Janet and Tim arrived at Simla:

To make a Simla Special on the north terrace of Simla, overlooking the Arima valley towards Asa Wright's plantation: It is evening and the sun is grazing the tops of the giant Pui trees in the valley. There are no signs of other houses. The scientific crew is gathered around the lily pond winding down from the day's activities (except of course Janet and Tim if they have a bat release that night). [In the rainy season, the group gathers indoors on the veranda or in the large, high-ceilinged living room.] The faithful go to the small table and squeeze a lime (the small west Indian limes not the big ones in North America) into a highball glass, add two teaspoons of sugar (none of this simple syrup folderol) and stir. Then take the bottle of Old Oak Trinidadian rum and add some to the glass, amount to be splashed in, not measured. The amount varies shall we say. Add Angostura Bitters, usually 2 shakes. Then ice cubes, special ice cubes from water purified by Jocelyn with a special filter, as we all know that ice in the tropics is dangerous. Stir. Some add water (also purified); some do not. Sip, relax, let the cares of the day fall away. Engage in banter or polite conversation [or share the tales of the day's work] until the call for dinner is heard, served by the kitchen staff on china and white linens.

So, you see there is much more to a Simla Special than ingredients. Note this is different from a classic rum punch such as the one served at the bar of the Queen's Park Savannah Hotel in Port of Spain. That could be consumed as a liquid refreshment. The Simla special had less liquid and should be sipped. Generally, only one glass was consumed, as it was considered a bit much to consume as much as two, with an evening of data entry ahead.¹¹²

The dinner that followed was a four to six-course meal, typically British fare, often intermixed with local Trinidadian specialties. When Jocelyn determined that a course was finished, she rang a tiny silver bell. That tinkling alerted the maids to clear the dishes and bring the next course. Jocelyn put considerable effort into planning menus for all the meals, dealing with what could be gathered locally and, most probably, adding to the pantry whatever delicacies could be procured during outward journeys.”

The staff were truly helpful. Admin were mainly from Britain, and service, including kitchen, were largely local Trinidadian. Bertha, the “wonderful cook” at the station, was a plump, warm, kindly sort who “spoiled” the various staff with special goodies. (Later followed by Lavinia, also very well-liked.) Tim and Janet Williams did try to get back on time

for dinner. If successful, they often had to change rapidly back into “bat clothes” and run off to the bats. Had the displaced bats returned to their home roosts and when? Besides the 40-minute drive and 30-minute climb to Guanapo cave, that meant one of Bertha’s scrumptious desserts was to be missed. But Bertha took pity, put some aside, and saved it for them. (Gingerbread was a favorite.)¹¹³

Asa Wright

The researchers encountered several eccentric persons and personalities. I will limit myself to describing one, the widow, Asa Wright. Always, at her home, in the afternoon, places were set for tea, ready for any potential guest. An Icelandic woman, described as tall, outspoken, moody and strong (in all senses of the word), she owned a working cacao plantation not far down the road from the station. Many enjoyed tea at her home, often with some trepidation initially as they approached the fine house. Was she going to be in good humor? Later on, no longer needing a specific invitation, they would feel comfortable enough simply to “drop in” at tea time and be fed her cook’s excellent scones and jams. As Tim Williams relates, “Brusque at first [Asa] was really warm-hearted and befriended us on our first visit.”¹¹⁴ On her initial visit, Julia Chase Brand had forgotten about the pet bat on her head, or was it her shoulder? (A long story; it was a bat that had become too plump to fly).¹¹⁵ Asa took it all in stride and delight.

Those who were truly befriended by her earned special privileges. In particular, they were invited to visit the gorge on her property which sheltered the mysterious, echolocating oilbirds (Guacharos).¹¹⁶

Don Griffin had a story about Asa that revealed, perhaps, as much about Don as it did about Asa. Tim retells the tale, one of many about “her exploits and run-ins with the local authorities.” It was Griffin’s favorite Asa story, the saga of her pet pig.

In Trinidad, one could either license a Land Rover as a commercial truck or as a private car. The fee for the truck was much greater than for the car and Asa objected to paying more than she had to. ... [She] licensed her farm truck (a Land Rover) as a private car. One day she was apprehended in Arima with a small pig in the back of her Land Rover and the constabulary charged her with licensing a commercial vehicle as a private car. She maintained that the pig was her personal pet, not a farm animal being taken to market.

The trial was set, but it was some eight months later that Asa was to appear in court. By this time, the pet piglet had grown to over 500 lbs. and had a nasty disposition. Nothing daunted, Asa tied a red ribbon around the pig's neck and took it into the courtroom to prove that it was a family pet. Needless to say, this caused quite a disturbance in the courtroom and all the local news reporters flocked to see the spectacle. The Magistrate was incensed at the disrespect shown his court and ordered the pig to be removed. When the bailiff attempted to do this, the pig objected strongly and, to make a long story short, pandemonium ensued. The pig clearly had the upper hand and treed several court officials on the magistrate's bench. The observers howled with laughter; the reporters gleefully recorded every detail and Asa gathered up her

pet pig and left. Apparently, the magistrate considered pressing charges of all sorts, but reconsidered in view of what Asa might do at her next court appearance.¹¹⁷

Once again, as Tim sees it and I certainly agree, this is “an example of the sort of humor that delighted DRG. Often, he took pleasure in the downfall of the haughty administrator, be it via the Navy heated underwear, the Air Force bat bombs, or some magistrate brought low.”¹¹⁸ Eventually, as the field station suffered financially, the Asa Wright Foundation acquired the station and still manages it today as part of the Asa Wright Nature Reserve, though not in the “civilized” style of Beebe and Jocelyn’s time. The staff is reduced; researchers do their own cooking.

Local Traditions and Patois

Steel drums: Trinidad had an oil refinery and after World War II, numerous old oil drums were still lying around. Some Trinidadians discovered that by cutting off the bottom, one suddenly had a bass instrument. And then, cutting at different levels, one could produce alto, tenor and soprano drums. Then, some carefully placed dents in the top, and ... different notes could be sounded. Trinidadian bands burst forth, playing all over the Caribbean.¹¹⁹

Not just the locals, but the researchers loved the music, too. Rod, Julia, Tim and Janet, Jack and Inger were often off to the Hilton Hotel in the capital Port-of-Spain for a Friday night of dancing. Quickly, they became aficionados of the Trinidadian “jump up” and the limbo ... a happy night off!

Carnival! Celebrating before the serious times of Lent began, Trinidad’s festivities were known throughout the Caribbean. They began the Sunday before Ash Wednesday (the start of Lent) and bands played all day and most of the night. Revelers joined the singing and dancing through the streets in most every village and town. The official big parade and band competition in Port-of-Spain was on the Tuesday before Lent. The “mood was wonderful.”¹²⁰

The Earth Shakes! Much partying arose on New Year’s Eve or “Old New Year’s Eve” to “Trinis!” For Tim and Janet, it was the biggest party they had ever attended. Invited by friends at the University of the West Indies, in St. Augustine, they joined literally hundreds of other celebrators. The dance of the night was the “jump up,” traditionally danced til the music stops ... and it didn’t stop. The musicians seemed indefatigable. The floor itself seemed to shake as the dancers jumped in unison. Too many to remain inside, hundreds of people also danced outside on the tennis courts. A few days later, John Tomblin of the University’s Seismology Department “gleefully reported that their seismographs had recorded a most unusual type of activity that night in Trinidadian dance tempo.”^{121, 122}

Patois: It always helps to speak the language. Trinidad’s official language was English, but its locally used Creole or Tringlish reflected not just English, but its other “owners” as well, the French and Spanish. Mixed in were phrases from the West African

ancestors of many Trinidadians. And the speaking all had a marvelous charm and sing-song tone, distinctive to a native ear from every other Caribbean Creole.

Around the field station, one of the Trinidadian (Trini) specialties likely served was “San Kootch” (from the Spanish) which was a thick soup made with meat, ground provisions and vegetables. Though full, a Trini might have proclaimed, “Better belly buss than good food waste,” in other words, better to stuff yourselves than not finish edible food. And a warning to the cooks not to leave dessert around: “Don put cockroach before fowl,” i.e., that’s temptation, impossible to resist.

Someone away from the station might need a “pail closet,” thus good to know just what that is ... an outside latrine consisting of a seat with a hole in it atop a pail. The new arrivals, so admiring the Trinidadian wonderland, might be described as “never-see-never-come,” i.e. unfamiliar, so excited about everything. One should not be “chupit” (stupid). And a warning: “Massa Day Done,” a reproach that Colonial days are gone and old privileges and oppressions not acceptable. (This is from a speech in 1961 by Eric Williams, the first Prime Minister of Trinidad and Tobago)¹²³ Finally, a very handy phrase about living life in Trinidad: “Any time is Trinidad time,” i.e., things get done and people arrive at almost any time, an excuse for being late.^{124,125}

Folklore – bats: Like the Chinese, for whom the bat is a symbol of Good Luck and happiness, most Trinidadians like bats. But then there is the much-feared Soukayant.

*According to local folklore, the Soukayant is an old woman with the body of a vampire who lives in a silk cotton tree [Ceiba pentandra (L.) Gaertn]. It was said that she would fly out of her tree at night to suck the life out of someone foolish enough to be out wandering around in the dark. In this way, she could re-enter the body of a human. Because of this, no Trinidadian ever wanted to be out in the forest alone at night.*¹²⁶

The Williamses speculated that the “source” for this belief might have been the *Vampyrum spectrum* (Great False Vampire Bat), the largest bat by far in the neo-tropics ... and ... it lived in silk cotton trees!

One night, perhaps, perhaps, the Soukayant stalked Janet and Tim. Once again, they were out in the dark, checking on bat returns, this time with the radio tracking receiver. As usual, they were seated atop their car. And ... yes ... it was always at least mildly terrifying at night. Trinidad’s two most poisonous snakes, the fer-de-lance and the bushmaster, were nocturnal.¹²⁷ But this night, there was something more. Just as they were settling in, two extremely frightened local plantation workers very seriously warned them: Janet and Tim’s car was close to a silk cotton tree, far too close. Beware the Soukayant! Tim and Janet remained despite the threat. Time passed in the dark; there was only a slight bit of red light that lit their notebook and receiver. And suddenly, a sound unlike any they knew. It got closer ... and closer. It sounded like a SWOOSH. It was coming from the direction of the cotton silk tree. Ever closer and louder, not like the sound of flying bats they knew so well. Over their heads. They crouched down low. Gradually the sound grew less. They had survived! Had the Soukayant decided to let them be?¹²⁸

Frustrations = Photographers¹²⁹

Griffin was, of course, an important figure in the field of animal behavior. Trinidad seemed an enticing place to visit. Hence, journalists and photographers asked to come.¹³⁰

And Rockefeller University wanted publicity. They wanted publicity about the significant research being conducted by their faculty, especially compelling when it was happening in dangerous, exotic places. Griffin was pressured by President Detlev Bronk himself to facilitate such public relations. Reluctantly, Don agreed. It was always an interruption to the ongoing efforts. Most of us recall Griffin's relating a tale about at least one of the incidents noted below.

On one occasion (1964), a reporter arrived who liked animals. This was Nina Leen, a well-respected photojournalist of animal behavior and a frequent contributor to the widely read *Life* magazine. With a jacket of many pockets, probably useful, and fur-lined boots, definitely not useful, she was not exactly prepared for trekking in the muddy, hot and humid tropical forests of Trinidad. And though she wanted photos of Griffin and his work, she was *not* eager to go into the bush or enter caves; the entrance to an old abandoned mine tunnel nearby would suffice for her. Fishing bats, an interest of Don's, now under study by Rod Suthers, were conveniently housed at the station and had been trained to fly over a pool with fish. To entice the bat to go fishing, Don was to hold bits of fish on a long wire into the water. When the bats detected ripples on the water's surface, typically indicating a fish, they would gaff it with their long, curved, nasty-looking claws and bring it to their mouths. That was the desired photo. Many, many photos were taken, none quite good enough. "Just lean a bit further. A little bit more," pleaded Nina. Those who knew Don recognized that the patience of this restrained, polite man was being sorely strained. And then the inevitable: with one final lean, a splash as Don plunged into the water. All, Rod, Janet, and even Don, burst out laughing, while Nina was deeply apologetic. Griffin survived; the pool was only a foot deep and Jocelyn arrived at that moment with a fresh pot of coffee. So ended the session and a photo was published, one taken before Don had landed in the pond.

Nina's meeting with Don and the fishing bats was significant in her professional life. She was an "animal lover," but during her prior experience with bats, she found them "frightening," seeming like "something evil flying around." But Griffin's fishing bats were a totally different matter ... beautiful, "red, with silver wings," catching and eating fish. She was fascinated. So began her photography project with diverse bat species, spending days and nights watching them, and coming to "like their doglike faces."¹³¹ The results included photos in an edition of Rockefeller University's *Research Profiles* in an article about Griffin,¹³² a picture story in *Life* magazine¹³³ and a book.¹³⁴ (A photo of Griffin taken by Leen may be found earlier in this chapter.)

A second event concerning RU publicity for Griffin's research involved two "big city" visitors from the popular *Look* magazine. Much to Griffin's annoyance, they intended to stay and follow researchers around for a week. For the first day, they remained around the station, taking multitudes of photos. Then they wanted a trek to a bat cave, though not totally prepared for this. They were warned it would be long, difficult and stinky; they were not daunted. The female journalist wore her fancy leather boots with heels and carried lots of gear, while the greatly overweight male reporter wore only shorts, a short-sleeved shirt, and sneakers and carried a six-pack of beer. They declined offers of more suitable apparel.

Griffin, “with a twinkle in his eye ...” suggested to Tim and Janet that they select a cave “as rugged as [they] saw fit.”¹³⁵ So as not to disturb the bats they were studying, the Williamses chose a cave that would give the visitors a sense of the rigors the research required. The magnanimous journalist offered to carry some equipment for the laden photographer; she gave him only her flashbulbs, which he stuffed into a shirt pocket. (No electronic cameras in those times.) The day was hot as usual; “the walk was steep and tiring,” and everyone sweated, particularly the obese reporter. “Both the reporter and photographer were impressed that we went to all this effort to find and catch bats.”¹³⁶

At the mouth of the cave, the group nearly had to crawl to enter. Weary, the journalist rested and leaned his hand against a huge rock inside ... covered with guano and crawling cockroaches enjoying the feast. The photographer asked for her flashbulbs, but despite repeated tries, they would not go off. The reporter’s sweat had corroded them. Finally, the macho male journalist, certain he could make them work, snatched one. He pushed it into the flash and stared straight into the reflector. He pushed the button. Zap! It worked ... it exploded and blinded the photographer! For the next few hours, they had to lead him by the hand out of the cave and down the treacherous path. The disheartened pair returned to their fine Hilton Hotel in Port-of-Spain and hot showers. A message the next day: With a big smile, Don shared the information; the team had decided to head back to New York City ... immediately. (The reporter’s eyesight did improve.)¹³⁷

A Birthday Party and the End of Summer

Don was turning 50, his birthday August 3 during the summer of 1965. And Tim and Janet, grateful for all the help he had given them as a mentor and a friend decided to lead the effort to organize a birthday party. But it was to be secret; it was to be special. It had to have music and, in Trinidad, that music, of course, would be a steel band. Jocelyn was let in on the surprise, for she would organize Simla’s preparation for such an event, including the food. All the people in Trinidad who had become Don’s friends over the years were to be invited.

And it happened!

The surprised and happy look on his face when the truck with the steel band drove up was wonderful. Next, all the people started to arrive.” ... [Then the food appeared.] “On a beautiful afternoon, with the sounds and smells of all the good things of Trinidad, we celebrated Don’s 50th birthday. It was such a marvelous and very happy occasion, and we were delighted that we could do something so special to express our gratitude to this wonderful person who had come to mean so much to us.”¹³⁸

And this evening, as on other nights of music, the normally reserved, even staid, Don Griffin was dancing in the moonlight with Jocelyn.

Don’s professional role in Trinidad, for the Williamses, and the other students, postdocs and visiting bat researchers, was to help them become established in a project. He continued his own bat research as well, often with fishing bats and comparative echolocation studies. Frequently, the students’/postdocs’ research continued the work Griffin had begun to explore, but the work became theirs. He did not claim authorship as so many lab heads did unless the research clearly was a fully joint effort. Don would offer advice and constructive criticism, but always encouragement. Duties at Harvard and later at

Rockefeller would call him back to the mainland, or other distant projects, but he would always return to oversee progress. And, suggests Tim, he probably was quite happy to have an opportunity to see Jocelyn again.

A closing thought, written by Janet Williams, but expressed by others, too, in their own ways ... how the place, the culture, the forest had permeated their being and made them love it all.

Often as we climbed the hills and mountainsides and even deep inside the rain forest, we would hear, or actually almost feel, a distant thump, thump, thump, thump. ... We came to realize ... the deep throbbing was in fact the sound of a distant bass drum.¹³⁹ ... We had come to love the tropics, with all its vines and flowers, insects and birds, bats and caves, beaches and palm trees.¹⁴⁰

ENDNOTES

ENDNOTES FOR PART ONE BEGIN HERE

¹ Elizabeth Hanson, 2000, p. 92.

² John Kobler, 1970, p. 17-19.

³ Donald R. Griffin, 1936.

⁴ Timothy Williams, personal communication, August 24, 2020.

⁵ Timothy Williams, personal communication, September 15, 2020, E-mail.

⁶ Volume Two - Chapter 14, "Behind The Man: Significant Women," is devoted to the women who were influential in Don Griffin's life.

⁷ Timothy Williams, personal communication, August 24, 2020. The prior information about Griffin and EO Wilson is compiled from the interview.

⁸ John Kobler, 1970, p.17.

⁹ John Walsh, 1965.

¹⁰ Peter R. Marler, 1985. This is Marler's (1928-2014) autobiographical essay in Donald Dewsbury's collection of memoirs by scientists of animal behavior.

¹¹ I would like to acknowledge the footnote in Richard Nash's dissertation (2016, p. 227, Footnote 30), alerting me to the photograph. Photographic reference is [Photograph of Marler, Pfaffman], Series 1, Box 6, Folder [Corr-Ma-Me], RG450G875 Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Unfortunately, most Rockefeller University papers, including this photograph, are no longer held in the Archives and are not available to me or other researchers.

¹² Elizabeth Hanson, 2000, p. 85.

¹³ Alan Steinbach, personal communication, August 18, 2020. Telephone interview. Dr. Steinbach was a graduate student at Rockefeller University, Ph.D. 1967.

¹⁴ Landscape descriptions are taken from the Rockefeller University website:

www.rockefeller.edu/events-and-lectures/facilities-inside

¹⁵ www.rockefeller.edu/peggy

¹⁶ Timothy C. Williams, personal communication, September 15, 2020, E-mail.

¹⁷ Janet McIntyre Williams (JMW), 2014, p. 13.

¹⁸ Timothy C. Williams, August 24, 2020, personal communication. Telephone interview.

¹⁹ JMW, 2014, p. 15.

²⁰ Timothy C. Williams, August 24, 2020, personal communication. Telephone interview.

²¹ Jack W. Bradbury, July 2014, Video on Cornell University website.

²² Jack W. Bradbury, personal communication. August 11, 2020. Telephone conversation.

²³ Jack W. Bradbury, personal communication. August 11, 2020. Telephone conversation.

ENDNOTES FOR PART TWO BEGIN HERE

²⁴ See the section "Jocelyn Crane Griffin ..." in Chapter 14, "Behind The Man: Significant Women."

²⁵ Volume Two – Chapter 14, "Behind the Man: Significant Women," section "Jocelyn Crane Griffin ..."

²⁶ JMW, 2014, p. 15.

- ²⁷ Jack W. Bradbury, personal communication, August 11, 2020. Telephone conversation.
- ²⁸ Timothy C. Williams, n.d., "Simla," unpublished ms. Unless otherwise indicated, the quoted material above and the description of the site and station are taken from the essay.
- ²⁹ JMW, 2014, p. 26. Janet Williams describes the incessant beeping. Other descriptions of sounds are compiled from telephone conversations with Timothy Williams and Jack Bradbury, August 2020.
- ³⁰ Jack W. Bradbury, personal communication, August 14, 2020. Telephone conversation.
- ³¹ JMW, 2014, p.66-67. Information in the preceding paragraph was developed from JMW's book and telephone conversations in August 2020 with Jack W. Bradbury.
- ³² Griffin's studies of Oilbirds are described in Volume One - Chapter 10 -Part 3, "The "Oilbirds" of El Cuavo Del Guácharos, Venezuela – Birds That Echolocate?"
- ³³ Jack W. Bradbury, personal communications August 2020. Telephone.
- ³⁴ Jack W. Bradbury, personal communications August 2020. Telephone.
- ³⁵ JMW, 2014, p.72. Information and quotations about insects are from this page, unless otherwise cited.
- ³⁶ Timothy C. Williams, Janet M. Williams and Donald R. Griffin, 1966a.
- ³⁷ Timothy C. Williams, Janet M. Williams and Donald R. Griffin, 1966b.
- ³⁸ Timothy C. Williams and Janet M. Williams, 1967.
- ³⁹ Jack W. Bradbury and L Emmons,1974.
- ⁴⁰ Jack W. Bradbury, 1970.
- ⁴¹ Julia Chase Brand, 2020, "Spider stories," unpublished ms.
- ⁴² Julia Chase Brand, 2020, "With bats," unpublished ms., p. 6.
- ⁴³ Jack W. Bradbury, personal communications August 2020. Telephone conversation.
- ⁴⁴ Text Box: "David and Ade Pye ... and Bat Detectors" in Volume One, Chapter 11, Part 2, "Echolocation Research by Griffin and Others."
- ⁴⁵ J. David Pye, personal communication, January 23, 2018. Telephone interview.
- ⁴⁶ Jocelyn Crane's trials and tribulations managing Simla are discussed in the section "Jocelyn Crane Griffin ..." in Volume Two - Chapter 14, "Behind The Man: Significant Women."
- ⁴⁷ JMW, 2014, p. 68.
- ⁴⁸ Jack W. Bradbury, personal communication, August 11, 2020. Telephone.
- ⁴⁹ Research with fishing bats by both Don Griffin and his grad student/colleague Roderick Suthers is discussed further in Volume One - Chapter 10. Part 2, Tropical Bats - Comparative Studies Begin," subsection "Fishing Bats and Yet More" and in Volume Two – Chapter 12 -Part 2, "Trinidad- A Research Station in Paradise ... Muddy Roads and Many Bats," Subsection "Fishing Bats."
- ⁵⁰ Roderick A. Suthers, 1965, p. 319.
- ⁵¹ Alan D. Grinnell, 2018, p.292. Grinnell discusses their experiments which were not sufficiently extensive to be published.
- ⁵² Further information about Ann M. Graybiel is available in Volume Two - Appendices - "Griffin's Harvard Students: A Few Biographical Sketches"
- ⁵³ Julia Chase Brand, personal communication, September 19, 2020. Telephone call.
- ⁵⁴ Roderick A Suthers, 1965.
- ⁵⁵ Rockefeller University, 1966, p. 9.
- ⁵⁶ Roderick A. Suthers, 1966.
- ⁵⁷ Julia Chase and Roderick A. Suthers, 1969, supplemented with information from a telephone call with Julia Chase Brand on September 19, 2020. Both the Chase and Suthers experiments and those by Bradbury and Nottebohm were published in the same issue of *Animal Behavior*.
- ⁵⁸ Roderick A. Suthers, Julia Chase and Barbara Braford, 1969. Supplemental information was provided in a telephone conversation with Julia Chase Brand on September 19, 2020.
- ⁵⁹ Several references were cited by Suthers et al. for pattern discrimination experiments with laboratory rats. These were Karl S. Lashley, 1930 and 1938; P. E. Fields, 1932; Munn, 1930, and summarized in Munn, 1950.
- ⁶⁰ The Trinidad Regional Virus Laboratory was founded by the Rockefeller Foundation in 1953 in collaboration with the governments of Trinidad and Tobago. Jack W. Bradbury, personal communication, August 11, 2020, indicated Dr. Loregnard's position with the lab.
- ⁶¹ Jack W. Bradbury, personal communication, August 14, 2020. Telephone.

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- ⁶² Julia Chase Brand, 2020, "With Bats," unpublished ms.
- ⁶³ Julia Chase Brand, 2020, "With Bats," unpublished ms.
- ⁶⁴ Sac-Winged Bats, Sheath-Tailed Bats, And Ghost Bats: Emballonuridae, n.d. in Encyclopedia.com
- ⁶⁵ Donald R. Griffin, 1953.
- ⁶⁶ Donald R. Griffin and Alvin Novick, 1955.
- ⁶⁷ Donald R. Griffin, 1985, p.82 discusses these experiments.
- ⁶⁸ Donald R. Griffin, 1998a, p. 77-78.
- ⁶⁹ Julia Chase Brand, "With Bats," unpublished ms.
- ⁷⁰ Julia Chase Brand, personal communication, August 28, 2020. Telephone interview and September 20, 2020 E-mail for her biographical information.
- ⁷¹ Jeré Longman, October 25, 2011.
- ⁷² Roderick Suthers' later research is described briefly in Volume Two - Appendices - "Griffin's Harvard Students: A Few Biographical Sketches."
- ⁷³ Unless otherwise indicated, information in the section about Timothy and Janet Williams is taken from a telephone interview with Timothy C. Williams by Carolyn A. Ristau on August 24, 2020.
- ⁷⁴ I suggest that, although Don and Tim were not using the term "cognitive map" at that time, a bat could use the echolocation information to construct a map of a "familiar area." The air absorbs ultrasounds produced by bats too rapidly to be effective beyond a few tens of meters. Thus, the bats could construct a larger map of a "familiar area" by piecing together overlapping map segments tens of meters in diameter; the map might also contain distinctive features that were perceived via echolocation.
- The Rockefeller University, 1966, p. 9 is the source of information about ultrasound absorption.
- ⁷⁵ JMW, 2014, p. 15-16.
- ⁷⁶ Timothy C. Williams, n. d., "Simla." Unpublished ms.
- ⁷⁷ Timothy C. Williams, personal communication, September 15, 2020, E-mail.
- ⁷⁸ Timothy C. Williams, personal communication, August 24, 2020. Telephone interview.
- ⁷⁹ Timothy C. Williams, personal communication, September 2, 2020, E-mail.
- ⁸⁰ Timothy C. Williams, personal communication, August 30, 2020, E-mail.
- ⁸¹ Hope Ryden, personal communication, 2004. Unpublished notes to Katy Payne for a Griffin obituary.
- ⁸² Timothy C. Williams, personal communication, August 31, 2020, E-mail.
- ⁸³ JMW, 2014, p. 16.
- ⁸⁴ JMW, 2014, p. 32.
- ⁸⁵ JMW, 2014, p. 32-34.
- ⁸⁶ JMW, 2014, p. 45.
- ⁸⁷ Timothy C. Williams, personal communication, September 11, 2020, E-mail. Contains the information and quotations about recapturing bats with transistors.
- ⁸⁸ Timothy C. Williams and Janet M. Williams, 1967.
- ⁸⁹ Timothy C. Williams, Janet M. Williams and Donald R. Griffin, 1966a.
- ⁹⁰ Timothy C. Williams, Janet M. Williams and Donald R. Griffin, 1966b.
- ⁹¹ Timothy C. Williams and Janet M. Williams, 1967.
- ⁹² Timothy C. Williams and Janet M. Williams, 1967.
- ⁹³ JMW, 2014, p. 35-36.
- ⁹⁴ Timothy C. Williams and Janet M. Williams, 1969.
- ⁹⁵ Information in this paragraph was compiled from Janet M. Williams' 2014 autobiography and telephone interview with Timothy W. Williams, August 24, 2020.
- ⁹⁶ Unless otherwise specified, all the information about Jack Bradbury and quotations used are derived from a telephone interview by CR with Jack Bradbury on July 8, 2020 and subsequent calls in the next several weeks.
- ⁹⁷ Jack W. Bradbury, personal communication, July 8, 2020. Telephone. This quote and all others in this chapter, unless otherwise specified, are from that telephone call and subsequent ones over the next several weeks.

- ⁹⁸ See discussion of Griffin's earlier work on bats' ability to discriminate shapes/objects in Volume One- Chapter 11- "Bat (and Bird) Science at Harvard ... and Afterwards," Part 1, "Griffin's Lab: The People, The Projects", subsection "The Shape of Things ..."
- ⁹⁹ Jack W. Bradbury, personal communication, August 11, 2020. Telephone.
- ¹⁰⁰ Jack W. Bradbury, personal communication, August 11, 2020. Telephone. The paper published from this work was Jack Bradbury and Fernando Nottebohm, 1969.
- ¹⁰¹ Timothy Williams, 1968, Ph.D. dissertation.
- ¹⁰² Timothy C. Williams, personal communication, October 5, 2020, E-mail. "Bronk's Zoo" was a reference to the New York Zoological Society facility at the Bronx Zoo, part of the IRAB joint venture with Rockefeller University.
- ¹⁰³ Timothy C. Williams, personal communication, August 24, 2020, E-mail.
- ¹⁰⁴ Jack W. Bradbury, personal communication, August 11, 2020.
- ¹⁰⁵ Carl D. Hopkins, personal communication, October 1, 2020. Telephone interview. Unless otherwise indicated, all information in this section about Carl Hopkins derives from this interview.
- ¹⁰⁶ Bowdoin Magazine, 2017. A brief version of this story of Griffin's lecture is published in the Bowdoin Alumni magazine cited here.
- ¹⁰⁷ The Field Courses are described in Volume Two – Chapter 12, Part 4, "The RU Animal Behavior Group: Their Research," subsection, "The Field Study Courses – 'Extraordinary Opportunities'"
- ¹⁰⁸ Carl D. Hopkins, 1972.
- ¹⁰⁹ Griffin's mobile radar apparatus, the "Witch" is discussed in several places in this book, most notably in this volume, Volume Two- Chapter 12, Part 5, "Griffin Lab Research: Early RU Years"
- ¹¹⁰ Timothy C. Williams, n. d., "Simla", unpublished ms.
- ¹¹¹ Julia Chase Brand, unpublished manuscript, "With Bats," p. 2.
- ¹¹² Timothy C. Williams, personal communication, September 24, 2020, E-mail.
- ¹¹³ JMW, 2014, p, 29-31.
- ¹¹⁴ T. C. Williams, n. d., "Simla," unpublished ms.
- ¹¹⁵ Julia Chase Brand, personal communication, August 28, 2020. Telephone interview.
- ¹¹⁶ JMW, 2014, p. 68-69.
- ¹¹⁷ T. C. Williams, n. d., "Simla," unpublished ms.
- ¹¹⁸ T. C. Williams, personal communication, October 1, 2020, E-mail.
- ¹¹⁹ JMW, 2014, p. 41.
- ¹²⁰ JMW, 2014, p. 43-44.
- ¹²¹ T. C. Williams, n. d., "Simla," unpublished ms.
- ¹²² JMW, 2014, p. 43. Information about the New Year's Party has been compiled from both Timothy and Janet Williams' descriptions.
- ¹²³ Eric E. Williams, 1961.
- ¹²⁴ Triniinxisle.com, 2018, Trinidad Dictionary.
- ¹²⁵ Matador Network, (n. d.).
- ¹²⁶ JMW, 2014, p. 21.
- ¹²⁷ JMW, 2014, p. 30.
- ¹²⁸ JMW, 2014, p. 49-51.
- ¹²⁹ The information in this section is derived from an interview with Timothy Williams on August 24 and Janet Williams' (JMW) autobiography, 2014, p. 37-40. Quotations are from the book.
- ¹³⁰ JMW, 2014, p. 37.
- ¹³¹ George P. Hunt, March 29, 1968, p.3.
- ¹³² Fulvio Bardossi and Judith N, Schwartz, 1986.
- ¹³³ Nina Leen, March 29, 1968.
- ¹³⁴ Nina Leen, 1976.
- ¹³⁵ JMW, 2014, p. 38.
- ¹³⁶ JMW, 2014, p. 39. Unless otherwise specified, the quotations are from p. 39.
- ¹³⁷ JMW, 2014, p. 37-40. Unless otherwise specified, the information about the two incidents with journalists and photographers is taken from p. 37-40.
- ¹³⁸ JMW, 2014, p. 42. The rest of the information about the party is taken from p. 41-42.
- ¹³⁹ JMW, 2014, p. 44.

¹⁴⁰ JMW, 2014, p. 73.

CHAPTER THIRTEEN

AFGHANI ART and RUSSIAN BATS

Overview

In 1978 Donald Griffin and his wife, Jocelyn Crane, visit art in Afghanistan and Uzbekistan. Jocelyn's magnum opus, *Fiddler Crabs of the World*, had been published in 1975. Still fascinated by the fiddler crabs' communication with claw positions and movements, Jocelyn is extending her interests to humans and art and later earns a Ph. D. in art history based on human gestural communication.

The couple's journey continues to Russia where Griffin meets with a Russian bat scientist, who later visits him at Rockefeller University. While in Russia, Griffin encounters a young woman scientist whom he later helps escape to the United States. Griffin reminisces about Russian life and science under Communist rule; the Russian scientist observes life in the USA.

[This chapter, taken almost entirely from Griffin's unpublished memoir, has occasionally been "lightly" paraphrased by CR, since some writing seemed more akin to notes, rather than a finished manuscript. Griffin's writing and CR light paraphrasing are in italics, with each section preceded by DRG. Brackets and "CR" are used wherever CR has added information not in the original Griffin writing. I have also added titles to subsections, but not bracketed them.]

Recollections of the Trip with Jocelyn to Kabul and onto the Soviet Union and Leningrad¹

[CR: The trip by Jocelyn Crane Griffin and Donald Griffin occurred in 1978; they had been married since 1965. Jocelyn's "magnum opus," *Fiddler Crabs of the World*, had been published in 1975. Now, fascinated by the fiddler crabs' use of claw positions and movements to communicate, Jocelyn was extending her interests to humans and art. She later earned a Ph.D. in art history at New York University (1991) studying a sub-topic, namely the use of human gestures in the art of Medieval illuminated manuscripts.]

DRG: *This trip was part of Jocelyn's general effort to study the history of human communicative hand gestures in art. This she had done for several years and continued later, but she was very anxious to go not only to Kabul in Afghanistan, but also on to three sites in Uzbekistan to see at least the locations where sculptures have been excavated as well as what was in various museums. We left from London for Kabul, but I cannot remember whether we made other interesting visits in Europe beforehand. I do remember the flight in an Afghan airlines Boeing 727. It was crowded and in getting on board in Heathrow, there was a very pushy Indian, with lots of suitcases, who seemed anxious to get to the head of the line even though all seats were assigned and he was not going to get to any different seat no matter whether he was first or last to board the plane."*

... [I awoke from the overnight flight at dawn, groggy but] impressed to look down on ancient wheat fields with grain being threshed by oxen pulling some sort of mechanism in a circle around a threshing floor. Landing at Kabul and a taxi to a downtown hotel was uneventful. [We made our way around the city by taxis] to the fascinating archeological museum which had many original objects which I'm afraid were largely destroyed or looted by various wars.

[CR: This is the “Kabul Museum” aka “The National Museum of Afghanistan.” It has been described as “once one of the greatest museums in the world.” Despite attempts to protect some of the artifacts by hiding them as well as promises to secure the museum, during the “various wars,” after Griffin’s visit, it has been hit by a rocket, and items looted and sold. Even the soldiers sent to guard the treasures had plundered and still later, the Taliban had purposefully smashed any image-bearing objects. Still, in 2018, with less than a third of the collection remaining, there were magnificent pieces on display.^{2,3} During Don and Jocelyn’s 1978 visit,] **DRG:** *“there had already been the revolution which dethroned the king, and the taxi driver proudly pointed out the hole in the tower of the royal palace made by a shell, and burned out military vehicles on the streets beside the palace. These had not been removed even several months after fighting had stopped, probably to serve as a sort of reminder of the revolution.”* [CR: Mohammed Zaher Shah, the king of Afghanistan had been dethroned in a bloodless coup in 1973. Griffin is presumably referencing the violent Communist fighting of 1978, followed later in 1979, after the Griffins’ journey, by an actual Soviet military invasion.]

DRG: *This was all in 1978, which was a sort of window of opportunity for trips of the sort we made. Jocelyn was, in effect, an amateur travel agent who loved to pore over the international airlines guide and select itineraries that suited her ambitions, but were not necessarily those a travel agent would ordinarily have picked. It had been impossible before this to fly from Kabul, Afghanistan to Tashkent, Uzbekistan, part of the Soviet Union, and, a year or so later, the revolution in Afghanistan would have made such a trip impossible.*

We were scheduled on Aeroflot, the Soviet national airline and, at the time, the largest airline in the world.^{4,5}

Our trip had all been arranged in a conventional fashion in New York with permits from Intourist for entry into the Soviet Union by an Aeroflot flight from Kabul to Tashkent, and a schedule of visits to archaeological sites via Tashkent and also others in Samarkand and Bukhara. [CR: These are all located in Uzbekistan.] In order to confirm these, I had to go to the Soviet Embassy in Kabul. This was an almost fortress-like structure on the outskirts of the city to which I was taken by taxi. I cannot recall whether the taxicab waited or whether I was confident I could obtain a return taxi. But it was a somewhat frightening thing to ring a bell at an outer iron gateway, have the gate automatically open and clang shut behind me while I pressed another button and spoke by phone to someone inside. The woman who answered spoke excellent English, caused a massive inner door to open, and then it was a routine matter to confirm our paperwork and reservation. But it gave me a feeling of tension and I could not help wondering why the Soviet government felt it necessary to have their embassy in such a semi-fortress.

*[While in Kabul, we did meet some interesting people, among them an] American archeologist couple whom we visited one evening, whose names escape me at the moment. They had been in Afghanistan for many years and spoke very candidly about the whole political situation. I did wonder the entire time whether their house was bugged. They remained after the real Communist revolution occurred [CR: presumably the Soviet military invasion in December 1979,⁶] and I recall reading their discussion of the later events in some publication when we were back in New York, but do not **remember that we ever spoke with them again. But in Kabul we had a very pleasant evening at their house.***

...[On] the morning we were to fly from Kabul to Tashkent, I discovered that the hotel would not accept an American Express credit card. It was necessary to have “hard” Afghani currency, and I was told to go to a bank to obtain this. It was not an absolute, disastrously late time, and bank was within easy walking distance. One of my clear recollections is of standing in line at the teller’s window and watching a man ahead of me remove the voluminous turban around his head and remove perhaps several liters of Afghan bills which he was depositing. Our hotel bill also required a substantial volume of Afghanis, and I was glad that the walk back to the hotel was brief and not in a threatening part of the city.

Everything was routine on the flight, and we had a clear view of the snowcapped Himalayas and Jocelyn was thrilled to look down on the Amu-Darva River, which is the boundary between Afghanistan and the (then) Soviet Union Uzbekistan.

Troubling American Tourists in Uzbekistan

After we landed and emerged through a routine airport, we were greeted cheerfully by an Intourist guide with a list in her hand who called out helpfully “Mr. and Mrs. Myers?” We had to explain that that was not our name and were able to show proper Intourist paperwork. She was puzzled and troubled as to how to deal with these different American tourists, but arranged to have us driven to our hotel. There we were welcomed cautiously but told that we could not leave the hotel until the authorities had checked with Moscow to find out whether we were there legitimately. At that time the Soviet Union operated on a single time zone, so that it was well outside of business hours in Moscow.

Jocelyn was most annoyed, because she had a carefully planned itinerary and this delay would mean that she could not visit some of the places that had been important in her planning. The staff was kind to us, however, and spoke English so that we had no difficulty obtaining dinner, dinner. Sometime much later the next day, an Intourist guide arrived at the hotel saying that the paperwork was sorted out and we could now begin our tour of Tashkent.

The guide, a lady, spoke excellent English and in the taxi drive, we began asking her questions based on Jocelyn’s extensive reading. Her replies were a bit hesitant, although perfectly clear, evidently because it was not a prepared speech that she was used to making. From some tourist literature, I was aware of an Ecological Institute in Tashkent and asked about it. This flustered our guide slightly, and since she seemed to know nothing about it, I did not pursue the subject. After perhaps five minutes of this sort of conversation, we paused and she went through an entertaining switching of gears and began her prepared spiel about Tashkent. Impressively, her English speech roughly doubled in velocity for this as compared to answering our questions. In addition to the routine sort of tourist account that one would expect under the circumstances, she was very eloquent in assuring us that the separate republics of the Soviet Union were really independent states that had joined the union voluntarily and could, if they were so foolish as to so desire, withdraw as well. I remember feeling, and I’m sure Jocelyn felt the same way, that this was obviously claptrap for the benefit of American tourists. Little did we know what would happen some years later.

[CR: Don Griffin is presumably referring to the collapse of the Soviet Union in December 1991, into 15 separate countries.⁷]

[CR: Don Griffin recalls that Jocelyn and he visited museums and archaeological sites in and around Tashkent, but, writing in January 2003, he did not remember details. Local trips and

museum visits to Bukhara and Samarkand were uneventful. Continuing unsettling, fairly minor events kept arising, however, on their journey.]

DRG: *Since we were not part of a tour per se, confusion was frequent. Once, having endured various muddles while attempting to get dinner the first night at a hotel, by the next evening, a solution had been found. A small table for two was set aside with a sign saying, "Non-Group Tourists." A more disquieting event occurred the evening before we were due to fly on to Moscow.⁸ A very kind tourist guide came to us, saying there was only one seat available on the plane, but that whichever one of us stayed behind would be put on a plane the following day. Since all our paperwork was joint, with no separate visas or Intourist papers for the two of us, I found this quite frightening. I was certainly not about to leave Jocelyn behind and go on to Moscow, nor did I relish the thought of staying behind myself without knowing what would happen when she reached Moscow. The guide was quite adamant, and I finally took a deep breath and decided to pull out all stops to avoid this separation, which, thankfully, was managed.*

[**CR:** I do smile at Don Griffin's protectiveness. Jocelyn was a very intelligent, very capable woman, who had, I believe, traveled considerably more widely than Don, was most experienced in handling snarly situations, and knew more about the countries and cultures than he did. She had managed and co/managed the Smithsonian Tropical Research stations in Venezuela and Trinidad and the various associated international scientists for over 20 years.⁹ Being a woman, however, in those times, and particularly in those countries, *did* put her at a significant disadvantage.]

A Russian Bat Biologist Who Had Visited New York and a Bat Cave and Complained about Tolls

DRG: *I should have mentioned earlier that part of our plan was to stay only overnight in Moscow and fly on immediately to Leningrad [CR: renamed again to St. Petersburg in 1991] where Jocelyn had plans to visit the Hermitage museum. [CR: Founded by the Empress Catherine the Great in 1764, it is the second largest museum in the world (by square footage), surpassed only by the Louvre. The collections are superb.]*

DRG: *In Leningrad was also a Russian biologist I knew and was hoping possibly to visit. He had worked on echolocation, with some publications having been published in English. His name was Konstantinov and he had even visited me in New York. At the time of his visit his English was quite adequate, though hesitant, and we had talked at length about Russian studies of bat echolocation. He had even wished to visit a cave where bats were hibernating, and with some difficulty I had arranged that.*

At the time I was fairly new at Rockefeller University, and I had not been visiting bat caves or doing any bat banding for several years. But I knew of an excellent cave outside of Albany, and two Rockefeller graduate students and their wives were also interested in seeing a few hibernating bats. [CR: These were Timothy and Janet Williams and Jack and then wife Inger (Mornestam) Bradbury. Both men were destined to become most accomplished researchers of animal behavior, including bats'.] So, I arranged a trip in two cars to drive to this cave in Clarksburg, New York, all in one day.¹⁰ Konstantinov rode with one student couple on the way to Clarksburg and the other two rode with me. [CR: Do note, what seems to me, the typical polite and egalitarian behavior by Griffin. Many a distinguished scientist would have taken the visiting "dignitary" with himself; not so, Griffin.]

DRG: *The cave is in a state park, and not at all distant from where one can drive, although one walks down a relatively narrow opening in a cliff to reach the mouth of the cave. Janet Williams was one of the student wives, and I remember Konstantinov, who is a big Russian bear of a man, lifted her by the hand either up or down a small climb which was impressive. The cave had very few bats and the visit were routine. We were only able to show him that, indeed, small bats do hibernate in caves in North America and we then returned to New York.*

Along the way, a few episodes disquieted Konstantinov. On the trip north [to the cave], he was a passenger with either Timothy and Janet Williams or Jack Bradbury and his wife. Significantly, the drive occurred during late fall, deer hunting season.

Konstantinov had told me that his visa did not allow him to go more than 50 miles from New York City, although he had, as part of his same visit to America, been touring national parks in the western United States. I told him essentially not to worry, that no one would know that Clarksburg was probably more like 100 miles from Manhattan. But once we got out in the country, he noticed men in orange colored clothing carrying shotguns and I explained that it was deer hunting season. He was very worried, apparently fearing that these might be FBI agents. We reassured him that America was too large, and that the FBI would have great difficulty following our car. But he was not altogether reassured.

I also told him not to expect any big game such as he had been seeing in the West, that we had only one species of deer and that hunters were not allowed to shoot with rifles but only shotguns with large pellets. I had hardly explained all this when suddenly a large six- or eight-point buck leaped almost over the hood of my car as it crossed the road. It required a sufficiently sudden stop that Konstantinov had to fend off the windshield. So, I'm afraid his confidence in my statements about the hunters and the FBI were somewhat undermined by this episode.

Somehow, it turned out that the student couples were not anxious to ride all the way back to New York City with Konstantinov. [CR: Sometimes, attempted politeness backfires.]

[CR: Timothy Williams recalls how Konstantinov spent a good deal of time proclaiming the superiority of the Soviet system. The roads were better, the trains better; even cars were better. At one point, Konstantinov said he was thirsty, so Griffin suggested they stop at a supermarket to buy some drinks. The group walked through the supermarket and Konstantinov was dumbfounded. He had never seen a big American supermarket with aisles and aisles of food. Finally, though, he stopped at a display of birdseed and announced that in Russia, we have much better-quality cereal than this for breakfast. Said Don, "Oh, no, that's birdseed." Konstantinov became quiet.^{11]}

[On the way back, the two couples] ...DRG: *squeezed into one car and I had him to myself on the way back. Conversation was a little difficult, because his English vocabulary and the range of topics about which he seemed to wish to talk, were both rather limited. A long drive, partly in the darkness, I ran out of conversation, so that for long periods we rode on in silence. What did stimulate him was when we came to turnpike tollbooths. He would mutter in his deep, gruff voice something like, "Haven't you already paid for these roads with your taxes?!" I would try carefully to explain in simple terms about turnpikes built with bonds, and how much better they were than other highways, indeed how we could not have made this trip in a single day without the New York State Thruway. But he was obviously unconvinced, because at the next tollbooth he would ask the very same question and I would try to devise a more convincing answer.*

A Visit to a Leningrad Lab: Observing and Being Observed

All this is background for our experiences with Konstantinov and his colleagues in Leningrad. Clearly, we were observed, as probably were all tourists. Having settled in a fine tourist hotel, we noted a middle-aged woman sitting outside the hotel rooms on every floor, obviously keeping track of the comings and goings of the hotel guests. The hotel was fairly close to the Hermitage Museum, and we realized that the university was within walking distance. Because the museum was not open, we decided to walk to the campus and attempt to contact Konstantinov. I should explain that I had written to him before our trip saying that I expected to pass through Leningrad on certain dates and that if it were convenient, I would like to visit him. I thought that this was diplomatic, in case he did not wish to be known to have American visitors. He could easily leave word at his laboratory that he was out of town or unavailable and no one would know that he had been sought out by an American scientist. There would have been no official notification of our intended visit.

Strolling around the campus, we failed to find anyone with whom we could communicate in English, French, or German, but finally, someone gesticulated that we should try a certain building. We entered its door and found posters on the hallway walls indicating research on electroencephalograms [EEGs] was being conducted. [CR: EEGs are non-invasive recordings of brain activity, achieved via electrodes placed on the scalp.] They were the sort of posters used for presentations at a scientific meeting and then re-used for a home university display. Inquiring at an obvious departmental office, I managed to make clear that I was interested in visiting Professor Konstantinov. A secretary promised to telephone him and asked us to wait in the department library. This gave me an opportunity to see how limited this library was. It did contain some standard references in English, but only rather ancient ones and no signs of contemporary journals. Of course, they may have had a better library elsewhere in the institute that I did not see.

After a few minutes, we realized that a young lady was running, panting, out of breath, across the lawn and into the library.

She turned out to be Janna Lipmanova, a sort of postdoctoral fellow in Konstantinov's laboratory with excellent English. She had been dispatched to welcome us and was our guide and interpreter for a couple of days. While Jocelyn visited exhibits in the Hermitage, I spent considerable time in the Konstantinov laboratory visiting with him and his younger colleagues.

As a digression, I should mention that the Hermitage was fascinating and that I did accompany Jocelyn on many of her visits there. The whole section that interested her particularly was closed for the period when we were in Leningrad, but they were kind enough to open it especially for her and give us a guided tour.

Back to the Konstantinov laboratory. No one but Janna spoke English appreciably, not even Konstantinov who had done so when visiting America. I had several questions about the English translation of a monograph that Konstantinov and others had written from this laboratory, and I had several disagreements and skepticisms. I had brought the monograph along with me on the trip and had made comments in the margins indicating my questions and skepticism. They seemed not to understand my more critical questions, which may simply have meant that they were too diplomatic hosts to wish to enter a scientific controversy. Or Janna may have filtered their comments to some extent. I tried to be diplomatic and to discuss these questions as I would in North America or Western Europe, but I may not have fully understood the nuances of such discussions in the Soviet Union.

In the lab, I was shown some rather standard exhibits of apparatus for studying bat sounds, some previously published data and a movie. They also showed me a 16 mm motion picture of an expedition to Far Eastern Siberia. This included long periods of movies taken through a train window on the Trans-Siberian railway and pictures of field work in fairly Arctic conditions, probably on the shores of the Arctic Ocean with seals and other Arctic animals. This is about all I remember about the visit to the Konstantinov laboratory.

During our visit in Leningrad, Janna walked with us out on the campus far from other people or probable bugging microphones and we talked candidly about many subjects, but I carefully avoided anything remotely political. She did not talk about political matters either nor about her family. She did shyly confess that she was a Lenin Gold Medal recipient and had worked in the Russian space research program as well as working with Konstantinov on bat echolocation.

After our cordial visits, Jocelyn and I invited Konstantinov and his wife to have dinner with us at the hotel. Janna came along as interpreter. The dining room menu was quite elaborate, but, as was commonly the case, only a very few and the simplest of the menu items turned out actually to be available. Nevertheless, we had a pleasant dinner and cordial conversation. Mrs. Konstantinov had no vestige of English, as far as she revealed at that time, but Janna was an able and pleasant interpreter. After dinner, Konstantinov politely said that he would like to buy us drinks in the hotel bar. Not knowing what the situation would be, we gladly accepted, but apparently a mere professor at the Leningrad State University was not allowed to buy drinks in a tourist hotel. Only tourists with hard currency could do this. Poor Konstantinov was obviously embarrassed, as were we all. But that episode is also a typical example of conditions in the Soviet Union in 1978.

A Woman Scientist Escapes the Soviet Union and Saves the US Space Program?

The sequel to this visit came two or three years later. In my office at Rockefeller, I received a telephone call out of the blue from Janna's brother, not ever mentioned during our visit. Her brother's telephone message was that she wished to escape from the Soviet Union. No hint of that had emerged in our talks in Leningrad. Her brother had emigrated and was in the United States trying to make arrangements for Janna to enter our country. This entailed many complications and the discussions continued for a few months, as I recall. There were questions about the exact procedure she should use and how she could attempt to arrange for employment or at least for scientific visits in the United States. Her brother, whose first name I unfortunately do not recall, said at one point, "Well, we will telephone Janna and see what she wants us to do." I was astonished and said, won't the authorities intercept your telephone calls and won't that complicate her attempts to obtain permission to leave the Soviet Union? His answer was, "Oh, no, they are much too busy to monitor telephone calls. Don't worry about that."

There came a later period, Janna had left the Soviet Union and was visiting in Western Europe, but still had no visa to enter the United States. I and other American biologists who had known of her work with Konstantinov wrote letters to the INS [CR: Immigration and Naturalization Service] saying that her entry into the United States would be scientifically helpful both for research on bat echolocation and for our space program. I'm afraid that I was carried away by my enthusiasm and used such terms as that our space program would be seriously handicapped without the valuable information that this lady could bring.

In any event, she was eventually admitted [CR: in 1982, possibly also through her status as a Jewish refugee from the Soviet Union]. I lost touch with her for several years when we moved to Lexington, Massachusetts¹². At that point, she was married to Edward Kaplan, a professor of literature at Brandeis University; they had two children, and she had been working [since 1983] in a physiological laboratory [Ashton Graybiel Spatial Orientation Laboratory] at Brandeis that was involved with research on space flight and was headed by the husband of my former student, Ann Graybiel¹³. Later I learned that Janna has been training and preparing, and hoping to become an astronaut in the American space program, but I do not know how far she has progressed in that endeavor. [CR: Resources indicate that she helped develop the program for private and commercial payloads to space and even for training astronauts, though there is no indication of her training to become one or of achieving that end].¹⁴

Whew ... Arriving in Finland and Home

Finally, I can vividly recall a great sense of relief as our plane landed in Helsinki, Finland. While we had had no untoward episodes, apart from the plan to have us separated in our flight from Samarkand [in Uzbekistan], I think, rather than Tashkent, we had no unpleasant episodes, and indeed everyone treated us with great cordiality. Nevertheless, there was an oppressive atmosphere which we felt to have lifted as we landed at the Helsinki airport. We simply changed planes in Helsinki and flew on to Stockholm on our way back and had no other interesting events on that trip.

ENDNOTES

¹ The quotes in this chapter by Donald R. Griffin, are from Donald R. Griffin, 2003, January 15, BOOK KabulLeningradIthaca, unpublished ms.

² National Museum of Afghanistan website, <https://www.nationalmuseum.af/>.

³ Kabul Museum, n.d. Retrieved March 22, 2018 from Lonely Planet website.

⁴ Richard A. Zickel and Eugene K. Keefe, 1991, Soviet Union.

⁵ Patrick Smith, 2004, March 9.

⁶ BBC. (1998, April 26). Afghanistan: 20 years of bloodshed.

⁷ This final demise of the Soviet Union had several complex causes: the enormous difficulty of integrating distinct ethnic groups after the Bolshevik Revolution of 1917 into a Russianized union, the repressive totalitarianism of the Communist regime, growing economic stagnation, and, in 1985, Mikhail Gorbachev's decision to create "glasnost," or freedom of expression. With glasnost, came the release of decades of pent-up frustrations and hostilities. Beginning at the periphery, in the non-Russianized areas, organized, nationalist movements began to arise, demanding autonomy. Finally, after a failed coup and massive protests throughout the Soviet Union's major cities, Gorbachev resigned in December 1991. The Soviet central government collapsed. By January 1992, 15 independent countries existed, though most were loosely connected through the newly formed "Commonwealth of Independent Republics."

⁸ Griffin later recalls that the potential separation concerned a flight to Samarkand. See last page of chapter.

⁹ Jocelyn Crane's impressive career is discussed in Volume 2 -Chapter 14, "Behind The Man: Significant Women" in the section, "Jocelyn Crane Griffin ..."

¹⁰ That journey is about 365 miles one way or 6-7 hours of driving each way. I wonder if Griffin was correct in recalling his destination as Clarksburg, for he later estimates the distance to be about 100 miles. Clarksburg is near Buffalo, not Albany. Albany is about 150 miles from New York City, a 2 ¾ hour drive, and a much more reasonable, if somewhat lengthy day trip. And to complicate matters yet further, Timothy Williams, one of the two RU grad students on the trip, recalls the destination as Breakneck Ridge on the Hudson River, above Croton, N.Y., about 60 miles and 1 ½ hours from the RU Manhattan campus.

¹¹ Timothy Williams, personal communication, August 24, 2020. Telephone interview.

¹² This move occurred after Griffin’s “retirement” from Rockefeller University and over a year at Princeton. The Griffins lived in Lexington, Massachusetts. Don had an academic appointment at Harvard’s Field Station in Concord, Massachusetts, where he continued his research.

¹³ As described in Volume 2 - Chapter 12-Part 2, Part 2- “Trinidad- A Research Station In Paradise ... Muddy Roads And Many Bats,” Ann Graybiel had been an undergraduate, working with Don Griffin when he was a Harvard Biology Department faculty member. She had even accompanied him on a field trip to Simla in Trinidad, where she had helped him and his graduate student Roderick Suthers study echolocation by the fishing bat (*Noctilio leporinus*). She later became an acclaimed neuroscientist at the Massachusetts Institute of Technology. A brief biographical sketch is available in Volume 2 – Appendices.

¹⁴ Astronaut Training, n. d. Retrieved March 27, 2018.

CHAPTER FOURTEEN

BEHIND THE MAN: SIGNIFICANT WOMEN

Overview

Descriptions of several accomplished women, good friends of Don Griffin's. Two were his wives: one, the mother of his children and a teacher; the second, the noted marine biologist, Jocelyn Crane. The women offered Don friendship, advice and companionship and were often also sailing and hiking buddies and volunteers for his fieldwork. (Perhaps) a few were likely romantic interests as well.

I discuss the women's accomplishments, in particular, the work of Jocelyn Crane, renowned for her studies of fiddler crabs. Griffin and Jocelyn had first met (1960) when she was managing the field station in Simla, Trinidad, where he had come to conduct bat research. Part of this tale includes the delights and travails of life at Simla and of Jocelyn as the *woman* director.

Introduction

Like us all, Don Griffin had long-term friends, partners and colleagues who play significant roles in our lives, advising us, supporting us, remonstrating with us. Among those persons in Don's life were his parents, his male associates and women: his first wife - the mother of his children, his second wife, his children, and others I have mentioned. In this chapter, I would like to focus on a few of the women who offered him advice and support as close friends or as his wife. Quite possibly, at some points in his life, some of these women were not only significant companions and consultants but romantic partners as well. Don, however, given his quite Victorian, restrained upbringing and his reserved nature, was most circumspect in discussing his relations with women. He valued his privacy and that of his family and friends. We thus find no mention of romantic interests or courtships, even in his personal, unpublished memoirs. Archived letters relevant to his relationships are either closed to researchers or have been lost or not donated to the archives. Nevertheless, from others' recollections and a selected set of available letters, we can construct a rather vague personal story, while respecting his, his friends' and his family's wishes for privacy.

The particular women to be described in this chapter are Margaret (Robinson) Olmsted (circa 1919-2001), a lifelong friend, beginning in childhood in Barnstable, Massachusetts; Ruth (Castle) Griffin (1915-1998), Griffin's first wife and mother of their four children; Jocelyn Crane Griffin (1909-1998), Griffin's second wife; and Elizabeth ("Betsy") Weaver (1921-2008), a long-time friend, also since childhood.

Early Days

Don's encounters with young women in his early youth were, often, at least a bit odd. Consider this remark: "Your hair, how lovely! My, it's just like the fur of a Red-Backed Vole." As we have learned, Don's words to that effect did not elicit a positive response from the young lady, like Don, an early teenager.¹ That sincere compliment does suggest Don's awkwardness with women, then with young, later, with older ones. It also reveals the enthusiasm and admiration for animals held by many of us who have had the privilege of observing and studying them.

Nevertheless, women friends, or at least acquaintances, were just about always part of Don's life. When sailing, when "batting," either in his youngest ventures or as the years went by,

women were often included, or at least some of the time. By and large, fewer women than men seemed to be interested in those activities, and both his secondary school and Harvard University were all-male institutions. A shy young man did not readily acquire an entourage of females.

Margaret (“Peg”) (Robinson) Olmsted [born circa 1919 - died 2001]

Barnstable, a place to sail. Don’s family had moved there when he was nine (1924), and “Peg” Robinson and he often went sailing together. As did many others, the Robinsons spent only the summers and holidays on Cape Cod. The family lived the rest of the year in Ithaca, New York, where Peg’s father was a Cornell University faculty member. Peg’s brother Doug (Douglas H. Robinson) was also Don’s good friend, both as youngsters in Barnstable days and during Harvard undergraduate times when they both entered together as Freshmen.

I know little else about Peg. She was about 4 ½ years younger than Don. While he was an undergrad and graduate student at Harvard, she studied at the eminent women’s college, Wellesley, in Massachusetts. To this day, Wellesley is still one of the few “seven sisters” to remain all-women; the “sisters” were considered to be the female counterparts to the once all-male “Ivy Leagues.”

There *is* something of a mystery about the relationship that developed between Peg and Don. Only snippets of correspondence mentioning her name are to be found in the Rockefeller University Archives where many of Don Griffin’s personal and professional papers were located.² At the same time, an entire folder containing correspondence between herself and Don and possibly other memorabilia is marked “Restricted” and cannot be viewed by researchers. (Only one other folder is closed, that of William Edgar Curtis, Griffin’s graduate student at Cornell, studying obstacle avoidance by owls and bats with him.)³ Thus, I will mention the accessible few bits that may suggest a growing, close, deep and caring relationship, even in their youthful days.

Both Peg and Don married but to other persons. It seems likely, though I have no specific evidence, that Don married before Peg became Mrs. Olmsted. From rather fuzzy memories of mine and others, I gather that Peg’s career was in chemistry and she was associated with a university in Ohio, where she lived with her husband.⁴ After her husband passed away, she moved back to Cape Cod, to Woods Hole. At that time, Don and Jocelyn were also retired on the Cape.

But those are the “bare bones” of a life. Snippets from various remembrances suggest pleasant times that Peg and Don spent together. Many of the shared early youthful times in Cape Cod involved boats, in particular, creating the “better boat.” When almost 25 years old (1940), after a few not overly successful attempts at building boats of various sorts, Don joined forces with Peg. Together, they built the Snickersnee from a kit, lasting for many a sail not only by them both but with many others. As Don reminisced later (1987), in his writings, he was still using that boat.⁵ Peg, too, long remained in his life.

Her brother, Doug, was not only Don’s friend but a companion on many a bat banding expedition, particularly while in college; Peg also joined some of these.⁶ Various letters to Don from Doug and Mrs. Sarah Robinson, the mother of Doug and Peg, suggest the warm relationship between Don Griffin and the Robinson family. In a letter of Jan 11, year undated, but before 1938 when Don graduated from Harvard, Mrs. Sarah Robinson, Peg’s mother, enthusiastically thanks Don for the visit to their family. Teasingly, she notes that though they trusted him as “one of the family,” he was neglectful in the matter of dishwashing. “Be comforted- we shall save you stacks of them the next time.” And thanks are likewise given for safely depositing Peg at the Wellesley station, presumably

as both were returning to college. Also, Mrs. Robinson warns Don, " ... don't let her use up too much of your time before exams."⁷ Another letter, with no year, mysteriously mentions returning Don's handkerchiefs which had arrived "eons ago." Again, she hopes that Don will be quite firm with Peg and not let her impose on him.⁸ In the letter from Mrs. Sarah Robinson before Don's Harvard graduation (1938), she mentions Don's visit with them over the Christmas break, hoping he will be able to repeat such visits. In her view, Don had added such delight to the lives of both Peg and Doug over the last two years.

Yet another letter from Mrs. Robinson⁹ mentions a persuasive letter from Don. With it, Griffin had convinced the parents to permit Doug to join Don in fieldwork on Kent Island, Maine for the coming summer, 1938, after Don's Harvard graduation. Doug had sent Don a highly appreciative note thanking him for convincing Doug's parents about that forthcoming expedition. Doug noted that even his mother thinks it a good idea "tho she is worried as usual about my getting my feet wet, etc."¹⁰

Then a gap in the letters from Mrs. Robinson until June 6 (no year) when she mentions Peg and her husband's baby daughter and Don's baby, Nancy.¹¹ This would have to have been after Nancy's birth in May 1943. Don would have been conducting "military research" at Harvard. And Mrs. Robinson adds, she "shamelessly" read Don's card aloud to Peg and will send it to her. That's all. No more mentions of Peg.

I must admit, each time I reread those last available letters from Mrs. Robinson, mentioning her daughter Peg to Don, and saying kind words about Don, my heart sinks. I am saddened. What happened? Were they indeed "just friends," whatever quite that means? Friends sustain us throughout our lives. And though we do not know the nature of their correspondence or their relationship for most of their lives, by the end of their times, they were both back in Barnstable, still befriended, helping each other and enjoying each other's company.

They seem to have maintained some kind of communication during Don's first marriage to Ruth, but Peg was not, it seems, welcomed by Ruth. An early friend of Nancy (Don's eldest daughter) remembered that Nancy did intensely dislike Peg, but, simultaneously, it seemed that the relationship between Ruth and Don was no longer a happy one. There was not a sense of Peg's "stealing Don" away from Ruth; that emotional distancing seemed already to have happened.¹² Yet Jocelyn, his second wife, felt happily relieved to have Peg and Don go sailing together, so that she, Jocelyn, didn't feel compelled to go when Don felt like sailing. I did once meet Peg and stayed at her home in Cape Cod. She has been described as "old New England, earthy, warm, practical."¹³ I would concur, and add "most intelligent, gracious, welcoming and friendly."

When I met Peg, it was the early '80s. I was in Don Griffin's lab at The Rockefeller University, hoping to conduct field experiments investigating the nature of injury feigning by ground-nesting birds, most likely piping plovers.^{14,15} Was their behavior quite so reflexive as typically described in the literature or was it far more flexible and strategic? Is it in some ways a purposeful use of an innate behavior pattern? With its many acres of protected land and nesting plovers, Cape Cod seemed a potential research site, worthy of further exploration. Griffin, too, was enthused about my proposed project. I was operating on the usual almost shoestring budget of animal field researchers. Those funds derived from a small grant by the Harry Frank Guggenheim Foundation, no doubt facilitated by Don's being President of that Foundation at the time. Don offered to help find accommodations for me with friends in the area. That turned out to be the

home of Peg, then living in Woods Hole. Peg and I had a most pleasant time together. After her husband's death, discovering herself retired and alone, she'd not only moved back to familiar land but decided to figure out what "old ladies" did ... birdwatching! A way to have an absorbing activity, meet interesting people and travel in the congenial company of other bird watchers. So that's what she'd become. Likewise, she mentioned, "just for companionship," she had a male roomer in her home, though I never met him.

And she fed me. With considerable effort, she had prepared "Brunswick Stew." Fortunately, not the bonafide traditional recipe, which calls for "possum" and/or squirrel. Believed to have been invented in the early 19th century, the states of both Virginia and Georgia lay claim to the stew, as does the town of Brunswick, aka Braunschweig, Germany. Depending on local vegetables and available small game, the recipes vary greatly. Even Queen Victoria considered Brunswick stew a favorite.¹⁶ Peg's version, thankfully, was cooked with rabbit, from those she raised in her back garden. I could well imagine this resourceful woman tromping off into the field to capture one, if needs be. As events transpired, I chose a different study site, in the Delmarva Peninsula of Virginia, but it was a pleasure to have met Peg.

Numerous years later, in 1998, Don's second wife, Jocelyn Crane, passed away. That was also the year that his first wife, Ruth Castle, died. Don was fortunate to have the friendship of Peg, again on her own, no longer even the roomer present. She had a beautiful house, on Bar Neck Road, in Woods Hole, opposite the Yacht Club,^{17, 18} and still loved sailing. This they did, often launching from that Woods Hole Yacht Club, which was considerably more pleasantly appointed than the Barnstable Yacht Club so graphically described by Kurt Vonnegut.¹⁹

Besides the sailing, they shared many a dinner at the Landmark Restaurant in Woods Hole, near Peg's home. Sometimes, Don's compatriot, co-worker and assistant in the field, Greg Auger, and Greg's wife, Wendy Williams, an accomplished author, joined the two for a meal. On the waterfront, overlooking the water, and, sometimes, the settling fog, it was a relaxed, calm place to spend a leisurely meal, comparing the day's events. As always, Peg could be quite direct and outspoken with Don, teasing him about his "autoplagerism," as he himself termed it. Trying to spread his message in various journals and formats, he did often say again what he had said before and again before that ... still meeting each time with resistance from his peers.

Then Peg grew ill, struck by cancer, usually attempting to refuse visits from anyone, even Don, but he did come by. He was concerned that he seemed not able to visit as often as he thought he should. Sometimes, again, it was research in the field that "interfered." She passed away, in 2001.

Ruth Castle Griffin (1915-1998) (Griffin's 1st wife and mother of their children)

We have skipped far ahead, for, back in 1941, as a fairly penniless graduate student, Don Griffin married. The young woman was Ruth Marion Castle. They met, according to a long-time friend, while both were graduate students: Ruth at Radcliffe, the women's college at Harvard, and Don at Harvard.²⁰

Ruth Castle, a Village Girl?

Ruth's family background was modest, working-class. Her mother was a first-generation German immigrant. Neither of Ruth's parents had more than a primary school education. Ruth was the first in her family to have a college degree.²¹ Life for Ruth began in Gillette, a very small town in

New Jersey, better termed a village in those days. She considered herself “something of a country girl,” and indeed, throughout her life, she chose to live in bucolic areas, as possible. Childhood was a fairly simple life, with limited finances, but with the delights of a family dog, learning to swim in the small murky, clay pit pools, exploring, not the Bronx River or Barnstable Bay as Don was doing in his childhood, but the meandering Passaic River near the house and the “Great Swamp”²² a couple of miles away. The latter was the habitat for almost 250 species of birds. Living thriftily, more so it seems than Don’s own thrifty family, Ruth was enduring clothing handmade by her mother from the discarded clothes of other family members. The embarrassment ... walking down the street in a dress everyone must of course recall was her aunt’s “old-lady” fabric apparel. Very expertly made, though, she admitted, with seams so perfectly finished, one might wear the dress inside out.²³

Like Don’s family and many a family of the day, there was a connection to the railroad. For Ruth, it was daily transportation to grammar school, high school and even the first years at Montclair College until she moved into a dorm. Even more importantly, it was her father’s employment and the family’s source of income. Don’s ancestral background, both paternal and maternal, had important economic connections to the railroad, both in administration and other employment.

Ruth Castle, the Scholar

Like Don, Ruth was a serious student, but unlike him, she had considerably more artistic proclivities. As an undergraduate, she played the violin, was a member of the Orchestra and the Glee Club, and active as Secretary of an international honor society Kappa Delta Pi,²⁴ all these during various years of her college career. The honor society was a limited one, open only to the top 20% of those entering the field of education, but Ruth was easily included in that segment of students.

The academically inclined Psychology Club and Science Club likewise engaged her. In the Montclair College yearbook, she’s cited as “running off with the honors in classes.” Yet also, she is “dancing at formals with lovely merriment ... and hibernating in the library.” Mysteriously, “label her Rufus” appears in the same Yearbook description,²⁵ which could allude to her reddish hair,²⁶ wordplay with her name, maybe even a tendency to blush ... I don’t know. A more remote, but quite unlikely possibility according to her family, is that the nickname refers to Dr. Rufus Reed, the Faculty Advisor of the Science Club.²⁷ He seems to have been a teacher highly devoted to his profession, quite detailed, rigorous and demanding, and Ruth, with her outstanding academic skills and interests, was likely an especially well-regarded student. In his honor, a scholarship has been established at the university, specifically for *female* chemistry students, suggesting his empathy for the greater difficulties faced by prospective women scientists.

Ruth Castle, the Novice Teacher

Ruth received an undergraduate degree in Biology in 1936 from Montclair State Teachers College in New Jersey.²⁸ And eventually, she did become a teacher, but by a rather circuitous route. Whether her plans while at Montclair had been to teach biology or to undertake research is not immediately obvious. Even though Montclair *is* a Teacher’s College, it was also a financially wise choice: it was close enough to home so that Ruth could commute to her classes, which she did the first two years, and was presumably far less expensive than many other choices.

Initially, just after graduation from Montclair (academic year 1936-37), she was the Science Department Secretary at Long Island University, New York. Summers of 1936 and '37 were spent as a Research Assistant working with her Montclair professor and mentor Charles Hadley at the Marine Biological Laboratories in the pleasant town of Woods Hole on Cape Cod. In the Fall of 1937, she was hired at the well-regarded women's college, Vassar, slightly "up-state" New York, in Poughkeepsie. At that time, the region was an area of farms and green, rolling hills near the Hudson River. The extensive, leafy Vassar campus even included a stable of horses for the students to ride and learn to ride if they didn't already, one of life's "important" skills. At Vassar, Ruth was an Assistant in the Zoology Department, what might be termed a teaching assistantship and "loved campus life" as she had at Montclair and would later at Radcliffe College.^{29,30} She even became a Vassar College "Resident" (Academic year 1938-39), or "House Fellow," considered part of the faculty, a position entailing even more mentoring and advising students than she'd already been doing.³¹

Ruth, though undoubtedly a lover of nature and the outdoors and fascinated by biology, was not, however, a member of the outdoors "horsey set." In those days, that set comprised many Vassar students. In contemporary times, Vassar is, instead, recognized as one of the elite schools with an extensive scholarship program and an increasingly diverse student body.

Life at Radcliffe

During the time Don and Ruth first knew each other, Ruth was a graduate student at Radcliffe College. Not a trivial matter to be admitted into Radcliffe College for undergraduate or graduate studies, either then or now. So, we know we are contending with a most intelligent, academically-minded young woman. Likewise, an outgoing, very sociable person, quite a counterpoint to the shy, young Donald Griffin.

After her employment stints, perhaps to earn funds for graduate study, Ruth began her work towards a Biology M. A. at Radcliffe. Although both Radcliffe undergrads and graduate students have to be serious students, they also found time for far less cerebral activities. The Radcliffe Yearbook of 1940 paints quite a different picture of undergraduate life than appears in a later interview with one of Ruth's close friends about grad student existence. We find in the college yearbook a depiction of eight or ten girls lounging on a weeknight evening in the smoking room: one is filing her nails "to the agony of another" with the dreadful noise; another expertly shuffles a deck of cards and plays solitaire; one fiddles with the radio (no TV was common then). Still others smoke "and work on their interminable knitting." Of the reported conversation, one can only remark that it generally doesn't inspire major intellectual challenges ... with requests for a hand of bridge, seeking an agreement that "Jewel Tone II is better than ...", and a complaint that "... it's just too much: seventy pages tonight ..." Worries are expressed about major exams over two months away and a pronouncement made, "I said to him, 'If you think I'd ...'". And someone comments more seriously, perhaps, to further develop a biased view, "Socialism and Communism are the root ...".³²

At the same time, in Bertram Hall, the Radcliffe graduate women's residence, there seemed to be different conversations. An interview³³ memorializes some reminiscences by the anthropologist Elizabeth Colson of "The Friends," a group of six women that included Ruth; they continued, throughout their lives, to remain in contact. [This group later sometimes termed themselves the "Bertram Five."] As Colson remarks, since we were all graduate students, "... there

had been a filtering out for people who were interested in intellectual questions, so we had much more interesting discussions.” Within the group were Ruth in biology and others in economics, French, mathematics, art history, and Elizabeth herself in anthropology. “Feminists?” “Oh, no,” we weren’t feminist or anti-men was Miss Colson’s retort to the interviewer’s query. Most married and had children; some divorced; some did not marry. As to parties, one member had described the group as “reserved, a little shy, and completely serious.” But, “No,” as Miss Colson noted, we did have parties and smoked, which “everyone” did. But not much, not even fairly described as “a little” in the way of liquor ... we couldn’t afford it. “Miniscule” was a better description. Most were not at all well off. “We were scraping along.” Whatever the economic scene, the camaraderie and mutual support flourished and remained, even in later years. The close friendships extended to some of the women and families sharing vacations and naming children after one another.³⁴ As the Radcliffe yearbook³⁵ described dorm life, certainly applicable to graduate as well as undergraduate students, “It is like a world within a world.”

Political Upheavals of the Times

The late ‘30s and early ‘40s were times of much political turmoil. I can find no record of either Don or Ruth participating in anti-Nazi demonstrations or other activism. Beginning in the ‘40s, however, Don was engaged in war research, much of it secret. That stymied a good bit of letter-writing chatter about the day’s activities. It, along with his marital state, also relieved him of other wartime responsibilities, namely, recruitment into the armed forces. In slightly later years, we have seen how Don, a faculty member at Cornell, joined others to promote the establishment of a *civilian* Atomic Energy Commission overseeing nuclear affairs and not leave such matters in the hands of the military.³⁶ While on the Harvard faculty, he helped promote and, in fact, contributed financially to a campaign to support legal expenses for Cornell Physics Professor Marcus Singer. Singer had refused to divulge possible Communist Party membership of friends and acquaintances to the McCarthy-era Congressional “House Un-American Activities” investigations.

Yet this was also a time when men were far more likely to become activists than were women, though there were outstanding women figures, such as Dorothy Day, Eleanor Roosevelt and the African American singer Marian Anderson. Because she was black, Anderson had been denied access to the stage at the Daughters of the American Revolution (DAR) auditorium. In response, Eleanor Roosevelt showed her support for Anderson by resigning in protest from the DAR and helping to arrange prominent concerts for her. In 1939, President Franklin D. Roosevelt, with the help of Eleanor and others, invited Anderson to sing before 70,000 people at the Lincoln Memorial.^{37,38}

Vassar College, when Ruth was affiliated, had a mixed history of response to the growing Nazi power. Phrased rather euphemistically, the Vassar Encyclopedia³⁹ states that “Vassar’s campus, perhaps more than much of the world, examined the rise of the Third Reich with a dispassionate, measured attitude.” In large part, this was probably due to the influence of Henry Noble McCracken, President of Vassar since 1915, and both a pacifist and an internationalist. He strongly advocated international educational and student exchange as a path to peace. Vassar students went to Germany, even in the ‘30s, and often returned with more positive views of Hitler and his policies. A Vassar faculty member gave a speech to a local Men’s Club, stating that “the charge Jews have corrupted the ethical standards of public life in Germany was ‘probably true.’”

Initially, in 1935, Vassar did *not* join 40 other college presidents, including some from the “seven sisters,” namely Wellesley and Mt. Holyoke, to publicly support a US boycott of the 1936 Berlin Olympics. By 1938, however, campus sentiment had shifted to anti-Nazism activism. Vassar President McCracken and Poughkeepsie’s mayor “sponsored a city-wide boycott of the ‘aggressor’s goods.’” This, then, was the milieu in which Ruth was living, but there is no record of her attitudes or participation.

Courtship and Marriage

Nowhere in available correspondence do we find any mention of Don and Ruth’s courtship, but we do find some letters from friends around the time of their marriage and later. Likewise, letters flowed between the two after they became new parents. They lived apart some of the time as Don worked long hours at Harvard in war-related research and Ruth and the baby stayed with her parents in Gillette, N. J.

In a letter congratulating Don and Ruth on their forthcoming wedding, a friend, Fred Packard, who continued correspondence with Don over the ensuing years, wished them every happiness. He stated, however, that his “real reaction” was one of envy. In describing Ruth’s charms, he quoted Solomon’s words, the “pearl beyond price.” These seem extraordinarily flattering words, until on further examination, it appears that Fred may never have met Ruth. His praise is based upon her being “a girl who would put up with such vagaries of the mind as bat-banding, autopsying every animal in sight, and leaping hither and yon after toads and newts.” Though lighthearted, quite a male-centric view of a relationship and marriage.

We skip then to the series of letters between Ruth and Don. Some letters were daily, even twice daily, from Ruth as the mother of their baby Nancy, who was crawling, then later, just about walking. It was a lonely mother, missing Don, who did not write as often as Ruth but seemed readily forgiven because of his work. The available letters are predominantly those from Ruth. She described the antics and achievements of Nancy in considerable detail, loving and proud of the wondrous little being. To an outsider, the specifics of the little one’s doings do get a bit tedious, though, presumably, not to a new mother. Ruth tried to persuade Don to rest, to take a bit of vacation from all his work. She felt refreshed, having just had her mother’s help with the baby. They addressed each other in tender words and expressed their affection for each other.

As young couples do, they exchanged some romantically silly letters. Once she pretended to be a pen pal, enclosing a photo of “herself” as the glamorous movie star of the day, Hedy Lamarr, exotically swathed in a white turban. He responded with a photo of “himself,” the famous strongman, Charles Atlas. He suggested that leathery cupid-winged bats may have brought her letters to him, letters that set his heart “a-pounding.” She mentioned that she was lonely,⁴⁰ as she certainly would be with a young baby, while her husband was living away, busily ensconced in a lab. She suspected he must be too, immersing himself in studies of bats which must make him “socially unwelcome to most people.”

In a light vein, he declined a visit from her flying to him with Mrs. Roosevelt, suggesting she wait ‘til she can fly to him with Stalin. His next week is to be extremely busy, with his visiting relatives and war work and joshing that his secretary who is “a gem to type all these letters” abruptly departed to work in a steel factory. “What women won’t do next!” In short, he was swamped, and please don’t come. Yet in the midst of the letter, he grew exasperated with his drivel.

“WHY THE HELL DO I TYPE THIS DAMN ROT!!!!”⁴¹ There are almost no other personal letters to Ruth available in the files.

Family Life

I know little of family life during the ensuing years. While the couple lived in Cambridge, at some point after the marriage, Ruth decided not to pursue an advanced degree at Radcliffe. Instead, she worked in a Boston medical laboratory. When Don joined the Cornell faculty in Ithaca, New York, they struggled to find a decent, affordable place to live.⁴² The efforts involved much laborious carpentry and construction work by hired workers and Don himself. Devoting herself to being a full-time mother for numerous years, Ruth bore and raised four children, including a set of twins. Don, of course, contributed as a father, and family dinners and picnics and outings were often shared, but Don was an extremely hard-working, devoted and ambitious scientist who loved his work. Many of those “outings” were the family accompanying him on professional excursions deemed safe enough for the children. There would have had to be conflicts between his role as husband and father and that of a strongly dedicated scientist. Adding to the stress were those of an overly busy professor dealing with unwanted administrative chores and the usual grading and long hours of course preparations. Even though scientific research was his primary objective, if Don Griffin were to teach a course, he would do it well, very well. He took those responsibilities very seriously. Ruth, likewise, when later a teacher, put much effort into her preparations. A daughter once remarked how it was only in his much later years that her father finally came to recognize the importance of things in life other than scientific research.

From the daughters’ reminiscences, some memorable stories emerge. Among them are the jaunts to the home of another bat enthusiast, Fred Webster. His Cambridge, Massachusetts garden included not only a trampoline for bouncing but also the spacious building housing it. And then the other fun! Their dad and Fred Webster would make a most unappealing mash of bananas and mealworms. Placed in a spoon, triggered by a rubber band, Dad or Mr. Webster would catapult the glop into the air. Griffin’s and Webster hoped that bats that had been brought into the building would try to catch the tasty (to the bats) morsels. Thereby, all could observe how the bats captured the tidbits.⁴³ With luck, perhaps, some photographs could be taken of the process.⁴⁴

Other outings also often involved bats. A daughter recalls a family excursion that included searching for bats. A potential bat hideout was detected! Most unfortunately, it was far too narrow a crevice for either Don or even Ruth, his supportive wife, to slither through to determine whether bats were living inside. But, in her father’s view, one of the daughters was quite responsible enough, physically able *and* thin enough to wriggle down the opening. The daughter holds an enduring memory: a certain amount of repugnance, certainly some fear ... perhaps better described more intensely than fear ... and squirming into the fissure. No one recalls the species of bat detected or even if the cranny housed any bats. Yes, we researchers and authors do sometimes ask a bit much from our friends and relations. In the book, *Being a Beast*, to be described later,⁴⁵ the author, Charles Foster, tries to better understand the worldview of a badger. To do so, he and his eight-year-old son lived, on and off, for 6 weeks, in a bough-covered trench in the forest, munching on worms as badgers do. They did also eat a friend’s homemade lasagna, as badgers don’t.

Other, more fond memories entailed their mother singing around the house, a pastime she much enjoyed throughout her life; once, she was a member of her college Glee Club. Often the

children were pleading for a specific merry, witty, but bloody and dire song.⁴⁶ A favorite not only of these young ones, "Abdul Abulbul Amir" was a popular music-hall song written during the Russo-Turkish War in 1877. In this ballad, two heroic warriors, Abdul, fighting for the Turks, and the Russian foe, Ivan, encounter each other. After boasting of their strength and extraordinary bravery, they enter a duel and both perish, leaving behind their comrades and loving, grieving maidens. With many versions, one highly bawdy creation was reputedly sung by British and American (and other) football and rugby teams.⁴⁷ In a children's animated cartoon of 1941, Abdul becomes the villain, a bully caricatured with a turban, thick lips, a beard and a big belly, fighting the "just" Russian Ivan, all this perhaps a bit of early anti-Middle Eastern prejudice.⁴⁸

Although we can be quite sure that the dreadfully salacious "Abdulla" version wasn't the one Ruth sang to her young ones, her daughter describes her mother as reveling in bad puns and relishing a certain low-brow streak. She thoroughly enjoyed children and "Fun was important to her." A sympathetic and good listener, a very sociable person.

On Her Own, but with "Independent" Old Friends

Ruth and Don divorced approximately 1964 or 65, and Don married Jocelyn Crane in December 1965. But throughout Ruth's life, while the children were young and later as they went their own ways, before and after Don and Ruth divorced, the "Bertram Five" from Radcliffe days remained in touch; they visited and sometimes vacationed together. Billy (Sybil P. (Bindloss) Sim) would charge in for a visit, driving "Puddles," her Model T Ford, painted bright yellow. Even when they were "well up in years," the group made an excursion to the vacation home of Billy and her husband on the rather remote Prince Edward Island, Nova Scotia, Canada.^{49,50}

These women seemed neither retiring nor impractical. Billy, as an example, left aside her Radcliffe M. A. in French Studies, and, working at an insurance company, conducted research primarily related to statistics and computing. Having led a team for a two-month study of the healthcare systems in five European countries, she culminated the work with a paper in the *New England Journal of Medicine*. That is a most prestigious publication, particularly for someone with neither a medical M. D. nor a scientific Ph. D. Later, ahead of today's earnest campaigns, she challenged her employer for equal pay, and, when not received, quit to work for a competitor.⁵¹

Inspirational Teacher

For Ruth, her M. A. in biology formed the basis of the science courses that she taught. Usually, the family spent their summers in Cape Cod, the site of Don's parents' and grandparents' homes; most often, his various research endeavors were conducted close by. In those summers, the children happily ran off to the Woods Hole Science School. It sounds like a delightful (and literal) "immersion" sort of course. Including not only classroom instruction and labs, the young persons did fieldwork collecting most anything by the shores. Splashing in the water was definitely required. During one summer there were not enough spaces in the Woods Hole Science School for all those interested. So Ruth decided to create and teach a science course for those "unlucky" souls. In her daughter Janet's words, her mother did so "with enthusiasm, prepared very conscientiously and took great pains to ensure that it would be an enjoyable experience for her class." In that, both Don and Ruth are quite similar in the level of preparedness and the enthusiasm they bring to their subjects, so enjoying the science that others are similarly motivated. Hence, the success Don

seemed to have with his many, many battling expeditions, finding volunteers to trek along with him through mud and snow and slippery, obnoxiously smelling caves to search for bats and band them.

Teaching, as Ruth's formal career, began when the eldest daughter, Nancy, was to enter a private high school. Don was on the Harvard faculty; the family was living in Cambridge, Massachusetts and Buckingham (officially Buckingham, Browne and Nichols School) was an excellent private school for girls ... which needed a Biology teacher. All three girls and one mother applied and all were accepted, the girls at lowered tuition rates since mom was to be a teacher at the school. A most helpful solution, for faculty members were not particularly well paid at either secondary school or university level institutions. And the start of a most personally satisfying career for Ruth, in an environment that was both supportive and "empowering" for both students and faculty.⁵²

"An inspiring teacher" was the view of Ruth held by a family friend and bat researcher, David Pye and his wife, Ada. As has been described, he had invented the very first portable bat detector, used by Don and other scientists.⁵³ Pye was the younger, younger by 16 years, and in his view, Griffin had been most supportive of him. Don was his "hero," though a hero with whom he did argue and disagree. The two families visited frequently when Don took a sabbatical in Cambridge in 1961 (academic year to summer 1962). David and Ada remained friends with Ruth, even after she and Don divorced in the mid '60s. "A very lovely person" and "one of our favorite ladies" remarked Pye, remembering Ruth.⁵⁴

Family: Children Growing Up

But "inspirational teacher" apparently did not inspire much appreciation by Don. Reputedly, Don held quite a different opinion about Ruth's career choice. From a daughter's viewpoint, "my father did not consider her work as valuable or as important as his own. He seemed, in fact, to believe that she had squandered her talents and opportunities and had misguidedly chosen the wrong path."⁵⁵

I know little more about the family's times. Unfortunately, in Ruth's last few years, illness prevented many of the activities she so enjoyed doing, even walking, reading, writing and finally even talking.⁵⁶ In deference to their wishes for privacy, I shall not describe in detail the lives and accomplishments of Don and Ruth's children: Nancy, the twins Margaret and John, and Janet.

I do know that a youthful admirer of Nancy thought her "quite a magical person," even "a little nutty, in an intellectual way." Nancy was then in her last year of high school (circa 1962 or 1963). At the time, the young man (Mr. X.) was living in Woods Hole, his family's home. Nancy had a summertime job working as a chambermaid at the Marine Biological Laboratories (MBL) and he had met Nancy in the town. Her family seemed to let the children lead quite independent lives. Even though the Griffins had a cottage in Woods Hole, Nancy was living away from them in "Homestead," which then provided quarters for the high school and college student summertime workers; the building still exists as part of MBL.

Mr. X. recalls one of their drives together from Cambridge to Woods Hole in an "elderly car," belonging to Don Griffin. It may have been called "Bluebeard, for the family seemed to name their cars something or other "Beard." Nancy was curled up in the passenger seat with a book balanced on her knee. She was memorizing the very, very long elegy in it, "Lycidas" by John Milton ... "just for fun," as he remembers it. When visiting Nancy at her home, Griffin was not usually there as a host to greet the young man. Nancy seemed to feel she had already moved out of the home and family. In

Mr. X's memory, Nancy found her father, "interesting, yet inexplicable." She, herself, was not so interested in science, but she was intrigued by the way that her father thought. Her mother, she considered to be a "strong woman." Unlike other person's reports. Nancy thought her mother did not get along too well with anyone. [But we should note this is still a teenage young woman, striving to be independent, and many a teenager considers parents to be quite different from what most others perceive them to be.]

Nancy completed high school at Buckingham in Cambridge, Massachusetts, the school where her mother taught Biology, and went off to college, majoring in English, and later became a writer and editor. Mr. X. lost touch, but did know that she had married and had a son; he married and had a family as well. Most unfortunately, Nancy died in midlife from a brain tumor (Nancy Griffin Jackson, 1942-1993).⁵⁷ I still recall Griffin, always most reserved about personal matters, shaken, but saying to me very quietly, simply, stolidly, sadly, that his daughter had died.

The middle daughter, Margaret Griffin (Weldon), was intrigued initially by Anthropology and it became the focus of her studies as an undergraduate at McGill University in Montreal. She remembers hearing of Heloise Redfield, the American Impressionist painter and also her great aunt, and feeling inspired by her life and work.⁵⁸ Later, Margaret became an accomplished photographer and ceramic artist, living much of her life in Montreal, Canada.

I know little about Janet Griffin Abbott or Margaret's twin brother John, other than that the daughters all married and had families, while John did not. He also had a more difficult time, generally, and has passed away (1951-2015). Margaret and Janet are still living.

Comments Don made in his last years to a few friends suggest some regrets: of being too ambitious and too motivated and of its impact, of paying less attention to family than he now wished he had. For family members, that must be a heartening statement. Yet science and certain other careers are exceedingly demanding, at least as they are conducted in our contemporary and past society. Achievements with respect to personal success (however defined) within a field and achievements in scientific understanding, both of which do not have to be very highly correlated with each other, typically demand enormously intense effort. Sometimes, luck or sudden intuition plays an essential role, as does great intellectual brilliance. Persistence cannot be overestimated. Neither can the help of others. But how difficult to balance it all. I wasn't his family. I experienced only his generosity as a mentor and colleague. I experienced his scientific thinking and his enthused delight with scientific research and thought. As someone far more significant than I has said, "... who am I to judge?"⁵⁹

Jocelyn Crane Griffin (1909-1998) (Marine scientist and Griffin's 2nd wife)

Don Griffin had a second wife, Jocelyn Crane, a very serious scientist, an internationally recognized tropical marine biologist. Although divorces are almost always hurtful events, one can sense both the attractions and common interests shared by Don with both of his wives. Ruth Castle was an outgoing and very sociable person, very bright. Probably, given Don's reaction to her career choice of high school teaching, she was originally hoping to do biological research. This, Don would have admired. Ruth's warmth and sociability were good counterpoints to Don's more reserved manner, though he did grow more outgoing over the years. They both very deeply appreciated the outdoors and nature.

Children and family are both a pleasure and an effortful undertaking, effortful especially when they conflict with perceived and desired professional responsibilities. This seems to be the

case with Don Griffin. Don’s field research, which he loved and was critical to his science, took him away from Ruth and the children for extended periods of time, even sometimes during the children’s summer holidays. It may not be too surprising, therefore, that Don would likely have felt fascination, admiration and attraction to Jocelyn.

The First Time: Don and Jocelyn Meet in Trinidad



Jocelyn Crane, 1963 by John Hill

It was during Don’s first visit to the William Beebe Tropical Research Station in Simla, Trinidad in 1960, that Don and Jocelyn first met.⁶⁰ Don was there studying the general problems of bat visual detection, echolocation and, more specifically, the abilities of the strange fish-catching bats (*Noctilio leporinus*). Jocelyn had been at the station for many years in association with William Beebe, Simla’s Director Emeritus. She was, at that point, “Assistant Director” and would have been involved in granting permission for Don to do research at the station.

At the time, Jocelyn was conducting research on her life’s major project, the study of fiddler crabs, which later culminated in her 737-page major treatise, *Fiddler Crabs of the World* (1975). When Don was visiting, Jocelyn had almost completed 784 of her drawings for the book.⁶¹ It came to be regarded as “the most comprehensive work on the biology and systematics of fiddler crabs ever published,” perhaps even of *any* crab genus.⁶² Reviewers thought most highly of the work, one

terming it “a reference for generations of students.”⁶³ But that wasn’t her only research endeavor; she had, for example, also studied jumping spiders, praying mantises, katydids, and butterflies.

The initial meeting at Simla between Don and Jocelyn did not, apparently, go very well ... at least from Jocelyn’s point of view, or, rather, her point of olfaction. Some of Don’s studies of the fishing bats were conducted within a large flight cage he and his crew had constructed at the station, containing a 12-foot-long pond within it. But alas, the cage and the pond and the bats smelled; in truth, they stank. Jocelyn was most displeased. William Beebe was most displeased. It made the lively, daily social cocktail hour considerably less lively; that was the time the bats came out, and no one particularly wished to sip cocktails in an atmosphere perfumed with bat odors. So, Griffin graciously moved the cage further away. And then, sagely, he amplified the bat detectors’ rendering of the bats’ sonar streams, much to the delight of the re-gathered cocktail attendees.⁶⁴

Jocelyn’s Early Days with Beebe’s Research Team

In 1930, immediately after graduating from Smith College, North Hampton, Massachusetts, one of the elite “Seven Sisters” all-women colleges, Jocelyn became a volunteer member of William Beebe’s Research team. This had long been her dream. She had read and re-read every one of Beebe’s writings, longing for the life of science and adventuring that he seemed to personify. She had prepared as best she could. Apparently, upon arriving at Smith, she had announced that she

wanted to be a Biology major and wanted to work with Beebe. She intensely disapproved of the animals available for study at Smith; they were all pickled.⁶⁵ Having undertaken her own undergraduate naturalistic research on local mammals, she had published those studies in the *Journal of Mammalogy*;⁶⁶ that was the same journal as the young Griffin's first paper. With her scholarly prowess, she had been awarded membership in Phi Beta Kappa at Smith. Her wealthy socialite mother had even contributed funds to the Tropical Research Station run by Beebe.⁶⁷

The group Jocelyn joined was part of the Department for Tropical Research (DTR) within the New York Zoological Society (NYZS), now termed the Wildlife Conservation Society (WCS). The WCS is more commonly and simply referred to as the "Bronx Zoo," a label that doesn't even hint at the far-flung research and conservation efforts sponsored by the society. Nor was the Bronx, in New York City, Jocelyn's initial assignment. That was, to her delight, at the remote Bermuda Biological Station. There, she quickly assumed positions of greater responsibility and by 1934 was writing her own articles.⁶⁸ Her studies around Bermuda of very small planktons, specifically, copepods,⁶⁹ led to her identifying about 60 species. Half of these had never before been classified around Bermuda.⁷⁰ Gradually, her interests turned to crab species and remained largely focused there for most of the rest of her life. (A complete bibliography of all her publications is provided in Boyko's fine biographical memorial of Jocelyn Crane.)⁷¹ Jocelyn had the honor of newly identifying and naming 27 species of *Uca* (fiddler crabs), 22 spiders and 10 fish, among several other species finds. Yet despite all these accomplishments, she had never earned a science degree beyond her Bachelor's from Smith. In 1947, however, Smith College awarded Jocelyn Crane an honorary Master's degree. (I would think that an honorary Doctorate would have been more commensurate with her many achievements, but then I do admit to some bias.) She did, at a much-advanced age, finally earn a Doctorate, but in Art History, not science, more about that later.

During her association with the legendary William Beebe, which lasted until he died, she had the rare privilege of descending with him on deep dives inside the famed bathysphere. Before her, and initially while a member of Beebe's team, she was not the only very intelligent, attractive, determined young woman scientist to accompany him on the dives. Early NY Zoological Society magazines show a smiling Beebe and similarly smiling Gloria Hollister, described as "his chief assistant on many of his voyages of exploration in the late '20s and '30s."⁷² Gloria had joined Beebe's team and his first expedition to Bermuda in 1928. On June 16, 1931, as a birthday gift, Beebe invited Gloria to descend with him in the bathysphere. She thereby set a women's world record for 410 feet and set a yet further record of 1208 feet in 1934. By 1936, she was leading an exploring party of the New York Zoological Society through the jungles of British Guyana, South America, a most remarkable status and responsibility for a woman at that time. On the trek, she discovered Kaieteur Falls, five times the height of Niagara, and via light plane, 43 other waterfalls. That trip and other requirements kept her away from Beebe and his team; Jocelyn was thus assuming more of Gloria's roles.⁷³ Like Jocelyn, Gloria Hollister became an inspiration and model for other women scientists, though, compared to male scientists, much less known. Later, she married Anthony Annabel, and she and her husband devoted significant efforts to conservation programs. That included helping found the pioneer land project of the Nature Conservancy.⁷⁴ However, and whenever it came to be, later covers of the same NY Zoological Society magazine portrayed, instead of Gloria, a smiling William Beebe and Jocelyn Crane by the bathysphere.⁷⁵

Many of the dives portrayed in those photographs were truly deep, thousands of feet deep. The vehicle was a marvel of the time, a steel sphere barely big enough to hold two persons. Through small, strong quartz windows, one could see the dark oceanic world. As the bathysphere itself was unpowered, it had to be lowered and raised back to the mother ship with an attached cable. Another tube secured the phone and electricity lines and kept them dry. Tanks held pressurized oxygen, while soda-lime and calcium carbonate on the walls absorbed the exhaled carbon dioxide and moisture. At least initially, air was circulated by the passengers waving ... palm fans! And the wonders to be seen outside those windows ... bio-luminescent creatures, extraordinarily strange fish and other organisms. Beebe compared it to space and the aliens that might dwell somewhere therein.⁷⁶

So, Jocelyn was much impressed with William Beebe and his projects, but, likewise, William Beebe became impressed with Jocelyn. As described by Carol Gould in her biography of William Beebe, Jocelyn had a zeal for all her endeavors, the mysterious fiddler crabs she began to study and, indeed, her involvement in any of Beebe's projects. "She had become important to him in every aspect of life. Her grit and determination, her love of research against odds, her youth, beauty and uncomplaining willingness to shoulder the burdens of an expedition – all endeared her to him ..."⁷⁷

Jocelyn came to replace Gloria not only in the magazine photos but in Beebe's affections as well. Beebe and Jocelyn became companions in every sense of the word, working together, traveling together and, after a while, becoming romantically involved. Somehow, although they spent so much of their lives sharing work, responsibilities, far-flung expeditions and the very positive camaraderie of the research team, he never divorced his wife. That was the second, Elswyth Thane, though he and she lived apart almost all the time. Perhaps he wished to avoid the publicity and scandal that had erupted in the newspapers after the bitter divorce from his first wife, Blair Niles. Some sources say that Blair re-married the very next day or at least very shortly after their divorce. Blair, too, loved to travel and later became a well-known author and travel writer.⁷⁸

Times within the Beebe group could be most merry and "civilized," even in the most remote places. There were often afternoon cocktails, costume parties, music nights and equator-crossing ceremonies. Somehow, President Theodore Roosevelt was aware of the project's activities, including the lively socializing, noting that the group was "fortunate" to enjoy their jobs.⁷⁹

Charles William Beebe ("Will")

Writing many popular articles, Beebe fascinated the public with tropical science and the intertwined wonders and complexities of tropical ecosystems. Largely through his influence, the approach to studying animals changed. He railed against the study of dead animals in museums which comprised most of the "natural science" of the day. He insisted that animals needed to be observed in their natural environments. In that, he and Don Griffin were compatriots. In her absorbing biography, Carol Gould sees "Will" Beebe, as an "effective transition" between the Victorian natural historian, who collected and classified specimens and the modern experimental biologist.⁸⁰ At the New York Zoological Society's celebration of the 50th anniversary of Beebe's association with the Zoo, a hundred letters poured in. Admirers wrote of Beebe's brilliance and of the profound effect his life and writings had on their own appreciation of nature and even their choice of careers. Yet the world of science was rapidly changing and various professionals, Griffin included, considered Beebe to have remained a naturalist; some would say, even a "showman

naturalist." In their view, he never progressed to the position of a serious scientist who conducted experiments in the field and then extended such studies into the laboratory. As Don remarks in his personal reflections:

I'm afraid I expressed the standard reaction of academic biologists, especially physiologists, to Beebe and his work. I believe I said it was entertaining descriptive natural history, but that I was interested in more substantial analytical studies of animals. Little did I know what my future held in store for me and my attitudes!⁸¹

Griffin's attitude toward the scientific work of Simla likewise changed after his first visit. He was extraordinarily impressed, particularly by the rigorous work conducted by Jocelyn Crane.⁸²

Beebe likewise faced criticism for such "unprofessional" actions as choosing to have women on his research teams. He even recruited artists, historians, writers and scientists from diverse fields for his expeditions. Thereby, he promoted the careers of several successful women scientists and artists, besides that of Jocelyn Crane. Among them were such luminaries as Gloria Hollister and the heartfelt environmentalist Rachel Carson. His use of artists was most sensible. Given the state of photographic technology during much of Beebe's time, careful artistry was essential in capturing the intricacies of the strange creatures of the dark deep. Sometimes the artists did have models, specimens dragged up from far below, either dead or in some altered state of life that remained after enduring the great pressure change from deep sea to the surface. Other times, the artists descended in diving gear with zinc tablets and oils to paint what they could. And often they were guided only by the descriptions from Beebe conveyed over the telephone system rigged between the bathysphere and mother ship.⁸³

A Worldwide Traveling Scientist

As noted, Jocelyn was, at the time she and Don met at Simla, a very well-respected scientist. She had often conferred with scientists and conducted research in far-flung parts of the world. From these journeys and the associated work, she had published both scholarly and popular articles, even some for children. The sites included treks to Zanzibar, Iraq, Venezuela, Malaysia and, of course, Trinidad, the home then of Simla.⁸⁴ Perhaps one of her most audacious and adventurous trips was a 1936 expedition to Iraq, studying Kurdistan's flora and fauna, traveling 12,000 miles across Palestine and the deserts of Syria all the way to Baghdad. Later travels included Australia, Japan, Afghanistan, and, of course, more familiar European regions.⁸⁵

Fiddler Crabs ... Live

Fascinating though they were, Jocelyn's occasional descents with Beebe in the bathysphere were not at all the focus of her endeavors. Her major book about fiddler crabs has been noted.⁸⁶ In it, derived from her own observations and existent scientific literature, were descriptions of the species she had studied, their habitats, their behavior, including communication, and all she could determine about their social lives and social structure. In addition to the highly respected monograph, she had also published numerous reports and journal articles about the fiddlers.⁸⁷ She was, like other biological scientists of her time, quite conservative in her descriptions of the fiddlers' behavior. While her popular articles might entail mentalistic terms, her professional journal publications utilized the classic terminology of biology and ethology. In particular, Jocelyn wrote of the fiddlers' "intention movements," *not* of their intentions.



Jocelyn Crane “immersed” in her fiddler crab studies
(by Milo Woodbridge Williams)



Male Fiddler Crab displaying its large claw
(by Elvira Draat)

Fiddler Crabs (*Uca*)

The fiddlers *are* intriguing. As small crabs, the largest species achieve a size of only two inches. They are sexually dimorphic, meaning that the male and female differ in physical characteristics, specifically, the males have one very large, oversized claw. It is completely useless for eating; the smaller claw has to retrieve and bring tidbits to the mouth and then discard the detritus in very small balls on the sand. It was the fiddler's use of its appendages in ritualized communication that particularly enthralled Jocelyn Crane. The large claw is especially critical in postures, acoustic signals and visual displays used to threaten a male rival or to entice a female into mating. The smaller claw "fiddles" like a bow, stridulating or rubbing across the larger claw to produce sound in some displays; hence the crab's common name. The vigor of that waving as well as the mere size of the large claw are strong determinants of the female's mate choice. Presumably, that vigor denotes particularly good health and good genes to pass on to offspring. In her broad-ranging study of *Uca*, Jocelyn observed that combat behavior and threat postures were very similar across species, but visual displays, particularly those used for mating, including rhythmic movements of the appendages, were definitely species-specific.

Despite the aggressive claw displays, or rather, because of them, actual combat seldom reaches maximum intensity, and serious injury virtually never occurs. The appeasement gestures used to forestall actual battle include such subtleties as turning away the major cheliped (claw). When deterrents are inadequate, the loser sometimes gives up his burrow. This is serious. At low tide, when the fiddler is foraging, gills needed for oxygen supply need to be kept moist to absorb oxygen from the air or water. A quick dart back to the water in its burrow solves any difficulty. Similarly, the female carrying his fertilized eggs needs the burrow for water and a home. Occasionally, the loser does not court afterward for varying periods of time (Crane, J., 1966).

Like other animal species, a male fiddler sometimes bluffs. When a claw is lost, in some species, the small claw grows to become larger, while the lost claw site will regenerate into a small claw. In other cases, the lost claw site creates a large claw, but it is quite weak. Its size, however, still (falsely) intimidates its male rivals (Callander et al., 2013).

Yet another intriguing detail about the crabs is their responsiveness to the diurnal cycle and tidal rhythms. Their color changes, becoming lighter in the day and darker at night, providing better camouflage and lessening chances of detection by predators (Smith, T. & Smith, R., 2012). The crabs are thought to impact the substrate quite positively: their mode of eating, picking up pieces of sediment, is believed to help aerate the ground, helping prevent anaerobic conditions. Many of these details were not known in Jocelyn Crane's time. Her work, however, including her discussions of the likely evolutionary origins of *Uca* displays and broader comparisons to vertebrate species, helped inspire continuing research. An example is the Rockefeller Ph.D. thesis of Beverly Greenspan, to be described in another chapter.

Searching for a Research Paradise

While Jocelyn steadfastly and enthusiastically continued her research endeavors, her administrative responsibilities grew ever more. When the Department of Tropical Research worked in Venezuela, it was she who was charged to find a new site for a station (1944). To do so, "on horseback, in small planes, or on foot, she trekked from site to site."⁸⁸ She chose El Rancho Grande, a large, unused building, situated 3,000 feet high in Venezuela's cloud forest mountains. Originally, it was to have been the grand retreat of Juan Vicente Gomez, one of Venezuela's dictators, though

he died before its completion. When Jocelyn saw it, the buildings were largely dilapidated, with leaking ceilings and many, many jungle creatures as inhabitants, but ... some usable parts. It was a magnificent site ... with bright macaws and toucans cawing and leisurely flying by⁸⁹ and fourteen different faunal zones.⁹⁰ With great effort, initial financial help from Creole Petroleum (a Venezuelan spin-off from Standard Oil) and permission of the Venezuelan government to use the site, the team of the DTR settled into their challenging but, in so many ways, splendiferous establishment. (Creole Petroleum was the same oil company that later (1953) lent their facilities, the company's camp, for use by Griffin and the Phelps's entourage as they searched for echolocating oilbirds in a nearby cave. That cave, the "El Cuavo del Guácharos," was the same one where Humboldt had found oilbirds a century and a half earlier.^{91,92}

It was at Rancho Grande, far from the muddy shores of her fiddler crabs, that Jocelyn became fascinated with small salticid jumping spiders. Like her fiddler crabs, these communicated by waving, not claws, but their small legs, to signal courtship or aggression.⁹³ Yet only two full seasons of rewarding work were afforded her and the team, these in 1945 and 1946. The group was grounded in 1947. According to the annual report, the team had so much useful material, that they needed a year away for analysis. In reality, funding had become extremely limited and the Venezuelan politics and government were in turmoil. In 1948, Beebe struggled to conduct research at Rancho Grande while hassling with government officials over new fees, the sudden appearance of new "licenses" needed for various pieces of equipment and other straight-out bribes. That same season, Jocelyn was off on a side trip to find a new site, but not, after Beebe's frustrations, ever again in Venezuela. This time the search was in Tobago and Trinidad, countries of less political upheaval.⁹⁴ She found another "paradise," this time in Trinidad. Beebe himself purchased that family estate of over 200 acres in the Arima Valley of Trinidad's northern mountain region. "Simla," it was to be called. Beebe named it after a charming site in India's Himalayan mountains, where he had studied pheasants.⁹⁵ That work had resulted in Beebe's massive four volumes, "A Monograph of the Pheasants."⁹⁶ Beebe donated Simla to the New York Zoological Society in 1950,⁹⁷ and the site became the permanent location for the Tropical Research Station. Jocelyn managed both the Venezuelan and Trinidadian stations.

Changes

But Beebe was becoming older. Born in 1877, he was 32 years Jocelyn's senior. In 1952, aged 75, he retired. While he remained Director Emeritus of the Department of Tropical Research, she became Assistant Director (1962).⁹⁸ After a time, he gradually grew weaker, suffering occasional minor strokes, but remained, for the most part, at the Trinidad station. Jocelyn continued to nurse and care for him until, fairly suddenly, he passed away on June 4, 1962.⁹⁹ After Beebe's death, in 1963, Jocelyn Crane became Director of the NYZS Tropical Research Department (which included the research station in Simla).¹⁰⁰ In 1966, she became Administrator of Simla, renamed to be the William Beebe Tropical Research Station.¹⁰¹

As noted, Don Griffin and Jocelyn apparently had first encountered each other at Simla in the summer of 1960, at a time when Beebe's demise must have seemed a looming conclusion. It is likely though, that Don and Jocelyn already knew of each other's work. It's also highly likely they even corresponded, at least during arrangements for Don's visiting the Simla research station. However, as Don continued expeditions there through August 1969, a student recalls quite a

different view of the rather reserved Donald Griffin. It was a tropical night, with the moon beaming through the lush, tropical forest, music playing, and Don and Jocelyn dancing together in that moonlight.

Don and Jocelyn married in December 1965. He had also left Harvard and moved to Rockefeller University, New York before that, in June 1965. There he had accepted a position as Professor and Director of the new Institute of Research in Animal Behavior (IRAB); he was instrumental in its development. However, the bonds between Jocelyn and Don must have been strong before that. For example, a colleague mentioned how, suddenly in June 1962, during Don's 1961 academic year sabbatical in London, Don had to rush off to Trinidad. One presumes this must have been to aid Jocelyn at the death of William Beebe. And in the summer of 1964, when Don was in Trinidad, overseeing his students' research, he and Jocelyn invited his student Timothy Williams and his new wife Janet to join them for a few days' trip to Tobago. A delightful short vacation, and only later did the Williams realize that they were to be seen as "chaperones" for Don and Jocelyn. As Director of Simla, Jocelyn thought it unseemly for her to be seen going off on her own with one of the visiting scientists. According to Tim, neither he nor Janet provided much chaperoning.

Yet, at least before the divorce, relations between Don and Ruth seem to have continued to be cordial. They were possibly driven, at least in part, by economic necessity. Even comparatively well-paid professors of the time still did not have high salaries. In the early mid-'60s, the Griffins were still living together in a home in Cambridge and had welcomed the family friend, David Pye, for a visit. During this time, as Don took David and several students out for a "batting" expedition, the VW microbus Don was driving was hit by a car and overturned. Don was badly injured with multiple pelvic fractures. A student endured a broken collar bone. Everyone else was badly shaken. Fortunately, someone came to calm them, a neighbor "medically" administering some shots of whiskey. "Batting" has its own small world: that neighbor was Kenneth Roeder, who studied moth sonar detection and bat avoidance by moths. Throughout the episode, Ruth was gracious and helpful, noted Pye. Luckily, she had not been in the car. Afterward, the not-then-legally-required seat belts were installed in the family and research vehicles.¹⁰²

Sometime after this, Don and Ruth were legally divorced. To manage such with the least hassle, he'd managed to live the required minimum number of months in Nevada needed to obtain a divorce granted by that state. Although he visited Beatrix and Allen Gardner, I believe he did not have the opportunity to visit their ape language project with the chimpanzee Washoe at the University of Nevada, Reno. That type of communicative intervention came to intrigue Griffin with its possibilities for two-way communication.

Directions from a Woman!

After Don and Jocelyn married, she was managing Simla from afar, because she had also become a Senior Research Zoologist with the Institute for Research on Animal Behavior (IRAB) (1966-1971).¹⁰³ Don was, at that time, the Director of IRAB, which was jointly operated by Rockefeller University and the NYZS. Thus, she lived both in New York City (NYC) and the mountains of Trinidad, flying back and forth. She wrote endless letters to prod the Simla staff to follow through on the many, many management tasks of running a station in the tropical mountains with difficult and tedious access to supplies. There was no internet, email or even functioning

telephone communication between the station and NYC. The road to a town with a phone was bad and even worse in the frequent rainy and muddy weather.

How the staff, in particular, Dr. A,¹⁰⁴ the Assistant Director of the Simla station, did rankle from being given instruction by a woman! This was the case, both when Jocelyn was first “Director” and later “Administrator.” Of course, she had managed many of the same tasks during the long years when Beebe was “Director Emeritus,” but then she had Beebe as her protector and she did not yet have either of the titles that Dr. A., in particular, would have liked. It should also be said, that Jocelyn ran a “tight ship.” Tasks were to be done, done on schedule and the end production was to be a worthy and robust accomplishment that met her high criteria.

In daily living standards at Simla, Jocelyn continued the Beebe tradition of a “civilized,” actually British Colonial, style. As described earlier,¹⁰⁵ the evenings began with cocktails and a fine multi-course dinner, all carefully overseen by Jocelyn Crane.

While Jocelyn held these management positions, tensions grew steadily. At first, Jocelyn reacted by generally avoiding being there when Dr. A. was present at the station. Later, she absolutely refused to be at the station if he was present. There were innumerable, clear indications, all documented in a volume of correspondence between him, Jocelyn Crane and Donald Griffin, that Dr. A. simply was not doing his job.¹⁰⁶ At this point, Don was Director of IRAB, and, as such, responsible to the NYZS for certain of its operations. In particular, he had oversight of the Department of Tropical Research (DTR) and the Simla facility.¹⁰⁷ In short, he was “above” the Simla Administrator, Jocelyn, and was Dr. A.’s “boss.” What ensued seemed inevitable. After conferring with Fairfield Osborne, the President of the New York Zoological Society,¹⁰⁸ it was agreed that Dr. A. would not become the next Director of the Simla station. Rather, he must leave. In the end, Dr. A. resigned, and in case he had not, Don had composed and ready, a letter firing him.¹⁰⁹ It was truly a sad state of affairs because the young Dr. A. and his wife had been quite good friends with Don and particularly with Jocelyn. Again, numerous, warm letters attest to that.¹¹⁰ To work at the Simla station, Dr. A. noted that he had left a secure university position,¹¹¹ planning to conduct his research on grasshoppers, butterflies and other insects, and do the required administrative tasks. He would live the often-adventurous life of a natural scientist dwelling almost as close to nature as one could in the beautiful cloud mountains. He did do all that, unfortunately even apparently purchasing a house and furnishings before his “resignation” (1966).¹¹²

Don’s last trip to Simla was in August 1969.¹¹³ Finally, Don and Jocelyn did resign from their associations with the station. Afterward, difficulties in managing the station continued, and, in 1970, it was closed, due to rising maintenance costs. Dormant until 1974, the NYZS then donated the facility to the non-profit conservationist and educational trust, the Asa Wright Nature Center (AWNC). To this day, the AWNC maintains the William Beebe Tropical Research Station, supporting research there, while continuing to assume annual deficits.¹¹⁴

Dwelling within the “Calm” of New York City

When Don and Jocelyn left all that, escaping to the “calm” of New York City and Rockefeller University, they lived in Jocelyn’s apartment. That flat was in the Hotel des Artistes at 1 West 67th Street, Manhattan. It was elegant, bequeathed to her by William Beebe. Eighteen majestic stories high, with a Gothic-style façade and marvelous gargoyles of artists and writers, the building was mere steps from Central Park.¹¹⁵ Beebe had had his own sun-drenched studio in the penthouse

there, while he kept as his residence, his own larger apartment just slightly down the street at 33 W 67th Street. When Beebe had originally purchased the penthouse studio, "L' Hotel des Artistes" was considered quite a "bohemian" sort of place. It was exactly that aura that attracted Beebe, with his circle of intellectual and artistic friends.¹¹⁶ Even now, as the residence of many a successful artist or musician, the tree-lined avenue is often referred to as "Artists Row."

It was for propriety's sake that Beebe had established the separate flat for Jocelyn, helping her lease, then purchasing it. "... nothing was ever acknowledged publicly about their relationship" and, according to the Gould biography, Beebe seemed to believe the relationship remained a secret.¹¹⁷ Jocelyn, or "Jocie" as Don called her, was also elegant and sophisticated. When we'd meet sometimes at one of their favorite New York City restaurants, she was always very well-dressed. Similarly, when we dined together in later times after they'd moved to a retirement community in Lexington, Massachusetts, she was always very mindful of her appearance. She was fashionable, though, at that time, perhaps, fashionable for some earlier period. Always, dresses or skirts, never slacks. Her hair was always well-groomed, her makeup in order. In her later days, I did notice, sometimes, the lipstick was just a little "off" ... a little jagged in outline. I would guess, though I do not know, that eyesight was a contributing problem. Don would wear a tie and jacket. In each locale, they tended to have a few, favorite restaurants, which they frequented. One, where I too ate with them, was Manhattan's "Malaga," a long-enduring Spanish restaurant, though no longer existing. Another particular favorite was "Grasslands" on Lexington Avenue, also gone. The evening would begin with a Martini, and the familiar waiter would know that order as they entered and likewise just how to make it to their specifications.

Sometimes the stunning apartment served as the gathering spot for entertaining graduate students or faculty. Most often, since Jocelyn "did not cook," all shared drinks at the Griffin home and then departed to a restaurant. Jocelyn might have greeted the guests as she stood on the second-floor interior balcony overlooking the first floor below. Glass walls opened the space yet further, affording views of the city and tree-lined avenue. Other walls were of a beautiful fine wood, perhaps chestnut. Some would tease Don that he had married Jocelyn for her apartment. Others noted that Don seemed a bit uncomfortable to be ensconced in quite such luxurious quarters.

Fiddler Crabs: Live and Dead

Yet much of Jocelyn Crane's life had not been spent in elegant clothes and often not in luxurious accommodations. She most happily tromped around in the tropical bush and sloshed in the muddy muck at the edge of many of the world's waters. There she found innumerable species of Fiddler Crabs. I captured some with her instructions in Puerto Rico as I was leaving after my own fieldwork. The particular species of interest was to be found, she told me, at another edge, the edge of the airport. I did get there, surveying the area for both planes and personnel who might be overseeing this "forbidden" territory. Not for her, these crabs, but for a Rockefeller University graduate student she was helping advise; he was to use them for his neurophysiological research. Alas, the airlines refused to let me take them on board and the box of live crabs was stuffed into the baggage hold ... and, as was even more frequent those days, lost. So was my entire set of audio recordings and research notes, which the airlines also refused on board. I was terrified. This was my first field trip; the beginning of my postdoctoral studies at Rockefeller University! I wrote the airlines, telephoned, wrote again, proclaimed that the contents were scientific data, and noted that

the boxes could probably be located now by their odor of dead and decaying fiddler crabs ... to no avail. Finally, after my few frantic weeks, Professor Marler, in whose lab I was conducting my postdoctoral work, asked about some of my initial findings from the Puerto Rico trip. I shamefacedly explained what had happened. Then, magic, or should I say corporate/big foundation/big bank magic. A top RU administrator called the airlines and voila, within a couple of days, all were located. It was on its way back to me at the Rockefeller University. Of course, the especially sought-after fiddler crabs were beyond dead and extraordinarily smelly, but my data were intact. Never underestimate the power of power.

While Don was at Rockefeller University, Jocelyn, officially affiliated with IRAB, had an office at the zoo. She was completing her previously mentioned magnum opus, *Fiddler Crabs of the World*. Although she did not have an official appointment at Rockefeller itself, she graciously volunteered her mentoring to some of the graduate students. Besides the student whose hoped-for Puerto Rican fiddler crabs never arrived alive, she helped advise Beverly Greenspan. Beverly, had initially intended to study bats with Don Griffin. Gradually, she became more fascinated by the behaviors of the fiddler crabs and by the phenomenon of “leks” in sage grouse, being studied by another RU graduate student, R. Haven Wiley.¹¹⁸ She combined these interests for her Ph.D. thesis.¹¹⁹

Jocelyn Crane ... A Model for Women Scientists

As a very successful woman scientist, Jocelyn was a model to other aspiring professional women. She, like Griffin, was a “tough” scientist. One did what was necessary to get the job done. Inconvenience be damned! Carol Gould relates some telling incidents. Carol was and is the wife of James Gould, then an RU Griffin graduate student. She later became a well-established science writer, including co-writing almost a dozen books with Jim. At some point after their time at Rockefeller, Carol and Jim had the first of three children. Jocelyn was, in Carol’s words, “Appalled.” “Working gals” didn’t do that. In fact, no one on Beebe’s team had a family. Even plants, though flourishing in the tropics and grown so easily there, were, outside of that supportive environment, an “interference” with life’s more significant tasks. Beautiful though they were, and Jocelyn did deeply appreciate beautiful things, plants took care and maintenance.

And cooking? Well, living in the magnificent apartment at the Hotel des Artistes had definite advantages. Each apartment had a dumbwaiter. Below was New Yorkers’ beloved restaurant, Cafes des Artistes and its fine food. The wealthy dwellers in the building didn’t cook. An order was placed, and hot, excellently prepared cuisine arrived via the dumbwaiter to one’s apartment. So, too, often with the Griffins, under Jocelyn’s management. There was, however, a tell-tale book in Jocelyn’s library, a cookbook, *The Working Girl Must Eat*, published in 1938; it is still available as vintage copies. In the introduction, the author, Hazel Young, speaks of “this business of meal-getting ... quite a chore ... We are emancipated and can ‘live our own lives!’ We are free to work all day ... and then rush home and get our own and possibly our husband’s dinner.” With almost a hundred “easy to get” dinner recipes in the cookbook, the girl can still be “smiling when dinner is on the table.” Presumably this “gal” who “didn’t cook” ... did, at least sometimes.

At Rockefeller, though continuing her own work, Jocelyn was, as always, an unofficial helpmate to Don. That might entail staying up at the R.U. Field station in Millbrook, New York as Don and students continued their batting work or bird navigation studies, or in yet other locales. She sometimes even joined them on a trek to other radar sites; assisting as needed in the research.

(The radar apparatus was transportable). On a batting trip to Italy, along with Griffin and Jim Simmons, she had earnestly taught them various useful phrases in Italian, one of several languages in which she was fluent. They learned several sentences ready for emergency use, should the occasion arise. In particular, if necessary, as Don and Jim might lay a ladder against an Italian house, they knew how to say, "Oh no, sir. We are not trying to abscond with your daughter; we are trying to reach the bats under your roof."¹²⁰

Recreating the Tropics and More Travel

Jocelyn had loved the tropics where she'd spent most of her life. She still loved the tropics and missed them terribly, having returned to the northeastern USA. When Don retired from Rockefeller University, he attempted to recreate a bit of the tropics for her. These tropics were to appear in Princeton, where they had moved as retirees, and where they lived for several years. (Griffin had both official and unofficial affiliations with the Princeton University Biology Department, which afforded him office space and the opportunity to interact with colleagues and students and occasionally lecture.) Don had a carpenter attach a sunny, glass greenhouse room to their Princeton home. Jocelyn filled the glassed-in garden with the bright colors she loved, splendid flowers and plants. I recall, especially, her flourishing Hibiscus plants. The plants, allowed to grow in a tropical environment, did so, quite readily and, apparently, were an acceptable additional task at this period of her life. She gave me one very large, beautiful, intensely red Hibiscus, which, alas with no warm, moist greenhouse in which to dwell, lasted, but not very long. My dry New York City house with a northern exposure and myself, a not very talented gardener, did not make for long, happy plant lives.

For most of her life, Jocelyn had traveled extensively and still loved to travel, considerably more so than Don. They usually journeyed together. Their voyage to Kabul in Afghanistan, Tashkent in Uzbekistan and finally Leningrad (renamed St. Petersburg) in Russia has already been described.¹²¹ That expedition, as many of Jocelyn's travels, involved carefully planned trips to remaining ancient and more modern artworks. In Leningrad, while Jocelyn was visiting the famed Hermitage Museum, Don met with Konstantinov, a Russian bat researcher. Very occasionally, Jocelyn went by herself and, in earlier days, sometimes with her mother. Don's resistance to traveling always had something to do with his ongoing research or writing, even and certainly after his so-called "retirement." He mused once, after she had died, that he should have traveled more with her. Others recalled how extensively they *did* travel together.¹²²

A Scientist Enters the World of Art History

Sometimes, in post-Trinidad days, Jocelyn's journeys were intended simply to travel and explore, though often to art destinations. Examining art relevant to her next major projects also became a key goal; the projects were her Ph.D. studies and then her intended book. Having spent almost a lifetime studying fiddler crabs and intrigued by the communicative use of their complex claw gestures, she became intrigued by the human use of gestures as depicted in art. She focused particularly on the illuminated manuscripts of Medieval times. Among other messages, fiddler crabs could communicate a readiness to mate or to attack the recipient crab. What was being revealed in the sometimes subtle hand and finger gestures of persons portrayed in the manuscripts?

Innumerable obstacles appeared in the course of Jocelyn Crane's Ph. D. studies. In particular, Jocelyn was a scientist, and her methods of studying art included statistical analysis of gesture type in different contexts, by different individuals, in different social classes. This was simply anathema to the faculty on her committee; such wasn't the approach of critical artistic analysis! Overcoming this and other obstacles, she finally earned her Ph.D. in Art History in 1991 from the Institute of Fine Arts of New York University.¹²³ Drawing from this academic manuscript, she was writing a more popular book, *Talking Fingers*, but she passed away before completing her endeavor.¹²⁴

She worked most diligently on her dissertation and the book. I recall when visiting, as Don and I went off on our peregrinations into the woods to a beaver pond or some such, she would beg to stay, nestled away in a cubby with her writing. Later, we all gathered for dinner. On my visits to them, it was Don I knew best, and so we tended to dominate the conversation. Most enthusiastically, we would discuss the latest in animal communication or the strange and wonderful behaviors of the plovers I was studying or his or our colleagues' research animals and projects. Unless particularly questioned, Jocelyn usually listened, making the occasional apt comment.

A Million Dollar Question

Yet it was Jocelyn who provoked my field research with chimpanzees and co-incidentally an entire change in my life. That transformation included the continent where I would live on and off for over 10 years, and, indeed, find my future husband. It began over dinner one evening in a Manhattan restaurant. She asked each of us, "What would you do if you had a million dollars in research funds?" Don replied, citing some instrumentation and equipment he would use to study insects. I believe, he particularly intended to investigate bees' communication, probably the "near-field acoustics." I paused and recalled the work I had done researching and writing to review a few recent books about the Ape Language Projects.¹²⁵ Instead, it had become a multi-year project comparing all the ape language projects, traveling to visit some, and drawing comparisons to human children's language and cognitive development. I truly felt I deserved to witness these primates in the wild and observe their cognitive and communicative behavior in their natural lives. Enough of written descriptions of experiments with caged great apes and attempting to analyze and critique the experimental designs. As I walked back home that night, I began to realize that I did not need a million dollars. I could do this far less expensively. And I did! I was on a shoestring budget, traveling in rickety cars and buses in Africa, using some of my own funds, largely my own accumulated equipment and a very small grant from the Psychology Department where I taught at Barnard College of Columbia University. One day in Nigeria, as I trekked through the rainforest, I had a sudden realization. I was funding the wages of the porters, cook and guide who helped me, feeding them, and paying the research fees for using the Gashaka Gumti National Park's land. And I was able to do this on less than it cost me to travel each day in New York City back and forth between Barnard and my home outside Manhattan. Yes, the exchange rate was biased towards the benefit of the US dollar, the salaries were very small as were the research fees, but the staff *did* eat heartily. Faced with the task of creating their morning's beverage, they faced a decision. To them, it was a choice between luxuries: instant Nescafe (coffee), tea bags, and Milo (a chocolate and malt powder popular in parts of Africa and other places). Both sugar and Nido (powdered milk) were

available to add to the mix. They used *all* of the above ... and in copious amounts. It was all a splendid undertaking for everyone involved. And it could be done!

I wish I could say, "Thank you, Jocelyn." Now, I regret not trying to engage her further in conversations. She was so modest that only now, as I write of her, have I become aware of all that fascinated Jocelyn Crane and all that she accomplished in her lifetime. I shall end with Don's dedication to her in his final book, *Animal Minds: Beyond Cognition to Consciousness*: "To the Memory of Jocelyn Crane My Love and Inspiration."

Elizabeth (Betsy) Weaver (1921-2008)

Betsy Weaver in Barnstable

It was a warm summer's day in Barnstable, in late August 2007, when I last saw Betsy Weaver (Elizabeth Chadwick (Edwards Clark) Weaver).¹²⁶ Don had passed away in 2003; they had been close friends, knowing each other since childhood times in Barnstable. We sat outdoors in her screened porch ... a simple affair, with a few chairs, a small table ... perhaps a lounging chair at the other end. Outside were overgrown grasses, but it was green and pleasant ... it felt like a porch somewhere in the countryside. The day was sunny. She was serving us all tea and we were munching on the bakery goods we'd brought.

"We" were Betsy, myself and Wendy Williams, my friend, a journalist, travel writer and non-fiction author whose book, *Cape Wind*,¹²⁷ had just been published. It focused on a project to set up windmills in the waters of Cape Cod. Wendy knew much about Cape Cod, but was one of the "newcomers," as she'd lived in Mashpee on the Cape for only about 30 years.¹²⁸ Betsy was from one of "the families." Her's stretched back six generations in Barnstable, where her grandmother had once owned much of the land. Betsy was a relative of Lothrop, who was considered by most to have been the founder of Barnstable,¹²⁹ but then again, many, many of the Barnstable inhabitants claimed to be related in some way to Lothrop. Betsy, most probably, actually was.

Yesterday had been her birthday, the 86th. A couple of days before that had been the memorial for her cousin who had passed away ... the family had gathered for both and had left only hours before.

Though Betsy had traveled very, very widely and had lived several years with her second husband in Texas and then an even longer time in Lexington, Massachusetts, it does seem that Barnstable was "home." She had retired there in 1990 with her husband. After he had passed away, she stayed on for her last years, close to much of her remaining family and to old friends. In the summertime, her sister Sarah¹³⁰ lived in the house up the driveway on the other side of the Barnstable library, the historic Sturgis library; her brother James¹³¹ was nearby also. All the phones were listed under her name. Betsy lived in Barnstable all year round.

Her house was not presupposing. A typical bleached Cape Cod cedar-shingled home, one of the very old ones, perhaps over 100 or 100s of years old. It was up the road, back from the road ... unseen from the main street through Barnstable, conveniently termed "Main Street." I'd been inside on other occasions. Mostly, I recall the "splatter paint" on her painted, wooden planked kitchen floor, which she had just been re-doing ... herself. "Splatter painting" was typically composed of small drips, often of various colors; it was pre-Jackson Pollock and a traditional Cape Cod mode of decoration. Apparently, the technique had originated on sandy, coastal Cape Cod and had largely been confined to those areas. Of course, "spatter-dashing," as it was also called,¹³² was an

inexpensive way to use up the remnants of old paint. It also created a surface that was both decorative and helpful camouflage for any new spots and stains, in particular, the grains of sand that were inevitably traipsed into homes of that region.

On the sunny August afternoon, Betsy reminisced about former days in Barnstable and the Cape. [No motels or hotels were or are permitted in Barnstable village, the historic area of Barnstable where she lived.] Earlier, when her grandmother was little, when Hyannis had been a “nice place,” it had also been the end of the railroad line from Boston. Today, by Cape Cod standards, Hyannis is an important, bustling, commercial town in the middle Cape. Part of that railroad line is a very popular hiking and biking path on the Cape. In her grandmother’s time, the trains were taken off the section to Barnstable. The arrival of additional people, visitors not “of” the area, was not appreciated. Nor, repeating the words of Betsy’s brother James, were additional parking spaces welcomed. They were hated more than new big buildings. Similarly, developers were regarded distrustfully. One of them, Bornstein, was mentioned. He had been born on the Cape but the “family was not *from* here.” He tried to create developments in Barnstable, but he, like the others, had been successfully stopped. Appallingly, he’d even put up a fake windmill somewhere to enhance “local color!”

Like many of the Barnstable inhabitants, Betsy was most proud of Barnstable and dismissive of the “other” areas, in particular the “Southside.” That was the site of golf clubs, upscale housing developments and even shopping malls. In the regions around Barnstable, there were University people, also some poorer folks, Betsy noted. But then, also on the Southside, was “Osterville,” with its grand ocean view estates, at least one gated community, and two private country clubs - people “go there and are simply not heard of again.” “Originally,” she mused, “Barnstable and Nantucket were not wealthy areas, but not so now. Now, in Nantucket, they’ve laid brick sidewalks ... truly foolish besides being expensive. Heaved up by each winter’s frost, they’re a danger to walkers,” she complained.

And then she recalled the incident of the rock music at the 5-year-old’s birthday party, loud rock music, very loud rock music. Betsy had just brought her deaf aunt back home from the hospital. Presumably, the music didn’t bother that aunt, but it annoyed the rest of the family. A phone call was made to the authorities, noting the aunt was recuperating from her hospital stay, but declining to mention her lack of hearing. The music was, almost immediately, turned way down. Betsy remarked, decades later, to us, “That is *not* music. Take it to Hyannis, where they will probably like it.”

In short, for a few families, Barnstable remained, perhaps remains, a town of privilege and only certain sorts of civilized behavior.

Boating, too, was enjoyed, both in Barnstable and otherwise on the Cape. In Barnstable, sailboats were the acceptable sort of craft, not yachts, not powerboats. Betsy, like Don, loved sailing. And just as she fixed “stuff” around the house herself, whenever possible, and was spatter-dashing the floor herself, so she had built herself a wooden sailboat. That was several years before, at age 75; she continued to use that boat.

A Conservationist

As an ardent conservationist, Betsy had fought fiercely to protect the natural environment. Most likely, she would have preferred alternative energies to oil and gas. However, one might

reasonably guess that she would have looked somewhat askance at the proposition to build windmills in the midst of Nantucket's waters. That proposal provoked much hostile reaction from the "ordinary folk" of Cape Cod and, especially, from both the wealthy conservative and liberal landholders of Nantucket and Hyannis. They did not wish their vistas to be despoiled by the "unsightly" windmills. This agreement served as one of the few occasions when both the liberal Democratic Kennedys and Republican Governor Mitt Romney joined forces.

What would have been seen if the windmills were erected? Sailors who ventured offshore could have gone to see them up close. Onshore perspectives might have offered distant views of small objects, beyond the far horizon. Often, the windmills would probably have been out of sight, hidden by the thick fogs that characterize Cape Cod. To this day, no such windmills have been built. The book by Wendy Williams and Robert Whitcomb, though offering both sides of the story, was decidedly in favor of the windmills.¹³³ Betsy, in a typical well-bred New England manner, did not raise the topic during our visit. Neither did we.

Trying to be an Independent Girl and Young Woman in Barnstable

But of Betsy. She was a striking woman, indeed a beautiful one. She spoke of the one time she recalled being "elegant." It was the occasion I think, when a young man, most handsome, from one of the "families," was about to be married. Speaking to Betsy about the wedding, he said, "You can't dress like that." He swept up her hair and placed a hat upon her head, the rim bedecked with a very solid bird. Somehow, there was a dress involved ... and there she was! As she looked in the mirror, she *did* see herself as "elegant."

In fact, she was both elegant and a tomboy, both in her youth and still at 86. She had had one sister and four brothers, and thought the boys' activities were always much more interesting than the girls.' When the boys wouldn't let her play, she practiced very hard to be better. Then, she thought, they would let her join them. They didn't! I asked if she thought they wouldn't let her join their games because she was a girl or because they feared that she might beat them? She didn't seem to know. Later, they let other girls play, the very beautiful ones who lived down the street, but not their sister.

Don let her play ... that is, he took her sailing with him. From age 11, she went crewing with Don on his sailboat. About six years older than she was, he was deemed "responsible." All the parents, even Don's, were quite content to let their children go out on the water, which was usually just Barnstable Harbor. Age 10 seemed to be considered sufficiently mature and capable to go off sailing by oneself. When the winds were too strong for racing, many a parent would pronounce, in good, tough Yankee fashion, "Nonsense! Just go sailing, not racing."¹³⁴

Recalling her Grandmother's comments, Betsy remarked how Don had been considered a "sickly" child and overprotected by his "rather Victorian" parents. On one occasion, Don, as a "responsible" teenager had taken Betsy out in his sailboat. Suddenly, a storm burst through. Betsy was covered with sea water whipped up around the boat. Quite convinced they were going to capsize, she was terrified; they didn't and she continued to sail with Don.

Racing *did* have some safeguards provided for the children. Though disparaged for his choice of vessel, Mr. Chase, the owner of the only powerboat in the Yachting Club community of Barnstable boat owners, was a rescuer. He participated in the races as the potential savior of

capsized sailboats. To the chagrin of the ignominious sailors, they and their boat would be towed slowly back to safety.

Betsy's youthful summers were typically spent with siblings and extended family in her grandparents' Barnstable home. This was the very house where her grandmother had been born. It was where Grandmother had sometimes entertained the older generation of Redfields, who also spent at least their summers in Barnstable. Betsy's uncle also summered in Barnstable, and ... he kept horses. Betsy loved horses. In the summers, she got to "exercise" them in Barnstable; when she was at Radcliffe, she "exercised" them at her uncle's Brookline, Massachusetts home.

Since Betsy's father had been a career military officer, she had moved with her family to his various postings. She was an undergraduate, then graduate student at Radcliffe College, completing a Harvard Master's in Chemistry in 1942.¹³⁵ At Radcliffe, she was a contemporary of Ruth Castle, who was to be the future wife of Don Griffin. But, Betsy assured me, she had "other interests;" she was not interested in Don as a potential husband.¹³⁶

Even at college, she chafed at the greater freedom afforded the boys; girls were to be "protected," like it or not. At one point during those years, when back at home, the worried housemaid exclaimed to her, "Oh, Miss Betsy. Your grandmother is looking for you." Whatever her transgression or curfew she had flouted resulted in Betsy's being confined to quarters for a month. In an attempt to regain her freedom, she wrote a long, playful letter to her father, hoping to win him over as an ally. But his reply exhibited no sympathy for her plight. With considerable irritation, over a half-century later, she pronounced to us, "My brothers could do anything they wanted!"

Marriage and not a Ph. D.

In 1943, in the historic St. Mary's Episcopal Church in Barnstable, "one of the most distinctive, quaint and beautiful churches in the Northeast,"¹³⁷ Betsy married John Thatcher Clarke. This was the same church where Don's parents had wed, where Betsy had been confirmed. Occasionally, Betsy did still attend St. Mary's services, though she admitted to the rector that she was, in truth, a "backslider."¹³⁸ By 2012, that rector was, for the first time in its history, a woman.¹³⁹ Even in Barnstable, a few things were changing.

Once married, Betsy's Ph.D. studies were interrupted, though she did manage to pursue at least some of her interests. She audited courses at Radcliffe and was once attending four classes, including organic chemistry, the course known to all as exceptionally tough. Radcliffe's Dean told her, "You could be in graduate school," but in those days she couldn't. Grad school had to be full-time and, by then, she had three young children. A major professor asked her to take an exam in the course she was auditing with him. At first, she demurred. He said he would grade it; she took it and he was so impressed that he said she could take *any* course in the department that she wished. The department chair had advice as well, "Be an archeologist; you won't need a Ph.D." She did become fascinated by archeology, was a skilled photographer and, combining her talents, got to document a dig in the Mississippi Delta in the late 1950s. And then there was a period of "Absolute Paradise." So she describes the time when, in 1960, she was one of the first small grant recipients from the newly created Bunting Institute at Radcliffe. Now, she had money for a babysitter and was free to study.^{140, 141}

Despite Betsy's chafing at the greater freedoms afforded boys and men, she was surprisingly (to me) positive about the attitudes she perceived in her part of Harvard's world. She

considered the professors to be very accepting of female students, noting that she quickly became “one of the guys” on the digs. Likewise, she “never had sympathy for females having a tough time,” for “it” was “easy.” Clearly, she is not taking into account what appear to be her most exceptional intellectual abilities. She also had remarkable organizational skills so as to balance all her interests and responsibilities as well as she did.¹⁴²

By 1961, she had divorced and soon married James Nevin Weaver, a biology professor at Texas A&M University in College Station. In Texas, she continued following her interests: she played the flute, made jewelry, and excelled at “feminine” artistic endeavors. Too often underappreciated, these included embroidery, smocking and even gourmet cooking. Of course, she also took care of her ever-growing children, now adolescents. She and her husband jointly hand-built a house on the family Texas “ranch.” Together they hiked, camped, sometimes climbed mountains and traveled. Often, they went to the Yucatán in Mexico where she was involved in archeological digs and he studied wild bees. The land, people and culture of the Yucatán remained a greatly beloved part of her life.

When Nevin Weaver accepted a faculty position at the University of Massachusetts, Boston in 1965, Betsy further cultivated her talents with studies in painting at the School of the Boston Museum of Fine Arts. She concentrated on landscapes, again reflecting her love of nature. Upon Nevin’s retirement in 1990, they moved to a family house in Barnstable. In Barnstable, she was sailing, walking the dunes of Barnstable Harbor, painting those vistas and fighting adamantly to protect the natural environment.¹⁴³

Friendships

The two couples, Jocelyn and Don and Betsy and Nevin shared some similar histories between them, similar interests and, likewise, many similar life goals. As an example, Nevin’s brother Van was in Betsy’s words, “quite well-to-do.” He once remarked to Nevin, “You were always the smarter one. Why do you think it is that I have become so wealthy and you not?” Nevin’s response: “Well, Van, it always surprised me that Harvard was willing to pay me to do exactly what I wanted to do.” This, of course, was precisely Don’s attitude. He frequently remarked how marvelous it was to be paid for having fun, though a strong desire to achieve and be recognized for the achievement was clearly also involved.

Similarly, the women pursued their interests. In so doing, they were both facing the gender-relevant extra obstacles and making far less money at their endeavors than did the men, if and when they were paid. The two couples did spend some times together, although Don did not purchase a home in Barnstable until after Jocelyn had passed away (1998). Until then, Don and Jocelyn were living in Lexington, Massachusetts in a retirement community, not all that far from Cape Cod. Don still greatly enjoyed sailing; Jocelyn, as we know, did not particularly. After Nevin died, Jocelyn had asked Betsy if she would go sailing with Don. In Betsy’s words, she wanted Don to have a “babysitter” for his sailing ventures. So, Betsy and Don sailed together, as did Peg and Don.

And after both Jocelyn and Peg had passed away, it was only with Betsy that he sailed. Perhaps, also occasionally, a visiting young relative might join him. His daughters, his grandchildren and, in particular, the young great-grandchildren visited; he had a room brightly decorated and filled with toys set aside for them. Dinners were often shared with Betsy, perhaps two or three times each week at Barnstable’s comfortable Dolphin¹⁴⁴ restaurant.

He told me, quietly and simply, a couple of years after his wife Jocelyn died, that he was going to ask Betsy to marry him. Perhaps, he thought, he could be of some help to her. Now at the end of his life, to his surprise, he seemed to be quite a wealthy man. But Betsy didn't marry him. She was, of course, a most independent woman, even in her 80s. As she had told us that sunny August day, when the electricity goes out in the winter, which is not at all atypical, she has a wood-burning stove in the kitchen, a "camper/back-pack stove" and candles. She's quite self-sufficient. Don never mentioned the matter to me again. I, respecting his privacy, did not ask him. But to me, 'twas sad. Companionship is more than dinners a few nights a week and whatever other shared events.

When I asked her, after Don had passed away, Betsy described him to me: He's "the only one who liked to walk on the marshes in the winter. It was such fun." "It was in his deepest self - a teacher, always opening things up." He was "the cat that walked by himself."¹⁴⁵ He was a "lovely mixture of fierceness and gentleness."¹⁴⁶

Betsy passed away the year after the summer afternoon on her porch. Her obituary requested that any donations be sent to the Southern Poverty Law Center, another of her activist concerns. The obituary also stated that she had died "after a short illness." There were intimations of how death would be faced that last summer afternoon. She'd lived a full life; her family and friends were slowly "leaving." In her view, her dying was not to be an occasion for heroic measures. Strong, resilient, independent to the very end.

Griffin's Last Years

In his last years, Don's life included close friends with whom he visited and corresponded frequently and with much pleasure. I have noted two of those friends. Respecting privacy, I have not mentioned any other. We can be pleased that Don found such persons for those times.

Reflections

As we consider the women who played significant roles in Don Griffin's life, we must remember the times when Don was a young man. Women were generally expected to get married, raise a family and be supportive of their working husbands. If the family moved, it was to a larger house or different neighborhood, or based on the husband's job requirement or convenience. Women typically did not work, nor were most college-educated.

But even Don's mother didn't truly fit this mold. She had married later than most of her generation. She had "womanly" skills, such as cooking, gardening, and sewing, but also, she was the one who repaired things around the Barnstable house. She helped the young son Don learn to use tools and constructed boats with him, usable ones to row or sail; his father worked with Don whittling simple, small, model warships. (Importantly, he also tutored Don and taught him writing skills.)

Although most of Don's "successful" ancestors were male, there was the very highly regarded Aunt Heloise, the artist, then hotel manager, then hotel owner. Being an artist, male or female, is a chancy, difficult career. She adapted successfully to her economic conditions. Most likely, many of the other female ancestors were talented and intelligent women, but I do not know about them and they did not gain the recognition that the men achieved.

Don's first wife, Ruth Castle, was a most intelligent and outgoing young woman. She gained an undergraduate degree at a teachers' college. After earning some funds, she then attended

Radcliffe College of Harvard University as a graduate student, intending to study for a Ph.D. in Biology. That was a challenging journey that few women accomplished. She earned an MA, but not a doctorate. Why? She stopped her studies and married Don. One surmises that the timing of the marriage had much to do with the looming entry of the United States into the Second World War. A married man who conducted scientific research for the war effort would almost certainly not be called away to battle. They had four children; she stayed home to care for them. She created and taught a Summer field course in Biology at Woods Hole on the Cape. When they were hoping the girls could attend a very well-regarded private secondary school, she obtained a teaching position there which brought income into the family and reduced the tuition costs. She thoroughly enjoyed teaching and was apparently an excellent and well-liked one. A daughter remarked that her father was disappointed that Ruth did not continue her doctoral studies and become a scientist as had been her original intention. When could she have done so? Possibly, possibly, after the children required less care.

Yes, other women did become professional scientists. Betsy Weaver became an archeologist, but one without a Ph.D., for with children she could attend classes only part-time. Thus she could not be part of a Ph.D. program. I do not know the trajectory of Peg Olmsted's career; she married, had children, and seemed to have done work in chemistry. Jocelyn Crane's scientific career was yet a different path. She was a very bright, determined, and focused young woman who had no financial difficulties and could afford to volunteer for the Beebe project. She then began a professional and soon also a personal relationship with a senior, influential man in her field of choice. Also by choice, she had no children and thought them a hindrance to a woman's serious pursuit of science.

Yet no matter how independent these most capable, intelligent women, they all followed their husband's path. They adapted to the priorities of the husband's/partner's career.

It would seem that Don's history with these particular women must have impacted his relationships with women in general, women in science, women in his lab and vice-versa. He must likewise have been influenced by societal attitudes during his early development as well as by those of the changing era when women gained greater freedom and recognition. Some have suggested that Ruth's obvious obstacles to pursuing a Ph.D. and a university-level academic career may have impacted him strongly. Yet her daughters said she thoroughly loved teaching and the personal relationships that can entail. She did *choose* to be a secondary school teacher, perhaps, at least in part, because she was witnessing very directly the demands of a dedicated scientist on the rest of life and relationships.

While Griffin was on the Cornell faculty, he had male graduate students.; the only female graduate student I am aware of is Ann Rawson, the wife of another grad student, Kenneth. Both went with Griffin to Harvard when he moved there. To my knowledge, he had at least three female graduate students in his Harvard lab. One was Ann Rawson. She did not obtain a Ph.D.; Kenneth did. I believe her pregnancy and childbirth impacted her ceasing graduate work. Another was Kathryn Ralls who, as a graduate student, studied scent marking and then followed a career in behavioral ecology and conservation biology. She was one of the founders of the Society for Conservation Biology. She did receive her Ph.D. with Don Griffin, and, at some point, married and had children. Jean B. Harrison was another female grad student; she studied the effects of body temperature on

auditory responses in bats. After several years on the Wellesley faculty, she went to UCLA. I don't know of her marital/family status.

Don did encourage at least one superlative woman undergraduate that I know of, Ann Graybiel. He invited her to join the group at Simla, Trinidad for a summer and encouraged her to undertake her own research project there. This did occur after his relationship with Jocelyn was blossoming, but we cannot claim that only her influence affected his behavior.

He was supportive of the scientific interests of the spouses of his grad students as well. At Harvard, I know of Janet Williams, the wife of Timothy Williams. While at Harvard and during his move to RU, Don's financial support and encouragement allowed Janet to join Tim in Tim's Ph.D. bat research at Trinidad. This was the initiation of a lifelong partnership for the husband-wife scientific collaborations. Don likewise supported Jack Bradbury's partner in Simla research.

It is clear by now, that the women who became Don's strongest and closest friends or wives were all very bright, capable, and quite independent beings. They were sensible and practical and could endure, indeed prosper, through the vicissitudes of life. Though certainly Don and Ruth had loved each other, they grew apart and Don found a soulmate in Jocelyn. She could share his all-encompassing scientific interests; they both had the same devotion to the enterprise of science. He enormously respected and admired Jocelyn and her work, and she, his.

Don's attitudes toward women scientists and acceptance of women scientists in his RU lab will be further discussed in a later chapter.¹⁴⁷ For now, let it suffice to say that he was far more encouraging than most RU lab heads. All the women I've encountered at RU who had worked with Griffin, either as a Research Assistant, a secretary, student, or colleague were effusive in their recollections of his support.

And do not forget that Griffin was always the polite gentleman (except when he wasn't, which was rare). His were still the "old-fashioned" gentlemanly ways: he held a door open for a woman; she went through the door first; he didn't curse (well, maybe); he listened to the other person. One felt respected in his presence, either man or woman.

ENDNOTES: MARGARET (ROBINSON) OLMSTED

¹ Noted in this book, Chapter 4, "Wandering in the Marsh."

² About 2020, The Rockefeller University withdrew all its holdings from the Rockefeller University Archives and, as of 2023, they are no longer available to researchers.

³ The studies conducted by Griffin and William Edgar Curtiss are briefly described in Volume One - Chapter 10, Part One.

⁴ Alan Steinbach, personal communication, August 8, 2020. Telephone interview.

⁵ Donald R. Griffin (DRG), May 29, 1987, BOOK 5B. Also mentioned in Chapter 4, "Wandering in the Marsh."

⁶ DRG files, December 28, 2002 to January 2, 2003, Recnotes II.

⁷ Sarah Robinson to DRG, n.d. (Sunday, likely before January 11, 1938, given placement in the RAC files), Series 1, Box 11, Folder 111, Correspondence- Douglas Robinson and Sarah (mother of Douglas), Sub-folder Robinson, Sarah (mother of Douglas), Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

⁸ Sarah Robinson to DRG, 11 Jan (no year) Series 1, Box 11, Folder 111, Correspondence- Douglas Robinson and Sarah (mother of Douglas), Sub-folder Robinson, Sarah (mother of Douglas), Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

⁹ Sarah Robinson to DRG, 8 May 1938, Series 1, Box 11, Folder 111, Correspondence- Douglas Robinson and Sarah (mother of Douglas), Sub-folder Robinson, Sarah (mother of Douglas), Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

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- ¹⁰ Douglas Robinson to DRG, 4 April 1938, Series 1, Box 11, Folder 111, Correspondence- Douglas Robinson and Sarah (mother of Douglas), Sub-folder Robinson, Douglas, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ¹¹ Sarah Robinson to DRG, 6 June 1943 or 1944, Series 1, Box 11, Folder 111, Correspondence- Douglas Robinson and Sarah (mother of Douglas), Sub-folder Robinson, Sarah (mother of Douglas), Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. The letter mentions Don and Ruth's baby, Nancy, so the date would have to be after May 2, 1943, Nancy's birth date.
- ¹² Mr. X., personal communication, 2020. Telephone call.
- ¹³ Wendy Williams, personal communication, February 15, 2005.
- ¹⁴ Information about plovers and Carolyn A. Ristau's (CR) plover research is available in Volume One - Chapter 7, "Flying with the Birds," section, "Preliminaries" and in Volume Three - Chapter 16, Part 3, section, "Deception and Manipulation."
- ¹⁵ Carolyn A. Ristau, 1991b, p. 92-102.
- ¹⁶ Marjorie Kinnan Rawlings, 1942 cited in "Brunswick stew," *Wikipedia*, Retrieved June 18, 2018.
- ¹⁷ Greg Auger, personal communication, November 5, 2016. In-person interview in Mashpee, MA.
- ¹⁸ Alan Steinbach, personal communication, August 8, 2020. Telephone interview. Both G. Auger and A. Steinbach give a similar description of Peg Olmsted's home.
- ¹⁹ Kurt Vonnegut, 2010. Described in this book, in Chapter 4, "Wandering in the Marsh" and in the Volume One-Appendix containing the full version of Chapter 2, "'Home:' A Reserved Village in Cape Cod."

ENDNOTES: RUTH (CASTLE) GRIFFIN:

- ²⁰ Elizabeth ("Betsy") Weaver, March 8, 2005, Interview by CR in Barnstable, Massachusetts.
- ²¹ Janet Abbott, personal communication, May 26, 2005. Email to CR with a copy of 1998 memorial of her mother, Ruth Castle Griffin, written by Jane Abbott.
- ²² The "Great Swamp" was established in 1960 as the Great Swamp National Refuge, a migration resting area or permanent habitat for almost 250 species of birds.
- ²³ Janet Abbott, personal communication, May 28, 2005, E-mail. 1998 Memorial Remembrance of Ruth Castle Griffin. Talk given by Janet Abbott in memory of her mother.
- ²⁴ La Campana, 1936, p. 63.
- ²⁵ La Campana, 1936, p. 26.
- ²⁶ Margaret Griffin, personal communication, December 18, 2018. Email to CR.
- ²⁷ La Campana, 1936, p. 112. Dr. Rufus Reed listed as Faculty Adviser to the Science Club.
- ²⁸ Montclair State University, n.d. It was later renamed as New Jersey State Teachers College.
- ²⁹ Vassar Miscellany News, June 9, 1937.
- ³⁰ Janet Abbott, personal communication, 1998. Memorial service for Ruth Castle Griffin.
- ³¹ Vassar Miscellany News, October 5, 1938
- ³² Radcliffe Yearbook, 1940, p.68.
- ³³ Elizabeth Colson, 2002.
- ³⁴ Janet Abbott, personal communication, May 28, 2005, Email. 1998 Memorial Remembrance of Ruth Castle Griffin.
- ³⁵ Radcliffe Yearbook, 1940, p. 68.
- ³⁶ This matter is discussed in more detail in Chapter 9, "...Early Years at Cornell University," section "Griffin and the Cornell Activists."
- ³⁷ J. J. Lewis, January 10, 2017.
- ³⁸ National Park Service, n.d.
- ³⁹ Vassar College Encyclopedia, 2015.
- ⁴⁰ Ruth (Castle) Griffin to Donald R. Griffin, 1 September 1943, Series 1, Box 4, Folder 38, Griffin, Ruth-1st wife, 450B-875, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ⁴¹ DRG to Ruth (Castle) Griffin, 1 September 1943, Series 1, Box 4, Folder 38, Griffin, Ruth-1st wife, 450B-875, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ⁴² See Volume One - Chapter 9, "A Flying Professor at Cornell: Early Years" for a more complete description of these times.
- ⁴³ Janet Abbot, personal communication, March 8, 2005. Interview by CR in Barnstable, Massachusetts.
- ⁴⁴ See Volume One - Chapter 11, "Bat (and Bird) Science at Harvard ...", particularly Part 1, "Griffin's Lab: People and Projects" for further details of the activities with the bats.

- ⁴⁵ Charles Foster, 2016. *Being a Beast* and a few other popular books concerning animal cognition and sentience are discussed in Volume Three - Chapter 18, “The Return ...,” Part 7, “Consciousness and Ethical Concerns” in the section, “Griffin, the Public and Animal Consciousness.”
- ⁴⁶ Margaret Griffin, personal communication, December 18, 2018. Email to CR.
- ⁴⁷ Ed Cray, 1999.
- ⁴⁸ Abdul Abulbul Amir, September 26, 2026.
- ⁴⁹ Janet Abbot, personal communication, Feb 13, 2019. Email to CR
- ⁵⁰ Sybil P. Sim (née Bindloss), April 2, 2017. [“Billy”] died December 31, 2016, a few weeks after her husband of 58 years passed away. Her obituary was published April 2, 2017 in *The Day*.
- ⁵¹ Sybil P. Sim (née Bindloss), 2017, Obituary.
- ⁵² Janet Abbott, personal communication, May 28, 2005, Email. 1998 Memorial of Ruth Castle Griffin.
- ⁵³ David Pye’s “bat detector” and his other work is described in Volume One – Chapter 11, “Bat (and Bird) Science at Harvard ...,” Part 2, Echolocation Research by Griffin and Others
- ⁵⁴ David Pye, personal communication, January 23, 2018. Telephone interview by CR.
- ⁵⁵ Janet Abbott, personal communication, May 26, 2005, Email. 1998 Memorial of Ruth Castle Griffin.
- ⁵⁶ Janet Abbott, personal communication, May 26, 2005, Email. 1998 Memorial of Ruth Castle Griffin.
- ⁵⁷ Mr. X. personal communication, 2020. Telephone call. Most of the information about Nancy Griffin derives from that conversation.
- ⁵⁸ Margaret Griffin, personal communication, July 8, 2018. Email to CR.
- ⁵⁹ Pope Francis statement on July 29, 2013. In McElwee, January 10, 2016.

ENDNOTES: JOCELYN CRANE

- ⁶⁰ Carol Grant Gould, May 29, 2019, Interview with CR.
- ⁶¹ New York Zoological Society, 1961, p. 49 as reported in “Jocelyn Crane” in *Wikipedia*, September 18, 2022.
- ⁶² Christopher B. Boyko’s (2000) Memorial biography of Jocelyn Crane, OUP, p. 417.
- ⁶³ H. O. Von Hagen, 1976, cited in C. B. Boyko, 2000.
- ⁶⁴ Carol G. Gould, 2012, William Beebe biography, p. 399-400
- ⁶⁵ Julia Chase Brand, September 20, 2020, personal communication. In a telephone interview, Julia Chase Brand, herself a Smith graduate, was told this tale about Jocelyn Crane’s goals by the Smith Biology advisor when Julia said that she wanted to do fieldwork.
- ⁶⁶ Jocelyn Crane, 1931. This is Jocelyn’s first publication, based on her undergraduate research on local small mammals in Massachusetts.
- ⁶⁷ Carol G. Gould, 2012, p. 295-6.
- ⁶⁸ Jocelyn Crane, 1934. This article, describing deep sea species found in net hauls is Jocelyn’s first publication with the New York Zoological Society.
- ⁶⁹ Copepods (*Copepoda*) of the phylum *Arthropoda* are tiny crustaceans, found worldwide, in almost every fresh or salt water environment. They are among the world’s plankton species, may be the most abundant animal species on earth, and perhaps even the largest biomass on earth. They can be up to .25 inches (.6 cm) long, while the smallest may be the size of a speck of dust, but they are a key element in the ocean’s food web. [<https://www.montereybayaquarium.org/animal-guide/invertebrates/copepod>]
- ⁷⁰ New York Zoological Society, 1935, p. 58-59.
- ⁷¹ Christopher B. Boyko, 2000.
- ⁷² Glenn Fowler, February 24, 1988. Obituary of Gloria Hollister.
- ⁷³ Carol G. Gould, 2012, p. 331.
- ⁷⁴ Glenn Fowler, February 24, 1988.
- ⁷⁵ Jack W. Bradbury, personal communication, July 8, 2020. Telephone interview with CR. Professor Bradbury related seeing the changing photos of Miss Hollister, then Jocelyn Crane in the NY Zoological Magazine, when he and Jocelyn were once cleaning out her office at the zoo.
- ⁷⁶ Joanna Klein, 2017. *New York Times* article.
- ⁷⁷ Carol G. Gould, 2012, William Beebe biography, p. 339.
- ⁷⁸ Catherine L. Hines, 2000-2017, Official William Beebe website.
- ⁷⁹ Joanna Klein, 2017. *New York Times* article describes Beebe’s research projects, including the social life at the field stations or out at sea.
- ⁸⁰ Carol G. Gould, 2012, p. 407.

- ⁸¹ Donald R. Griffin, June 3, 1987, BOOK 9A.
- ⁸² Carol G. Gould, April 29, 2019. Interview with CR, Princeton, N. J.
- ⁸³ Joanna Klein, 2017.
- ⁸⁴ C. B. Boyko, 2000.
- ⁸⁵ https://everipedia.org/wiki/Jocelyn_Crane/
- ⁸⁶ Jocelyn Crane, 1975. *Fiddler Crabs of the World (Ocypodidae: Genus Uca)*.
- ⁸⁷ Jocelyn Crane, 1966. One example of her many publications about fiddler crabs. See Boyko's Memorial essay for an extensive list of her publications.
- ⁸⁸ Carol G. Gould, 2012, p. 357.
- ⁸⁹ Carol G. Gould, 2012, p. 358-361.
- ⁹⁰ Carol G. Gould, 2012, p. 374.
- ⁹¹ Alexander von Humboldt, 1814.
- ⁹² Griffin's explorations in 1959 are described further in Volume One - Chapter 10, Part 3, "The 'Oilbirds' Of El Cuavo Del Guácharos, Venezuela - Birds That Echolocate?"
- ⁹³ Carol G. Gould, 2012, p. 365.
- ⁹⁴ Carol G. Gould, 2012, p. 367-8.
- ⁹⁵ William Beebe Tropical Research Station (WBTRS) website, 2004.
- ⁹⁶ William Beebe's 4 volumes of *A Monograph of the Pheasants* was published over a 4-year period (1918-1922).
- ⁹⁷ William Beebe Tropical Research Station (WBTRS) website, 2004.
- ⁹⁸ New York Zoological Society, 1952.
- ⁹⁹ Carol G. Gould, 2012.
- ¹⁰⁰ Jocelyn Crane was DTR Director and Simla station Administrator. The William Beebe Tropical Research Station (WBTRS) website states that Dr. Marc Buchanan was Director of the Simla station after Beebe's death until it closed in 1970.
- ¹⁰¹ C. B. Boyko, 2000, p. 417. Information Jocelyn Crane's professional positions are included in Boyko's excellent memorial biography article.
- ¹⁰² David Pye, personal communication, January 23, 2018. Telephone interview by CR.
- ¹⁰³ C. B. Boyko, 2000, p. 417.
- ¹⁰⁴ I have chosen not to specifically name "Dr. A," simply to protect the privacy of any family members. If some reader needs to identify the person, individual research will produce the information.
- ¹⁰⁵ Daily life at Simla is described in Volume Two - Chapter 12, Part 2, "Trinidad - A Research Station in Paradise ... Muddy Roads, Many Bats," particularly in the section, "Fun and Frustrations in Simla Life."
- ¹⁰⁶ These letters which are primarily from 1966 may be found in 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ¹⁰⁷ DRG to Mike Emsley, 23 December 1965, 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. The letter specifies the relationship between the William Beebe Tropical Research Station (aka Simla or WBTRS) which officially employed Mike Emsley and IRAB of which Don was the Director.
- ¹⁰⁸ DRG to Fairfield Osborne, 1 April 1966, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. The letter indicated that Michael Emsley should be fired.
- ¹⁰⁹ DRG to Michael Emsley, 31 March 1966, 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Griffin had prepared this letter, firing Emsley, to be used if Emsley did not resign.
- ¹¹⁰ Jocelyn Crane to Mike and Julie Emsley, 18 November 1965, 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. This is an example of the friendly letters between Jocelyn and the Ensley couple, signed "Best - love to all, Jocelyn"
- ¹¹¹ Letter from XXX to DRG. 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. The letter describes XXX's leaving the security of a university job to work at Simla. I have decided not to indicate the name of the letter writer in order to protect the privacy of any family members

- ¹¹² Mike Emsley to DRG, 6 May 1966, 450G, Box 15, Projects, Folder 146, Beebe Tropical Biology Station, Simla [1933-1969], Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ¹¹³ Summary, 450G-Box 15-Projects-Folder 146-Beebe Tropical Biology Station-Simla-1933-1969, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.
- ¹¹⁴ William Beebe Tropical Research Station, 2004, website.
- ¹¹⁵ Building: Hotel des Artistes, n.d.
- ¹¹⁶ Carol G. Gould, 2012, p. 239.
- ¹¹⁷ Carol G. Gould, 2012, p. 398.
- ¹¹⁸ R. Haven Wiley, 1973. This article is derived from his Ph.D. research which is briefly described in Volume Two - Chapter 12, Part 5, “Griffin Lab Research: Early Years,” in section, “Lekking Fiddlers?”
- ¹¹⁹ Beverly N. Greenspan, 1980. This article is derived from her Ph.D. research. Her work is described in Volume 2 -Chapter 12, Part 5, section, “Beverly Greenspan (Bats, then Fiddlers).”
- ¹²⁰ Carolyn A. Ristau, 1991c, p. xvii, as reported by Jocelyn Crane Griffin.
- ¹²¹ Jocelyn and Don’s trip to Afghanistan, Uzbekistan and Russia is described in Volume Two - Chapter 13, “Afghani Art and Russian Bats.”
- ¹²² Carol G. Gould, May 29, 2019. Interview with CR.
- ¹²³ Jocelyn Crane Griffin, 1991. *Pointing Gestures in Medieval Miniatures ...* This was her Ph.D. dissertation in Art History.
- ¹²⁴ Jocelyn Crane, n.d. *Talking fingers*. Uncompleted and unpublished book based on Crane’s doctoral dissertation.
- ¹²⁵ Carolyn A. Ristau and Donald Robbins, 1982.

END NOTES: ELIZABETH (BETSY) WEAVER

- ¹²⁶ Betsy Weaver, August 27, 2007. Personal interview by CR, Barnstable, Massachusetts.
- ¹²⁷ Wendy Williams and Robert Whitcomb, 2008.
- ¹²⁸ Wendy Williams moved to the Cape in 1980
- ¹²⁹ See Chapter 2, “Barnstable” for further descriptions of some Cape Cod villages and their inhabitants and history.
- ¹³⁰ Sarah Littlejohn Rueter of Barnstable and Boston, Mass. In Elizabeth Chadwick (Edwards Clarke) Weaver obituary (Elizabeth Weaver obituary), 2008.
- ¹³¹ James King Edwards of Barnstable and Providence, Rhode Island. In Elizabeth Weaver obituary, November 28, 2008.
- ¹³² Alexa Brazilian, May 17, 2017.
- ¹³³ Wendy Williams and Robert Whitcomb, 2008.
- ¹³⁴ Betsy Weaver, March 10, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹³⁵ Elizabeth Weaver obituary, 2008.
- ¹³⁶ Betsy Weaver, March 8, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹³⁷ St. Mary’s Barnstable, 2022.
- ¹³⁸ Betsy Weaver, March 10, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹³⁹ J. Watters, 2012.
- ¹⁴⁰ Elizabeth Chadwick (Edwards Clarke) Weaver obituary, November 28, 2008.
- ¹⁴¹ Betsy Weaver, March 10, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹⁴² Betsy Weaver, March 10, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹⁴³ Elizabeth Weaver obituary, November 28, 2008.
- ¹⁴⁴ The Dolphin restaurant is described further in Appendix-Chapter 2 - “Barnstable.”
- ¹⁴⁵ Betsy Weaver, March 10, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹⁴⁶ Betsy Weaver, March 8, 2005. Personal interview by CR, Barnstable, Massachusetts.
- ¹⁴⁷ A discussion of Griffin’s attitudes towards women in science and at Rockefeller University may be found in the following sections: Volume 3 - Chapter 16, Part 1, “The ‘60s Revolution - Musically, Culturally, Politically,” section “Women in Science - At RU and Beyond,” particularly in the sections, “The RU Report on Women” and “Women Scientists in Griffin’s Lab.”

CHAPTER FIFTEEN

BEFORE THE COGNITIVE REVOLUTION (Griffin Lab Life and Research)

Overview of Parts One, Two, Three and Four

Part One: A Revolution was simmering and sometimes exploding (the Cognitive Ethology Revolution to be discussed in the next chapter). Griffin and his lab were also continuing with past and new endeavors, conducting research with bees, bats, birds, humans and whales.¹ Griffin Lab life is described with an example (and anecdotes) of fieldwork preparations, specifically, for Carolyn Ristau's studies of possibly purposeful plovers.

Part Two: Overview of the Griffin Lab's prior RU research.

Part Three: Griffin's studies took him to remote Chillagoe, Australia, where he and other scientists enjoyed the idiosyncratic "fun" of research with echolocating swiftlets and bats. Marc Konishi conducted delicate brain research in a hotel room. Others used inventive technology and new "Griffinberg" contraptions to do their studies. Griffin, astonished, determined that bats were flying extremely high. Others' later research with bat GPS collars confirmed this and observed extraordinarily rapidly flying bats "surfing" on air currents.

Part Four: Back at RU, Griffin diligently pursued the possibilities of human echolocation. A brief history of others' prior attempts included Griffin's exasperation: "If only they knew the old work."

PART ONE

HOME IN THE GRIFFIN LAB

The Lab

In the days when Griffin was very much engrossed in cognitive ethology at Rockefeller University, his lab was still in Smith Hall on the Rockefeller University Manhattan campus. He had, as well, his enclave at the Millbrook field station. That's not to say that he had forsaken his radar studies of avian migration, though he finally ceased such work and bequeathed the radar apparatus to Ron Larkin when Ron moved on in 1980. To a more limited extent, Don was still involved in bat studies.² His strong personal and collegial research relationship with Jim Simmons helped fortify those interests; Don's similarly close relationship with Jim Gould stimulated his continuing fascination with honey bee communication. But certainly, in the mid-1970s, particularly when engaged in preparing and writing the *Question of Animal Awareness* (QAA), his mental energies were turning more strongly towards Cognitive Ethology and continued to do so.

For the original 1976 edition of the *Question of Animal Awareness* (QAA), Roseanne Blair was the secretary patiently typing and toiling over the preparation of innumerable draft manuscripts. Griffin heartily thanked her in the QAA Acknowledgements. Later, Rosanne, now Rosanne Kelly by marrying Mr. Kelly of the RU support staff, still toiled over manuscripts he and we gave her. (There *is* romance associated with science; more to come.) Now we would ply her with dictation or rough drafts for computer entry. Don composed by dictating into a tape recorder, writing in longhand on yellow, lined paper pads, or, sometimes, by typing into a computer. (He still

used the two-finger-typing technique begun in his youth.) Roseanne claimed it was just as much work for her now as in pre-computer days, for we just made many more drafts. She was indeed very patient and, quite frankly, far more accurate than various students of elite universities; they too were involved in data transcriptions of the very experiments in which they had participated. (These were my experiments with piping plovers in which the students had served as “intruders” or observers/dictators, to be described in the next chapter.³ I was, nevertheless, enormously grateful for all their help.)

Jocelyn Crane Griffin was a frequent and welcome visitor to the lab when not in her Wildlife Conservation Society office at the Bronx Zoo. Occasionally, the grad students were invited for cocktails in the impressive, elegant apartment where Don and Jocelyn lived on Manhattan’s Upper East Side, further described in a later chapter. Lunchtimes for lab members were often shared in the cafeteria and sometimes a subset of us went with Don to the more formal Faculty Dining Room. There we might sit at one of the long tables with more than one Nobel Prize winner in the conversations.

Back in his office, Don would often be writing, usually with an open door, but we were well aware of his gesturing. One hand waving, when we were about to enter, clearly meant he was busy, and please, not now. Two hands waving, egad! Later, after the one or two-hand wave, he would politely apologize for his “rudeness.”

For many years, David Thompson, Don’s technical research assistant, would be in one of the side rooms, dealing with some gadgetry/equipment. Dave was sometimes also “loaned” to other lab members in need of help. During my time, I was in the office next to Don’s, with my piles of papers and books, and my stuffed raccoon. For a while, my new observation tent was set up in my space as I contemplated where I might dare cut holes to peer through in the field.

Preparing for Field Work – The Cognitive Plover Example

Before leaving for the field, there were, of course, innumerable preparations to be made. These would be underway in Smith Hall or up in Griffin’s Millbrook workshop. Examples follow from my work with piping plovers (*Charadrius melodus*). Don occasionally participated in the fieldwork and *always* had most helpful advice, be it practical or theoretical.

A Bit About Plovers

As one might wander along almost any shoreline by the sea, some species of plovers will be nearby, foraging and darting away from the waves. My favorite, I must admit, for my students and I have spent many days studying it, is the little Piping Plover (*Charadrius melodus*). When one first encounters the bird, or rather when it first encounters you, you see nothing. It may decide simply to fly away, or, if you are far enough from it, to continue foraging. However, if it has eggs or young nearby, you will suddenly hear an insistent peeping in front of you. You search, seeing nothing. The determined peeping continues. And then, is that a clump of sand moving? No, it is the extraordinarily well-camouflaged piping plover, seemingly a lump of sand moving across the sand. It may suddenly break into a “broken-wing-display” sometimes called “injury feigning.” Is that bird badly hurt? It’s screeching now and flapping and dragging its wings. It scarcely seems able to walk. It’s tipped over on its side! Very curious, you approach ... the bird keeps moving and dragging its



Piping Plover (Top Left)

Plover Nest with 4 Eggs (Right)

Plover Beginning Broken-Wing Display (BWD) (Bottom Right)

(All photos by Eric Strauss)
(Another photo of the Piping Plover Making a Full BWD is in Chapter 16)⁴

wings. Together, you keep moving; it is always just a way beyond you. Suddenly, it takes off, flying perfectly well. What? You notice you are quite far from where you first saw that bird. What just happened? Have you been “had?” The parent bird was protecting its progeny. You are now far away from its eggs or young, and you don’t even know where those camouflaged eggs or infants are.^{5,6}

And the parents keep protecting their young, taking them to search for worms, crustacea, and insects, even mollusks, at the best spots they know. They all forage together on the mudflats or the newly exposed beach when the tide goes out. Though extremely tiny, light balls of fluff, the young are surprisingly able. They are “precocial,” able to walk the very first day of life, already foraging. After several weeks, the young tend to wander further and further from their parents’ watchful eyes. While foraging, the young gather together more often with some of the other young. And somewhere in the midst of all this, the parents have simply taken off. They have begun the migration to winter quarters. Admittedly, they are not flying as far away as the terns or godwits previously described.⁷ Some leave the crowded beaches where I first worked with them around New York City to winter in the Carolinas or Florida or Mexico or the Caribbean islands. And the young are left to migrate completely on their own ...with other newly hatched young who have also never flown to winter quarters!

Despite the intrigues of their migration, the aspect of plover behavior that greatly fascinated me and seemed most practicable for my studies was the parents’ use of the “broken-wing display: yes, an innate behavior, but was the plover using it strategically?

A Raccoon Races Down the Hall

The tale of fieldwork preparations should begin with the raccoon. Its name was “Rocky the Raccoon.” It had to be. Its home university was The Rockefeller University; its gait was definitely rocky; and a major song of the day was the Beatles’ “Rocky Raccoon.” What else could that raccoon be called?

Rocky was a stuffed raccoon, set upon a remote-controlled dune buggy. Where to find a predatory stuffed raccoon? New York City’s famed, abundant choices failed me; specialty shops did sell dead, furry raccoons, but they were arranged to be cuddly things. With considerable effort, the aid of Don Griffin’s enormous spider web network of connections, and many links to friends of friends of friends, I contacted an apprentice veterinarian. Her hobby was taxidermy. And, yes, she was fairly certain that she had, deep in the depths of her big freezer, a dead raccoon. It had been roadkill and was in very good condition. And, yes, she could stuff it. What, remove the bones? Yes, she could remove the bones to make it extra light. Ferocious looking, ready to stalk and kill? Well, she could try. I’d have to find some eyes, though.

All this was done to create a predator that I could control in my series of planned field experiments. My assistants and I would investigate the broken wing display aka “injury feigning” of piping plovers (*Charadrius melodus*). Was it truly just a fixed action pattern or could it use the display strategically to lead a predator away from its nest/young, varying its behavior as the situation demanded? And, I needed a predator on command. That was Rocky.

First, the toy dune buggy had to be geared down to normal raccoon speeds. Being a hotrod toy, it zoomed, instead of stalking. For this, the Rockefeller University electronics and machinery shop came to our aid, but their fees were enormous and even with my small grant from the Harry Frank Guggenheim Foundation, their work was totally unaffordable. Fortunately, they were intrigued by the idea and simply volunteered to do the hours of work during their break times and off-hours. So Rocky Raccoon would be stalking on a \$10,000 platform ... if we had paid for all the labor involved.

Before going to the field, the apparatus had to be tested. Both Don and my assistant Dave Thompson were captivated by this gadgetry. Dave found a convenient place for trial runs down the long hallway on the fifth floor of Smith Hall, outside of Griffin’s lab. An extraordinary number of runs seemed to be necessary. And since Rocky didn’t do U-turns well, he had to be recovered from the end of the hall, which seemed to take a very, very long time. Gradually, the truth emerged. Also, at the end of the hall, was the open door where a young, pleasant, attractive and single secretary



Carolyn Ristau and “Rocky” Raccoon, 1985. (by Ingbet Grütner) (From RU, 1985/1986)

was typing. It isn't an ordinary occurrence to see a raccoon dead or alive whizzing by and stopping outside your door. That necessarily provoked conversation. Many conversations. And, in a while, she became the fiancée and then the wife of Dave Thompson. Already a good ploy, though not yet the injury-feigning ploy of the piping plover.

Boys on the Beach

Finally, the time arrived for the first visit to the field site on Metompkin Island, Virginia. Metompkin is a barrier island about 10 miles south of the much larger and better-known Chincoteague Island, a National Wildlife Refuge, where wild horses roam. In the spring, Metompkin seldom had visitors, for it was reachable only by water; the fishermen remained in the ocean in their small boats. Don Griffin, Dave and I came with Rocky on the initial trip. It was a beautiful day, sunshine and springtime and very soon the piping plovers would be choosing sites for their dune nests. I was eager to try the device with Rocky on the bumpy, sometimes grassy beach site. Recall that this was my project and Dave was my assistant. Don came to make sure things began well and, it must be said, out of curiosity. And he truly enjoyed fieldwork and being outdoors in nature. At this point, he was living in Manhattan, New York City, and doing so alone for a while as Jocelyn was off traveling in the wider world for her art research.

But I didn't get to use the vehicle at all. Both Don and Dave romped about, testing/playing with the toy. However, I did find an absolutely perfect Indian arrowhead in the sand. Collecting such objects was a major hobby of Dave's. I kept it.

We did discover a significant glitch. I say "we" for, finally, I did get to play with my "toy" also. Its wheels were designed to race rapidly over a hard surface and this was not the circumstance in which it would have to operate. Just like normal-sized beach buggies, it needed balloon-type tires. Where to find them? So, led by Don, we hit the Dollar stores and others of that ilk and scurried about, bringing objects back to Don for his suggestions and advice. We gathered an extraordinarily strange collection of items ranging from a jar of pickles, which had a good-sized cap on it, to hardware sorts of objects to rubbery things. The salesperson tried to be of help, but, in his mind, there was no common denominator to what we kept choosing, and discussing intently and then usually returning to the shelves.

Of course, during my experiments, I eventually got to "play" many, many long hours with my "toy," re-fitted with balloon-type tires.

PART TWO

THE LAB'S RESEARCH (BRIEF REVIEW OF WORK PREVIOUSLY DESCRIBED)

Generally speaking, the focus of the Griffin RU lab's work was on animal orientation and communication. In the 1981-1983 RU bi-annual publication about each lab's work, Griffin described that research as encompassing "the physiological to the cognitive level."⁸ He emphasized the significance of social animals' "communicative behavior" to yield "uniquely suggestive evidence about internal representations of both spatial and temporal relationships."⁹ (Note how Don, at this point, carefully termed "communication" as "communicative behavior" though daring to speak of animals "internal representations," yet avoiding terms like "mental experiences" or "thinking.")

Bees: During these years, the lab's work with bees was that of Jim Gould (Ph. D.1975) and Mike Brines (Ph.D. 1978) which has been described in detail.¹⁰ When Jim next became a Princeton faculty member, he and Don kept up a most active interaction, and Don even conducted some bee experiments with him and his students, as will be discussed.

Birds: Much of the work with birds has already been described¹¹: 1) The Atlantis II study concerned flight directions of migrating birds over the ocean. 2) Don and Ron Larkin conducted research with the "Witch." That radar was usually located at the RUCFR station in Millbrook, N.Y., and used to examine the direction and wind speed of migrating birds. 3) Auditory stimuli were tested that might help guide the navigation of migrating birds. In playback experiments, some few sounds *disturbed* the flight, as observed on the Witch's radar; these were sounds of thunder on a deeply overcast night. Otherwise, Griffin never did find evidence for these ideas. 4) Studies of migrating birds' flight during thick clouds, obscuring any visual cues from the ground or sky, indicated the birds could still navigate, maintaining the appropriate flight direction. 5) Physiological studies of birds' metabolism during flight were conducted by José Torre Bueno (Ph.D. 1975). 6) Marilyn Yodlowski's (Ph.D. 1980) physiological research on the pigeon's middle ear suggested sensitivity to low-pressure waves or "infrasound" potentially useful for directional orientation¹² and was likely also involved in the reported ability of at least some bird species to "forecast" an approaching storm in advance and react.

Bats: While at RU, Don continued to have graduate and postdoctoral students and visiting faculty who joined him in bat echolocation studies or conducted their own. Among them were Hans-Ulrich Schnitzler (postdoc), M. Brock Fenton (visiting faculty), and Edward R. Buchler (postdoc);^{13,14,15,16} their work has been discussed.¹⁷ Griffin and James A. Simmons had life-long "bat conversations" and occasional joint research, beginning when Don was a member of Jim's dissertation committee (Ph.D. Princeton University 1969).¹⁸

Over time, from his teenage years until he passed away (2003), a fair amount of Don's research with bats was conducted in Cape Cod, often in the summers, sometimes associated with the Woods Hole Oceanographic Institute (WHOI).¹⁹ Beginning in 1960 and continuing after he joined the RU faculty (1966), Don's bat studies often were carried out around the RUCFR field station in Millbrook and for a while at Simla. At that Trinidadian research station, the perplexing fishing bats (*Noctilio*) avidly engaged his interest, as did comparative research. Some of Don's grad students conducted field studies with bat species at Simla, in particular, Don's Harvard grad

student, Rod Suthers, and his RU students, Jack Bradbury (Ph.D. 1968) and Tim Williams (Ph.D. 1968). (The students' work is described in detail in earlier chapters.²⁰)

Griffin also participated in expeditions, usually including bat studies. In 1980, both Don and his lab assistant David Thompson joined a project in Chillagoe, in Queensland, northeast Australia, to study the echolocation of bats and birds.²¹ More about that expedition soon. Generally speaking, at RU, Don became more involved with his studies of avian orientation than with bat research. Then gradually, though still conducting experimental work, he became deeply engrossed in the issues of animal awareness and in creating forceful arguments to convince other scientists of the need to study such matters.

There were also numerous conferences in which Griffin took an active role, often as a plenary speaker and often promoting his ideas about animal thinking and consciousness. Later I shall mention a few that participants considered particularly significant.

PART THREE

THE TRIP TO “THE MIDDLE OF NOWHERE”²²

The expedition to Chillagoe was in the early autumn of 1980. It was fun, a great deal of fun ... at least for this set of scientists! Animal physiology and perceptual abilities were the areas of intrigue. The region was replete with limestone caves and the group of scientists was avidly awaiting the opportunity to stomp off into those caves to find the bats and swiftlets dwelling there; others were in search of bowerbirds common to the region. The bat scientists were expecting to find several species of bats. Those intent on studying avian echolocation would be searching for the resident swiftlets, the Australian grey swiftlets (*Collocalia spodiopygius*), one of only two families of birds that can echolocate. Besides Chillagoe, the grey swiftlets were found in southeast Asia and other parts of northeast Australia. The other echolocating bird was from the family *Steatornithidae*, represented by one species, the oilbird (*Steatornis caripensis*). That bird was first reported by Humboldt²³ from a 1799 trip to the same Venezuelan caves later visited by Griffin.^{24,25} Both species use echolocation solely for navigating in the dark caves where they roost and nest, and apparently not for foraging. (Some scientists are not fully convinced of the latter.)²⁶ The oilbirds search for fruit, while the swiftlets are insectivorous.. Because the birds' habitats are located in fairly remote neo and paleotropical sites, their echolocation systems had not been studied in great detail at that time.²⁷

Rod Suthers, then an Indiana University faculty member, had organized the Chillagoe expedition with NSF funding.²⁸ But it was difficult to reach “the middle of nowhere.” After arriving by air, in Cairns, in northern Australia, the scientists endured a five-hour road journey to get to the site.²⁹ Mail to/fro the USA was ca three weeks round trip.³⁰

The Scientists and Their Fascinations

Among the approximately 15 adventurers were Don Griffin and his assistant David Thompson. As the only research assistant within the group, Dave was “lent” by Don to several other scientists, with Dave’s enthusiastic agreement. Dave even became co-author of several publications deriving from the group’s studies.^{31,32,33,34} The swiftlet’s echolocating precision taunted Don; just how small an object could it detect? The neurobiologist Masakazu (Mark) Konishi (then at California Inst. of Technology, Pasadena Ca.) was intent on recording from neurons in the auditory system of the grey swiftlet; the bird made a series of click-like signals, audible to humans, and used them to echolocate. The mechanisms used by swiftlets to produce the echolocating clicks engrossed Rod Suthers.

The bats likewise received devoted attention, some with the aid of very specialized equipment: transmitters attached to the bats, Griffin’s “kytoon” flying high with an advanced QMC recording microphone/bat detector³⁵ and Jim Simmons’ “new superperiodmeter, depicting multiple harmonics.” (“Jim is reveling with [it],” reported Griffin.³⁶) Among the bat devotee researchers were Griffin, Brock Fenton (then at Carleton University, Ottawa, Canada), the wife-husband team of Patricia (Pat) E. Brown and Robert D. Berry (both at UCLA, Los Angeles, California), Rod Suthers and Dwight Hector (both from Indiana University), Philip Jen (University of Missouri faculty), and Jim Simmons (then at Univ. of Oregon, Eugene, OR.).

Creating Laboratories “in The Middle of Nowhere”

Before undertaking their investigations, the scientists had to “set up shop,” providing exercises in adaptation and “making do.” Brock Fenton gleefully recalled those lab creations (recounting them several times in my interviews, out of sheer delight).³⁷ And Don Griffin wrote of them in a letter to his former RU Research Associate/then RU Assistant Professor, Ron Larkin:³⁸ “Everyone is very enthusiastic and helpful, and it really is a bit like the U.S. West a few decades ago.”

Mark Konishi and his colleagues, Jack Pettigrew (University of Queensland) and Roger Gates (Queensland University of Technology) needed a neurophysiology laboratory. They were hoping to begin to understand the neural analysis of sounds the grey swiftlets used for echolocating. Single-cell recordings were to be made from the auditory midbrain of anesthetized swiftlets, a delicate operation. So, they established the lab ... in their motel room. No disturbances. More accurately, not too many, for like most motel rooms, it could not be described as soundproof and the lodging was situated in a town. And the motel owner had two young children, playing and scampering about, as well as a meowing cat.

To record vocalizations of the swiftlets and the bats, the researchers needed a quieter environment. Where? The Chillagoe Town Hall. The group had managed to persuade the local council to give up the Shire Town Hall and rent it to the scientists for the four months of the study. Konishi and his colleagues used a “small, dark, sound-absorbing chamber (approximately 1.5 m in diameter) made from fiberglass insulation batts.”³⁹ (Not a typical hi-tech lab soundproofing.) The small swiftlet was tethered, and sound recordings were made as it was vocalizing and attempting to fly.

To gather together his needed equipment, Don had arrived in Cairns, meeting Dave Thompson there. Jocelyn Crane, Don’s wife, remained in Cairns and scoured the region for muddy flats, searching for *Uca* (fiddler crabs, her main research subject). Cairns was and is an actual city, in contrast to Chillagoe, which, Fenton estimates, had a population of maybe 100.⁴⁰ After a couple of days shopping in Cairns, Don and Dave had filled a Hertz station wagon with apparatus and set off for Chillagoe, the mere 5-hour drive. They, too, needed the town hall. Reported Don, “... we ... spent a few days ... building a black plastic darkroom/flight chamber 3 X 10 meters in size. The town hall is 13 X 13 m (not 20 X 20 as advertised). But we all fit in without even putting anything on the piano.”⁴¹

The Swiftlets: Findings ... with a Few Curses

Mark Konishi’s Neurophysiology

A few curses probably emanated from Mark Konishi and his colleagues, who by Griffin’s letter of August 29, 1980, were finding only low-frequency units (3-5kHz) in their swiftlets’ brains. The birds, however, were *producing* clicks up to 6 kHz, and even some at 8 kHz. Were the researchers simply not searching thoroughly enough? Yet more prodding in the midbrain did indicate that the upper-frequency limit of the acoustic sensitivity was a bit higher, around 6 kHz. That is far lower than in most echolocating bats that produce ultrasonics (above 20 kHz, ranging to 200 kHz in some species), but significantly higher than the echolocating oilbird. Good hearing sensitivity for the swiftlet correlated well with the click energy peaks and extended about an octave

higher than in the oilbird. The energy of the clicks was also significantly higher for the swiftlet than for the oilbird. Why? The authors suggested that the sensitivity to higher frequencies and the greater energy may be quite useful for the small swiftlets (10 grams) as compared to the much larger oilbirds (400 grams). With improved detection of small gaps and small objects, afforded by using higher frequencies, the swiftlets may be able to detect and fly through tinier gaps than the oilbirds can. Such abilities may also facilitate the swiftlet's detecting its nest, which is only about 7 cm (2 ¾ inches) in diameter and is glued to the cave wall. In comparison, the oilbird's nest diameter is up to 38 cm (15 inches) and would not require such fine discrimination to detect it.⁴² By September 15, Don noted that Konishi and his compatriots have "come and gone, measuring auditory sensitivity of swiftlets en passant."⁴³

Griffin's Fascination with Swiftlets

Griffin had long been intrigued by the birds, initially considered only as "potentially echolocating." Back in 1954, he had corresponded with a researcher from the Philippines, D. S. Rabor, who had observed locally another of the many *Collocalia* species, *C. inexpecta amelis*. This was shortly after Don had observed the echolocating oilbirds (*Steatornithidae* family) in Venezuela. *Collocalia* was said to make nests in dark caves, but there were few published details about their vocalizing. So, Don had written to the various authors, plying them with questions: Were the sounds made continuously? Did the birds fly in total darkness? Did the birds seem to use the sounds for echolocation? The responders were enthusiastic and the answers illuminating. Don quotes several in his 1958 book, *Listening in the Dark*. D. S. Rabor describes a "complex system of tunnel and caverns, totally dark inside. ... I can be sure about the swifts giving out a continuous twittering note as they flew about. ... [they] did not give out the twittering notes continuously when flying in the bright parts of the caverns ... In the open, they do not give out the continuous notes ..."^{44,45}

Griffin's other informants made quite similar observations, terming the sounds "clicking" or "twittering" or "a rending sound, like the tearing of silk." In Griffin's words, "all suggest a series of short pulses much like the buzz of a bat approaching a difficult set of obstacles or closing in on a flying insect." But Griffin is Griffin. In his next breath, in a section titled "The Need for Experimental Evidence," he warns "Yet we must not let our enthusiasm carry us away." He notes the clicks of other animals, such as a woodpecker's rat-at-at. Careful experiments must be done in which "senses are selectively impaired. Would *Collocalia* be disoriented if their ears were plugged?"⁴⁶

The field progressed. At one point, in 1974, Griffin reviewed a theoretical paper by Fenton on the evolution of bats and echolocation. Don asked, "Do swiftlets forage for insects at night?" The question inspired Brock Fenton's journey to New Guinea. No, they did not forage at night. But one sunset, Fenton stood by the entrance of a mine, the swiftlets' home. He observed that the returning birds suddenly began echolocating "clicks" as they passed from sunlight into the line of shadow from the setting sun. At sunrise, a similar phenomenon happened in reverse. The birds produced "clicking" as they were leaving the dark mine and stopped the sounds as soon as they crossed the shadow line into the light of the morning sun. Since each day, the sun was in a different position, causing a differently located shadow line, the exact location where the swiftlets turned their clicks on or off also changed. A clear-cut, astute observation.⁴⁷

Gradually, the swiftlet’s ability to echolocate in the dark became accepted, and Griffin planned to study a species of *Collocalia* on the Chillagoe trip. By this point, his interests were very specific: How precise is the swiftlet’s discrimination of objects?

Mistnetting Swiftlets ... Groggy Researchers and a Cat

First, the birds have to be captured. As Griffin describes,

Two batches have been mistnetted as they dive most impressively into 30–50-meter vertical holes ... only 2 meters in diameter and don’t hit anything. ... they are (at first) too strong and active to play any kind of obstacle avoidance games. They circle or hover in the dark and refuse to fly through a row of 6.3 mm dowels at all. But by tiring them out a bit I’ve been getting some data consistent with New Guinea 1969. Others are steaming ahead on several fronts.^{48,49}

Don’s comment about the 1969 New Guinea work refers to the Alpha Helix expedition to Papua in which Rod Suthers and he had conducted experiments with a different swiftlet species, *Collocalia vanikorensis granti*. Those swiftlets had avoided 6.3 mm. iron rods at better than chance levels.⁵⁰ The Chillagoe research was intended to determine more accurately the threshold size of obstacles detectable by the birds during their optimal performance.⁵¹



Photo: **Don climbing out of Christmas Pot Cave, 1980.** (by M. Brock Fenton)

The vertical hole Don described was the entrance to Christmas Pot, the swiftlets’ cave home. At the bottom of the shaft were several horizontal passages, all totally dark, leading to similarly dark chambers where the birds roosted and built their nests. Very early in the morning, groggy researchers stumbled down to the edge of the hole’s top entrance and set up a mistnet. The birds were then captured as they left the cave around dawn to begin foraging.

When Brock Fenton arrived, he simply suggested, why not net them as they arrive in the evening and keep them overnight? No more early, early morning wake-ups. A fine idea and readily accepted. Since the birds were so difficult to maintain in captivity, often refusing to eat, they were used in the experiments within 24 hours of capture and then released ... “in excellent physical ... condition.”⁵²

There was a snafu in this operation. The motel family’s cat discovered the captured swiftlets ... and ate them as snacks. But fate intervened. One morning, the children were crying, very saddened ... their cat was dead. Daddy had accidentally run over the cat. The scientists, however, teased Rod Suthers who regularly anesthetized his swiftlets for his syringeal research. “How much Nembutal did you need to do in the cat,” one or the other would query ... to Rod’s considerable annoyance. Years later, the question would “still get a rise” out of Rod, who, all agreed, would not have committed such a deed.⁵³

Another Kind of “Jiggling” Experiment and Another “Griffinberg’ Creation

Back to Griffin’s obstacle avoidance tasks with the swiftlets. In his August 29 letter, Don commented on their experiments, variants of Jurine’s useful “wire experiments” with bats.⁵⁴ In this instance, a bird flew through a grid of three rows of vertical rods or wires, with the rod diameter changed over trials. In most trials, each row held different diameter rods, making the bird’s passage more challenging. To ensure that the bird was not using its spatial memory to recall the rods’ position, the entire array of rods was shifted laterally between trials. During that changeover, the bird remained, hopefully contentedly, stuffed (gently) into the experimenter’s trouser pocket.

The grid construction was indeed another “Rube-Griffinberg” invention. Besides the wooden frames and the obstacles made of plastic-covered wires or dowels, the essential materials were merely rubber bands and pieces of string. The obstacles were attached by the rubber bands to the nylon string which permitted a row of the objects to be shifted. The researchers wished to gather data indicating the percentage of misses as the bird flew through the spaces between the grids as related to the rod’s diameter. But how to determine if the little birds hit or missed a dowel when flying through? It was completely dark inside the flight tunnel, and the researchers were outside and the birds were inside. Solution ... a flashlight, turned on at exactly the correct moment after the dowel was hit and the obstacle was still jiggling on the rubber bands that supported it above and below, attaching the dowel to the string and to the movable frame. Since, when flying in the dark, the swiftlets echolocate continually by making audible clicks, the researchers could determine the bird’s location when it had passed through a row of obstacles and turned on the flashlight. Simple! Of course, it was not that simple, and many a “wrong flashlight moment” occurred. The “jiggle” factor was also important and restricted the diameter of the rods/wires Don and Dave could use only 1.5, 3.0 and 6.3 mm (about 0.06 to 0.3 inches). Anything smaller or larger than those sizes wouldn’t jiggle long enough and the experimenters couldn’t judge correctly whether an obstacle had been hit or missed.

After describing the fancy equipment some researchers were using in Chillagoe, Don groaned a bit in a September 15 letter to Ron Larkin,

Dave and I have plugged away at the dull chore of measuring % misses. This seems routine and antediluvian, but damn it, they do it all with circa 8 kHz or lower, so I think it important to know just what they can and can’t detect.⁵⁵ [Don underlined the “I”]

(Ron replied most positively and empathetically.)

Griffin and Dave did indeed plod on ... and on. The researchers “ran” the swiftlets in hundreds of trials. The results indicated both great individual variabilities, but also that swiftlets could avoid obstacles as small as 6.3 mm in total darkness more often than they could avoid 1.5 mm wires.⁵⁶ Their rate of successful avoidance of the 6.3 mm rods was about the same as the birds’ performance when using vision, in the light, namely about 75%. One might expect the birds to be better than that during the lit conditions. Swiftlets *do* hunt successfully for small, flying insects during the day using vision. Don suggested that “gentle touches with the primary feathers caused little discomfort,”⁵⁷ so the birds didn’t really care too much if they bumped into the obstacles. Despite the variable performance, the birds *were* detecting small objects using audible sounds. Don raised this point again in the context of human echolocation, for if the swiftlets can detect such small objects with sounds within human hearing range, why shouldn’t humans be able to do the same? Further discussion later.

Rod Suthers and Dwight Hector were likewise engaged with the grey swiftlets, but they were determining the syringeal mechanisms that produced the clicks, capturing the birds at dawn, and bringing them to the town hall lab for the physiological work.⁵⁸

The Bats

In Don’s Aug 29th, 1980 letter, he remarked,

Last night Pat Brown mistnetted 15 ferocious ... Hipposideros diadema [the Diadem Leaf-Nosed bat] (ca. 50 grams) and released them with third generation Buchler lights. Several flew right back into the cave (or the mistnet), others were lost behind trees, but some roosted and seemed to be doing flycatcher style hunting while whistling at ca 50kHz loud enough for the QMC [a microphone] to pick up at 15 m. (+/-)⁵⁹.

And Don adds,

Dave is off with Pat and a local bat biologist and others to look for Macroderma in an old goldmine. He worries about reputed death adders, but never misses a chance to go anywhere new!

And on September 15, Griffin noted

Things are humming here, especially since Brock’s arrival. ... Pat Brown and her new husband are tracking cyalumed and radioed bats all night.⁶⁰

The third-generation Buchler lights aka “Cyalume” were later developments of the lighting devices that Don’s post-doc Ed Buchler had invented using the glowing substance Cyalume. Ed was the first to use it on bats, putting the substance in little balls which he attached to *Myotis lucifugus* (Little Brown Bats) living in an attic at the Millbrook field station. One could then spy the path of the bat until it disappeared or the Cyalume ceased glowing.^{61,62}

Using crystal-controlled radio transmitters, Pat and her husband, Robert, were managing to track those “ferocious” *H. diadem* in the field and gather data on the bats’ home ranges, activity patterns and foraging behavior. Even echolocation signals of known bats could be recorded at the same time. Unlike many other bats, but similarly to the flycatcher bird (Family *Tyrannidae*), *Hipposideros diadem* hangs in a stationary position, waiting to detect its prey; and then darts out to catch it. It can use Doppler-shift compensations (DSC),⁶³ altering the CF component of its signals to adjust for either approaching or receding insects. This contrasts with the better-known Greater

Horseshoe Bat, (*Rhinolophus ferrumequinum*) which detects its prey while flying; it can alter the CF component to account for its own flight speed but cannot compensate for negative Doppler shifts due to a receding insect.⁶⁴ (The Greater Horseshoe Bat is widespread, but *not* found in Australia.) These species differences, of course, raised more challenges for the researchers, eager to compare the echolocation adaptations to different hunting styles and environmental conditions and to understand the evolutionary histories.

And on the trip was a bat researcher, particularly interested in evolutionary relationships and comparative work. That was Brock Fenton, who knew Don over the years and had spent part of his sabbatical in Griffin's lab at the Millbrook field station (1976). In his September 15 letter to Ron Larkin, Don remarked that

*Brock Fenton just arrived two days ago, and is setting us a fatiguing example day and night. He and students have been getting all sorts of fascinating new bat data – for instance, they really can identify species now. If U. Illinois or IINHS wants an exciting seminar on modern analytical natural history, try Brock after November.*⁶⁵ [INHS is the Illinois Natural History Survey. Ron Larkin had a joint appointment at both institutions.]

While on the Chillagoe expedition, Brock recorded the search phase of echolocation calls of 12 species of bats, determining that each species could be identified by its call characteristics. Their hunting styles varied significantly. Some species, including the *Hipposideros* noted above, “made short flights from perches to intercept flying insects, while others flew continuously while hunting, reacting to targets at short (circa 1 m ...) or long (over 2 m) range.” Fenton's comparative work with species from North America and Africa exhibited similar adaptations of calls to hunting styles and environment.⁶⁶

Griffin further notes that “Rod, Dwight Hector (from I.U.) and Philip Jen have been recording response curves from IC units in various families of bats.” (The inferior colliculus (IC) is the principal midbrain nucleus of the auditory pathway, receiving inputs from both more peripheral brainstem nuclei and also from the auditory cortex. It is an extremely important way station for the auditory system of mammals, with almost all ascending and descending auditory pathways synapsing with the IC and helping to integrate information from auditory and non-auditory systems. Bat researchers were most curious to understand its functioning in echolocation.)

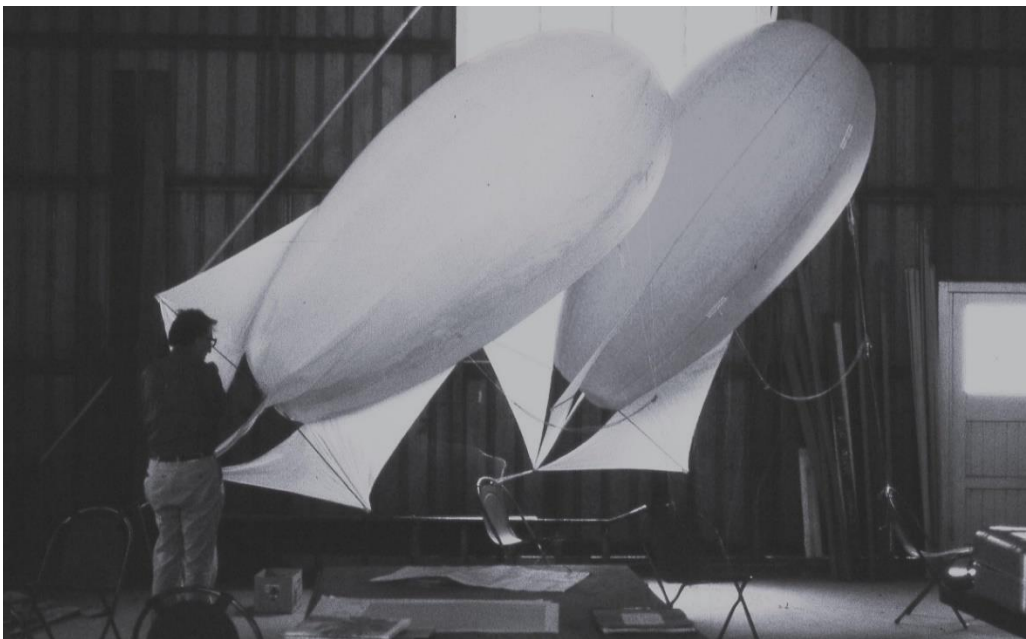
High Flyers (Bats and Kytoons)

The Mystery

Griffin, too, was studying bats. He was puzzled by yet another bat mystery. Previous researchers had noticed bats flying up so high, that they could no longer be seen with binoculars.⁶⁷ The particular bats were *Tarida brasiliensis*, commonly known as the Mexican or Brazilian Free-tailed bat, a member of the widespread *Mossidae* family. Don's former student, Timothy Williams, had, in his radar observations, observed that huge numbers of those bats sometimes climbed up to 3000 meters in the early evening.⁶⁸

The mysteries perturbing Griffin: “Why should bats fly so far above the ground? Are they hunting insects by echolocation as they so commonly do at lower altitudes?”⁶⁹ At that time, the technology *did* permit bats to be recorded in the field with portable equipment as several researchers on the Chillagoe expedition had been doing. But how to record them up in the air?

Solution: balloons, or rather “Kytoons” (tethered balloons with kites), equipped with radio transmitters and bat detectors. The Kytoons were quite marvelous inventions, its predecessor first created in 1893 for the Prussian Balloon Battalion. By themselves, neither kites nor balloons are stable bodies, dipping and flying away at angles, with kites sometimes crashing to the ground. But a kytoon *is* stable, gaining some of its lift dynamically as a heavier-than-air kite and some as a lighter-than-air balloon. As wind might push a tethered balloon to drift away and lean away, the balloon gets closer to the ground. On a kytoon, the same wind lifts the kite, thereby lifting the attached balloon, and counteracting the pull toward the ground. The kite action provides good stability for the kytoon, even in strong winds.⁷⁰ Don had created his own particular version of the contraption. (For the technically minded, Don and Dave’s paper provides a very complete description of the characteristics of the microphone and bat detector held by the kytoon.⁷¹)

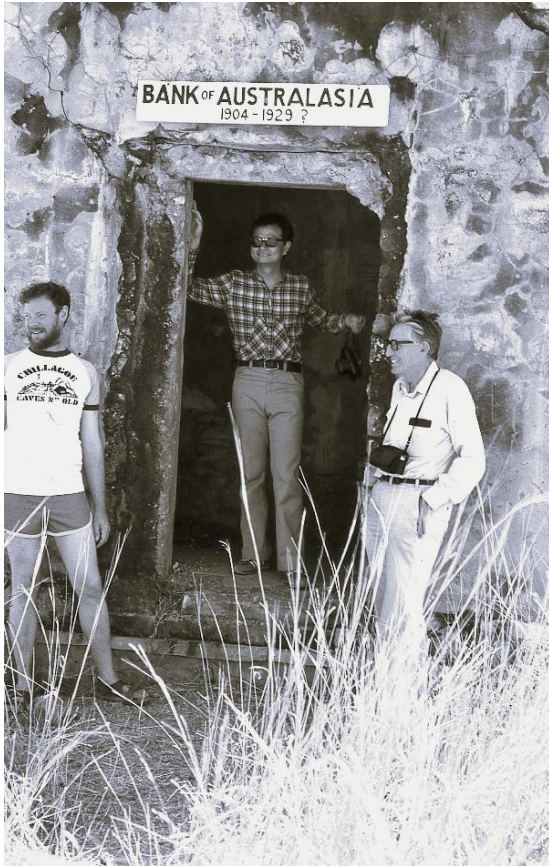


Don Griffin readying Kytoons (kite plus balloon). 1980. (by M. Brock Fenton)

One might wonder why Griffin had to come all the way to Australia to ask his question about potentially high-flying bats. In fact, Don *did* fly kytoons back in Millbrook, with the radar “Witch” at hand. But, as he wrote in a letter to Ron at RU in 1973, when Don was in Kathmandu, Nepal, the problems were those of legality and hill height.

Assuming we do what is legal and keep Kytoon below 150 feet, this could start from a Hilltop. Part of the newly bought “Keller property” is I think about 250 ft above Gravel Pit [site used for the “Witch” at RUCFR, Millbrook]. There is also a Hill Northeast around a pond, greater than/equal to 100 ft above radar. Probably these are too far away to be much help.⁷²

Griffin and Dave attached a chemiluminescent “Cyalume” light to the kytoon to aid in tracking its position in the air; this was the same “Buchler light” used by Pat Brown and Robert in their Chillagoe bat studies. A microphone bat detector hung suspended from the kytoon. Another three mikes/bat detectors were on the ground, to help triangulate the sound source. Height above ground could be estimated by knowing the length of the tethering line and estimating the length of



(Left to Right): **Jim Simmons, Philip Jen, Don Griffin in Chillagoe, Australia, 1980.** (by M. Brock Fenton)

the tethering line and estimating the angle of the line via a sighting device attached to binoculars held by an observer on the ground.

(About Microphones - WONKISH)

The special QMC microphone was the microphone/bat detector of choice for most of the researchers, Griffin included. Some, such as Brock Fenton and Jim Simmons, were content with their own versions of a “periodmeter.”⁷³ At the time, the QMC was the most advanced mike for the work, and was developed by David Pye, the researcher and “bat detector developer.”⁷⁴ And the initials “QMC” commemorated his home institution, Queen Mary College. Until Pye’s creation and other later commercially developed bat detectors, many researchers had their own custom-made devices. Fenton describes the multiple gadget-making as a “cottage industry” in the UK.⁷⁵

Brock recalls an “antique” device that Don had used for a considerable while, basic, but effective. It was a condenser microphone, a fairly simple device with a metal disk or “backplate.” Don was using a version of a condenser mic even before 1958 when he described its operation in *Listening* and deemed it a “precision instrument.”⁷⁶ As Brock

recalls Don’s device, it had thin aluminized, electrically charged mylar stretched over the backplate.⁷⁷ The mylar vibrated when hit by sound, duplicating the frequency of the incoming sound waves, with its force dependent upon the energy of the wave. Contact of the mylar with the backplate produced an electrical signal. Condenser microphones were especially good with high-frequency sounds and were the preference in most recording studios. The mylar adaptation for the bats made the device even more sensitive to the bats’ ultrasonics. Compared to “dynamic microphones” which required a diaphragm, magnet and coil, the condenser mikes were more responsive and lighter weight,⁷⁸ both being essential to Don’s work, for he mounted the microphones on the flying kytoons.

A Fine Plan ... But ...

The Kytoons holding the QMC microphone aloft needed helium. The tiny town of Chillagoe did not have a helium supply, so Griffin had sensibly ordered it ahead of time to arrive on the train, which passed through Chillagoe once a week. But ... as Don reports in his August 29 letter, “Helium due tonight on truck of friendly cane farmer (supplier forgot to deliver it in time for the weekly train), and so it goes.”⁷⁹ Something(s) else must have gone awry, for the published research paper

states that the work was conducted between September 18 - 29, 1980, substantially more than a few days after the expected helium arrival with the farmer.

Fishing line and reels were also part of Griffin’s specialized Kytoons. The Kytoons were tethered to the ground with a line, a Dacron fishing line handled via a deep-sea fishing reel equipped with a motor drive. So, as known by every person who’s ever attempted to fish, the line tangles and knots, both intended knots for securing and the multitude of unplanned ones. Not to ignore the difficulty of managing the bulky and wayward Kytoons, a groan voiced by almost all back in Millbrook. And all this is happening in the middle of the dark night.

Batteries: The four mike/bat detectors used at least 4 double A batteries apiece and Don changed them all every night. He had brought a massive supply (no such batteries in Chillagoe) and wisely stored them in the refrigerator to better preserve their charge. It was the group fridge, so used by others as well. One day, revealed Brock Fenton, someone had taken virtually all his batteries. The ever-calm Griffin was “really, really pissed.” He was “rubbing his hands together, you know the display,” Brock commented to me. Brock, also knowing the display, mumbled at the time, “I’m getting out of here.” Don wrote a note, pasting it on the refrigerator, “Dear colleagues, this may look like a lot of batteries to you, but I need them.” Brock also knows who stole the batteries. The person is still alive,⁸⁰ but didn’t believe that so many batteries were needed for Griffin’s research, thinking that many were “extras.” To preserve collegiality amongst researchers, the thief’s identity remains secret. But Don drove five hours to Cairns to purchase more batteries and another five hours back.

High Flying Research

Finally, the “bats aloft” research could begin. But how to know that the bats were hunting for insects and indeed *which* bat species *might* be zooming about up in the air? Brock Fenton’s previously mentioned Chillagoe bat study to the rescue.⁸¹ The species Don and Dave managed to record on high could be identified by their calls; they were, reasonably, the same species that could also be recognized hunting at much lower altitudes. These were members of the *Mossidae* family, genus *Tadarida*, specifically *T. becarri* and *T. jobensis*. The bats could even be observed, using a night vision device with binoculars. Sometimes, they hovered near knots in the line, even attacking them, presumably mistaking the knots for insects, inedible insects, set by fiendish humans.

Most of the time, especially at higher altitudes, such observations were not possible. How to know that the bats were *hunting* for insects up so high? Here the critical evidence was the rapid increase in pulse repetition rate and a final “terminal buzz” as a bat approached and neared its target. The bat and its potential prey were largely unseen by the human observers, but the radio microphone/bat detectors could send a signal which was then recorded on the ground. And that occurred. High above, at 200, even 300 meters (about 650 and 1,000 feet), increases in rapid bat pulses were detected. But could the bat possibly be detecting some object on the ground? Not reasonable, for high frequencies are rapidly absorbed by the atmosphere. Griffin surmises that “Ground echoes are almost certainly inaudible at altitudes of more than 100 meters...”⁸² In essence, being so high, the bats were flying in an anechoic chamber. There was no need to try to distinguish their echoes from other “clutter;” there was basically none (except for other flying bats). And in the evening, there were likely to be “updrafts,” aiding the bats on their upward journey.

Success for the experimenters, but with very hard, often frustrating work. In his September 15 letter, while expressing concern that both he and Ron write their drafts for an NSF Final Grant Report, Griffin noted, "I will have a full month of 40-hour days, and it is adaptive for us both to have a good report." Indeed, on October 11, Don wrote, "...we have just emerged from, some very full days and nights." Indeed, the published reports indicate overlapping periods of working simultaneously on *both* the swifts' obstacle avoidance *and* the kytoon research with high-flying bats. Don adds, in his typical reserved manner, "Someday, Dave's uncensored version would be of entertaining interest."⁸³ Fortunately or unfortunately, no such account seems to exist.

Subsequently, Dave Thompson continued their studies in 1981 in Utah and Nevada, again finding high-flying bats of the same genus (mostly *T. brasiliensis* and some *T. macrotis*). These, too, were making terminal buzzes, suggesting feeding at those high altitudes, up to 270 meters above the ground.⁸⁴ Still later work by Brock and Don (1982), again, with the help of Dave Thompson in the field, established evidence for yet higher flying by at least seven bat species in Zimbabwe. The researchers found feeding buzzes even at 500 meters high above the ground.⁸⁵ So, overall, a reasonable foraging decision by the high-flying bats. But, as with Griffin's work in animal awareness ... the reviewers of their paper had been most resistant. "Bats can't do that!" Brock recalls how the reviewers kept demanding recalculations and more recalculations.⁸⁶ But bats *could* do that and did.

The "bats aloft" continued to intrigue Don. At a 1985 scientific meeting, Griffin persuaded fellow bat researchers Sid Gauthreaux and Gary F. McCracken to collaborate with him on a study of the high-altitude foraging by Mexican free-tailed bats (*T. brasiliensis*). By this point, Don had recorded bat echolocation calls even at 500 meters (1,600 feet) altitude, while Gauthreaux had observed bat-like foraging flight at 800 meters (2,600 feet) on his radar. In 1986, the three were off to central Texas where millions of hungry, nursing bats consume tons of insects each summer night. The researchers did record free-tailed bats' calls, including feeding buzzes at 200 meters, but not quite the heights they were hoping for. As McCracken relates, Don bequeathed several boxes of equipment and the "bats aloft" project to him.⁸⁷ (This was the year Griffin was "retiring" ... at least from Rockefeller, and engaged in near-field acoustics research on bees with Jim Gould's lab and focusing more on Cognitive Ethology. A time for prioritizing.)

And Now ... for Something Yet More Astonishing!

Don Griffin would have been delighted with some of the latest bat research. One line of research continued studies of the Mexican free-tailed bats in Texas, specifically those at the famed Bracken Cave; millions of bats emerge nightly from that cave alone. In 1995, the U.S. Weather Service's new powerful Doppler radar was turned on, fortuitously only a few miles from the cave. The radar captured a tale of bats and moths. In brief, America's #1 agricultural pest, the corn earworm, depends on the migration of its moth form for distribution and for creating the next generation; the larvae cannot survive US and Canadian winters. The moths and nursing bats fly at the same elevations ... but ... the moths do not arrive in central Texas when the bats leave their caves each evening to forage. The moths arrive in the morning; these bats emerge again in the early morning, having nursed their young in between. The bats switch their diet to 97% moths from 37% at night, so the bats *were* consuming enormous numbers of moths, though presumably not as many as might occur if moths arrived in the evening. DNA analysis of bat feces and radio microphone recordings revealed that the bats were producing feeding buzzes at 750 meters (2,400 feet) and

eating the nearby moths, conveniently migrating on high.⁸⁸ Yet more intriguing, Mexican free-tailed bats were shown to be modifying the structure and frequency of their calls, depending on the altitude. Some changes were likely due to the greater clutter near the ground and to the relative abundance of prey at different heights, while the others were interpreted as adjustments to the changing atmospheric acoustical properties at different heights.⁸⁹

Still other research indicated that some bats fly even at 1600 meters above the ground; they do it primarily by surfing on air currents. (These are the European free-tailed bats aka bulldog bats or *Tadarida teniotis*.) That’s easy for birds, which, during the day, use the rising warm air caused by the sun’s heating up the ground, trees, etc. And birds have excellent long-distance vision, so they can “read” the landscape. But bats fly at night when the wind drops. How do they find the right air currents for “surfing?” Researchers outfitted some bats with GPS collars or backpacks. With that data and by consulting a digital model of the local topography and weather, researchers determined that bats in their study sought out south or west-facing slopes. Thus, prevailing night winds swept the bats up those slopes. Then rollercoaster-like, using their cognitive maps of the area, the bats navigated, on their way down, to the next slope and did it all again ... and again ... and again, traveling significant distances. The extensive work involved collaborative efforts from researchers across continents and disciplines.^{90,91}

And not only do the bats fly high, but many are simply zooming across the sky. Birds had been thought to fly more efficiently and faster than bats. But researchers, tracking the bats from an airplane, found that the Brazilian free-tailed bats (*Tadarida brasiliensis*) were, at maximum speed, flying faster than any previous record had documented. Among the techniques the bats use to conserve energy and to assist their rapid flight are the same ones used by birds: “flap-gliding” by which a bat or bird pauses to glide between wing flaps. The maximum speeds achieved ranged from at least 25 meters per second (mps) to 30 mps (90 - 108 km/hour). Those were 2016 data, and, by 2021, data from those nocturnal European free-tailed bats flying in roller-coaster fashion indicated self-powered air speeds up to 130 km/hour.⁹²

Bat research continues to astound. But what of other species, of human echolocating?

PART FOUR

HUMAN ECHOLOCATION (Griffin Research Onsite at Rockefeller University)

A Bit of History

People have long noticed that some blind persons seem able to walk around without bumping into obstacles. In the first published report (1749), the philosopher Diderot recorded the “amazing ability” of a blind acquaintance both to detect the presence of objects and even to judge accurately their distance from him.⁹³ Diderot was “not a practicing scientist, but as close to one as he could be.”⁹⁴ His interpretation was widely accepted that the blind man was sensing the action of air on his face. Perhaps, suggested Diderot, the facial nerve receptors had heightened sensitivity. That view, recall, was very similar to the one espoused by Cuvier, concerning bats’ obstacle avoidance abilities. Griffin sadly remarks how teachers of the blind would have profited from knowing the bat experimental results of Jurine and Spallanzani. Those bat results totally discredited the “air-sensing” notion and established evidence for an acoustic basis of the bats’ navigational ability. But, Don comments, those results were “lost to view in remote and dusty archives because of the caustic skepticism of Cuvier and his followers. What a pity...”⁹⁵

Many more theories emerged after Diderot, as cited by Hayes in 1935 in an excellent historical review.⁹⁶ Hayes enumerated 14 hypotheses, subdivided into those that relied upon a sensory, a perceptual, or even an occult source. The latter, according to Hayes, included magnetism, electricity, vibration of the ether, the subconscious, etc. Perceptual theories depended upon interpretations of sensory cues, while sensory theories suggested a heightened response of some sensory organs, of pressure or temperature on the face, or, finally, among others, audition.

Again: Griffin’s 1958 *Listening* is Relevant (The Cornell Experiments)

As with so many other topics, Don also dealt with the subject of human echolocation in his 1958 classic, *Listening in the Dark*, devoting some 50 pages to the topic. He included the special devices humans use to echolocate (e.g., radar). He specifically cited cases of blind humans who were extraordinarily capable of excellent locomoting: One person had no idea how he did it. The other, a young boy, Billy, said he listened attentively to the sounds about him as he careened about on his bicycle ... safely, without collisions.⁹⁷

In *Listening*, Griffin explained, in great detail, a flurry of experiments conducted on human echolocation. These were done in the 1940s, primarily at Cornell University’s Psychology Department. He was impressed by the work, considering them “rigorously controlled and wholly decisive on the obstacle sense of the blind.”⁹⁸ Although Griffin was at Cornell during much of that period (1946-53), he does not appear to have had any part in the research.⁹⁹ In the publications, he’s mentioned only with respect to evidence establishing the *acoustic* basis for *bat* echolocation.¹⁰⁰ The Griffin and Galambos experiments were cited in which preventing bats’ hearing or vocalizing resulted in the bats’ hitting obstacles rather than avoiding them.¹⁰¹ The Cornell researchers also highlighted bats’ rapidly increasing their rate of emitting vocal pulses as they approached near an obstacle; this phenomenon did not appear in deafened bats.¹⁰² Such results certainly emphasized the potential significance of acoustic cues in human obstacle avoidance.

The Cornell experimenters were two graduate students: one had been blind from birth and the other had normal hearing and vision. Professor Karl M. Dallenbach guided the research. Investigating the possibility of “facial vision” in the echolocation abilities of blind persons, they explored two different sources of sensation: exposed areas of the skin and the ears (both hearing and “air” on the ears). Two subjects were blind, two were normal; the experimenters were among the subjects.

It was a rather peculiar scene in the laboratory. All subjects were blindfolded very securely. To prevent skin exposure to air pressure (aka “airwaves”), some subjects were wandering about covered with massive, thick felt “veils.” These were “the thickest obtainable” felt, covering their heads and shoulders and much of their chest and back. The veil did not touch the skin, due to a peculiar, wooden construction supporting it. The subjects wore thick, wool-lined leather gauntlets. Differently sized, movable Masonite screens served as the obstacle. Sometimes, sounds were introduced to interfere with any acoustic cues the subjects might be using, e.g., clicking from their footsteps. The interference was a “moderately loud” electronic tuning fork played through earphones.

As the subjects approached the obstacle, they indicated when they first sensed its presence and then when they were about to hit it, then hitting it if they were incorrect. Importantly, all the subjects were trained to a criterion of 25 successful trials in which they did not bump into the barrier. Of course, the experienced blind persons reached the criterion much, much faster. The others wandered about the lab, hesitating, shuffling, meandering in various directions. After many experiments, the authors concluded that neither the face nor other exposed skin is a necessary or sufficient condition for obstacle avoidance. In short, the “pressure theory ... is untenable.” Aural stimulation, however, “is a necessary and sufficient condition for the perception of obstacles by our Ss.”¹⁰³ A further set of experiments eliminated the possibility that the *skin* of the ear was responsible for sensing air currents or pressure and established that hearing was the source of information about the presence of an obstacle.¹⁰⁴

Echolocation Broadly Applied

Decades later, when Griffin conducted his experiments at Rockefeller University, his specific interest was the *extent* of human echolocation; how sensitive could it be to the environment?¹⁰⁵ He knew humans used various sound techniques: tapping a special cane, using sounds from their footsteps or even mouth clicking.

Early on, he had purposefully applied the term “echolocation” broadly. Back in 1944,¹⁰⁶ Griffin had promoted “echolocation” to subsume the various known instances of animal and human use of reflected energy, that is, echoes. At that time only bats and blind humans were considered echolocators. He cited examples of “sounding” used by ships to determine the depth of the ocean floor beneath them, radio waves sent by airplanes to detect the distance of a mountain before them or the ground below, and, finally, even more sophisticated use of such waves with radar. The time between the output of a sound and its receipt by the sender was the measure used to calculate distance in those cases. (Recall that some bats use different properties of the sound waves to determine distance.) Given Don’s long-abiding passion for sailing, he drew many examples from boats at sea. A ship captain sailing in fog-bound coastal waters may blow a whistle, listening for an echo indicating a nearby cliff or rock. (Notice the use of a whistle’s high frequency which can give

more accurate distance information than lower-pitched sounds.) Long- experienced sailors are said to be able to detect objects as small as a buoy by such methods. Schools of fish and submarines are also located by sounding instruments.

A Promise: Human Echolocation Research (Confusing Clicks at RU)

While Don and Jocelyn were vacationing in Kathmandu (summer 1973), Don wrote to Ron Larkin of his intention to investigate human echolocation.

"... I have promised myself and NSF to have a go at human echolocation during the current year. I had hoped that Glenis¹⁰⁷ would join in such an effort, but she is obviously not going to. I'm not urging you to, but warning that I may draw some audio electronics into that effort, though probably not actively until after migration season."¹⁰⁸ [Underlining is Griffin's.]

Most of the letter emphasized ideas for exploring *birds'* potential use of echoes during migration. Griffin remained interested in human echolocation, as did others hoping to improve the plight of the blind; many blind persons did not achieve impressive or even satisfactory navigational skills.

Others, too, had been focused on the precise discriminative abilities of the blind. As early as 1965, C. E. Rice et al had experimented in controlled laboratory anechoic conditions (or nearly so). The five blind individuals generated their own sounds. They gradually improved, such that they could detect a target of about 1.5 to 6.5 inches in diameter at different distances.¹⁰⁹ Other work indicated that both blind and blind-folded normally sighted humans could detect a target monaurally, make simple shape discriminations, and locate a target in space.¹¹⁰ All this is good, but nowhere near the bats' abilities.

Griffin particularly wondered why we cannot do as well as bats or some birds. They have much smaller brains, but, apparently, special adaptations to extract pertinent information from acoustic echoes. Why can't humans mine such information? A frequently offered explanation was that humans had reduced sensitivity for a few milliseconds after sound emission; that could inhibit the reception of any returning echoes. Bats, instead, have both mechanisms to briefly protect the bat's damaging its hearing from its own loud vocalizing as well enhanced sensitivity to the echoes.¹¹¹

In the mid-1970s and early 1980s, Griffin created experiments in which humans were to discriminate between two different targets by echolocation. The echoes were those recorded from ordinary objects experienced in typical indoor situations. In some instances, he electronically removed the emitted signal from those sent to the human's ears, while otherwise, both the emitted sound and the echoes were present. Discrimination was only very slightly improved by the omission.¹¹² That is, inhibition of the echo due to the initial sound must not have much effect on a human's ability to use echolocation. The limitations to human echolocation must be due to other factors, he concluded. And the humans' target discrimination was not very good in either condition.^{113,114}

I recall being a subject in these or related experiments. In a chamber, well insulated from the lab's and city's noise, I listened via earphones to a series of clicks. I was to indicate whether they were type A or B (presumably echoes from the different targets). Being utterly confused, I felt unable to sort them and was just guessing, so I presume I did very poorly.

I can find no relevant publication and little other information about Griffin's human echolocation research. He did discuss the issue as part of his July 2003 Keynote Address to an international conference on Animal Acoustic Communication.¹¹⁵ He considered that:

*Human echolocation used by the blind is a neglected field. Under ideal very quiet conditions in an anechoic chamber, both blind and blindfolded subjects (with extensive practice) can detect and discriminate between relatively small objects. But in the real-world, blind people cannot do nearly this well.*¹¹⁶

Griffin's further comments may have included his own research, though others' work had already established the abilities cited. A later review (2014) of the literature by Kolarik et al described much additional research. Scientists determined that humans used a variety of cues to echolocate. The sound level of the echo was itself a cue as was the whole spectral envelope. As with bats, the delay between making a sound and receiving the echo ("emission-echo delay") was a significant cue, along with any differences between the signals to the two ears. Even after considerable training for sighted persons, the blind, on average, are better echolocators. Furthermore, in the human blind, both PET (Positron Emission Tomography) scans and MRI (Magnetic Resonance Imaging) indicate that they are recruiting additional brain areas for their echolocation tasks. Visual brain areas, specifically the occipital lobes, process echolocation information.¹¹⁷ Yet another example of the brain's fortunate plasticity.

The field continues to intrigue, garnering more needed attention.

ENDNOTES

NOTE: Letters from Donald R. Griffin (DRG) to Ronald Larkin (individually or including other RU lab members) and letters from Larkin to DRG have been accessed by me (Carolyn A. Ristau) from the private collection of Ronald Larkin.

PART ONE ENDNOTES BEGIN HERE

¹ The research with whales conducted by Roger and Katy Payne and work by RU grad student Peter Tyack is discussed in Volume Two - Chapter 12, Part 4 in the section, "Roger Searle Payne (RU Assistant Professor) and Katherine (Katy) Boynton Payne (Scientist)."

² See discussion of Griffin's RU work with bats in Volume 2 - Chapter 12, Part 2, section "The "Bat Researchers" and Others and Volume 3- Chapter 18, Part 5, "Back to Bats."

³ Some of Carolyn A. Ristau's research with plovers is described in Volume 3, Chapter 16-Part 3, section, "Manipulating Beasts..."

⁴ The photo of the displaying plover is in Volume 3, Chapter 16-Part 3, section, "Manipulating Beasts..."

⁵ Carolyn A. Ristau, 1991b.

⁶ For a description in this book of Carolyn Ristau's research investigating the plover's possibly "purposeful" use of the broken wing display, see Volume Three, Chapter 16-Part 3, section, "Manipulating Beasts - The "Injury-Feigning" Plovers."

⁷ Discussion of some shorebird migrations may be found in Volume One, Chapter 7, "Flying With the Birds," section, "Preliminaries" at the beginning of the chapter. The topic of avian navigation is the focus of that chapter.

PART TWO ENDNOTES BEGIN HERE

⁸ Donald R. Griffin (DRG), 1983, p.33. [RU Sci & Ed Programs, 1981-83].

⁹ DRG, 1983, p. 33. [RU Sci & Ed Programs 1981-83].

¹⁰ The bee research of Gould and Brines is described in Volume Two - Chapter 12, Part 5, section, "Research by Griffin Lab Members," subsections titled "James (Jim) L. Gould (And Bees That Lie)" and "Michael (Mike) L. Brines (Sky Maps)."

¹¹ Discussion of avian migration studies in Chapter 12.

¹² DRG, 1983, p. 33. [RU Sci & Educ Program] Griffin discusses M. Yodlowsky's thesis research. I have been unable to find a journal article about her dissertation research.

¹³ Edward R. Buchler, 1976a.

¹⁴ Edward R. Buchler, 1976b.

¹⁵ Edward R. Buchler, 1980a.

¹⁶ Edward R. Buchler, 1980b.

¹⁷ Brock Fenton and Edward Buchler's work was discussed in Volume 2 - Chapter 12, Part 3, section "At the Millbrook Field Station; Ulrich Schnitzler's research in Volume One -Chapter 11, Part 2, "Echolocation Research by Griffin and Others," section "Detecting an Insect and the Perplexing Doppler Shift.

¹⁸ Jim Simmons' dissertation study is discussed in Chapter 11, as are various joint research endeavors in which Don Griffin and he were both involved.

¹⁹ Projects, Woods Hole Oceanographic Institute, Box 15, Folder 51, 450G, Donald Redfield Griffin Papers, Rockefeller University Archives, RAC.

²⁰ Roderick Suthers' bat research is discussed primarily in Volume Two - Chapter 12, section "The "Bat Researchers" and Others," subsection "The "Bat Researchers" and Others." Bradbury's and Williams' research is also primarily described in the same section, subsections "Jack W. Bradbury, Griffin Graduate Student" and "Timothy C. Williams Griffin Graduate Student, and Janet M. Williams, Collaborator." Jack Bradbury's post-doctoral work with Peter Marler can be found in Volume Two - Chapter 12, Part 4, in the subsection, "Peter R. Marler."

²¹ DRG, p. 33-34. [RU 1983].

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²² Brock Fenton, personal communication, March 24, 2021. Interview via Zoom call. The phrase "Middle of Nowhere" was used by Fenton to describe the location of their research site in Chillagoe.

²³ Alexander von Humboldt, 1814.

²⁴ DRG, 1953.

²⁵ Griffin's trip to the Venezuelan caves with the oilbirds is described in Volume One - Chapter 10, Part 3.

²⁶ Signe Brinklov, M. Brock Fenton and John M. Ratcliffe, 2013.

²⁷ Roger B. Coles, Masakazu Konishi, and John D. Pettigrew, 1987, p. 365-366. Much of the information in the preceding paragraph is taken from these pages.

²⁸ For further description of Rod Suthers and his research, see Volume 2 - Chapter 12, Part 2, section "The "Bat Researchers" and Others," subsection, "Roderick (Rod) A. Suthers (1937-2019) and Julia Chase."

A brief biographical sketch of Suthers is included in Volume Two- Appendices.

²⁹ Brock Fenton, personal communication, March 24, 2021. Interview via Zoom call.

³⁰ DRG, September 15, 1980 letter to R. Larkin.

³¹ David B. Thompson and M. Brock Fenton, 1982.

³² David B. Thompson and Roderick A. Suthers, 1983.

³³ Donald R. Griffin and David Thompson, 1982a.

³⁴ Donald R. Griffin and David Thompson, 1982b.

³⁵ QMC and other microphones/sensing devices are mentioned in the section in this chapter, titled "About Microphones - WONKISH."

³⁶ DRG, September 15, 1980. Letter from DRG in Chillagoe, Queensland, Australia to Ron Larkin in Urbana, Illinois. Accessed from personal collection of R. Larkin.

³⁷ M. Brock Fenton, personal communication, March 24, April 15, and April 29, 2021. Interviews on Zoom.

³⁸ DRG, August 29, 1980. Letter from DRG in Chillagoe to Ronald Larkin.

³⁹ R. B. Coles, M. Konishi, and J. D. Pettigrew, 1987, p. 366.

⁴⁰ M. Brock Fenton, personal communication, March 24, 2021. Interview via Zoom.

⁴¹ DRG August 29, 1980. Letter from DRG in Chillagoe, to Ronald Larkin. Accessed from the personal collection of R. Larkin

⁴² R. B. Coles, M. Konishi, and J. D. Pettigrew, 1987.

- ⁴³ DRG, September 15, 1980. Letter from DRG in Chillagoe, Queensland, Australia to Ron Larkin. Accessed from THE personal collection of R. Larkin.
- ⁴⁴ D. S. Rabor, February 23, 1954 letter to DRG, quoted in Griffin, 1958, revised edition, p. 292.
- ⁴⁵ D. S. Rabor, February 23, 1954 letter to DRG, Correspondence, Ra-Ri, Box 11, Folder 107, 450G-875 Donald Redfield Griffin Papers, Rockefeller University Archives, RAC. Accessed Dec 18, 2018.
- ⁴⁶ DRG, 1958, 1978 edition, *Listening*, p. 294. The needed experimental evidence is discussed on p. 294-296.
- ⁴⁷ M. Brock Fenton, personal communication, June 22, 2021. ZOOM interview.
- ⁴⁸ DRG letter August 29, 1980 to R. Larkin.
- ⁴⁹ DRG letter October 11, 1980 to R. Larkin. The quote is a compilation of Griffin's description of the hole from his letters of August 29 and October 11, 1980.
- ⁵⁰ DRG and Roderick A. Suthers, 1970.
- ⁵¹ DRG & David Thompson, 1982a, p. 119.
- ⁵² DRG & David Thompson, 1982a, p. 119.
- ⁵³ M. Brock Fenton, personal communication, June 22, 2021. ZOOM interview.
- ⁵⁴ The "wire experiments" were described in Volume One - Chapter 6, "Young Men and Flying Bats," section, "Fine Wires."
- ⁵⁵ DRG, Sept 15, 1980 letter to R. Larkin.
- ⁵⁶ DRG & David Thompson, 1982a.
- ⁵⁷ DRG and David Thompson, 1982a, p.119.
- ⁵⁸ Roderick A. Suthers and Dwight H. Hector, 1982.
- ⁵⁹ DRG. August 29, 1980, letter to R. Larkin. Accessed from the private collection of R. Larkin.
- ⁶⁰ DRG September 15, 1980, letter to R. Larkin. Accessed from the private collection of R. Larkin.
- ⁶¹ Edward E. Buchler, 1976a.
- ⁶² For further description of Buchler's creation and use of Cyalume-filled spheres, see Volume Two - Chapter 12, Part Three, section "At the Millbrook Field Station."
- ⁶³ Doppler Shift Compensation is discussed in Volume One - Chapter 11, Part 2, section, "Detecting an Insect and the Perplexing Doppler Shift."
- ⁶⁴ Patricia E. Brown and Robert D. Berry, 1983.
- ⁶⁵ DRG letter September 15, 1980 to R. Larkin.
- ⁶⁶ M. Brock Fenton, 1982.
- ⁶⁷ R. B. Davis et al, 1962.
- ⁶⁸ Timothy C. Williams, L. C. Ireland and Janet M. Williams, 1973.
- ⁶⁹ DRG and David Thompson, 1982b, p. 303.
- ⁷⁰ George X. Sand, 1958.
- ⁷¹ DRG and David Thompson, 1982b, p. 303-304.
- ⁷² DRG, July 17, 1973, letter to Ron Larkin from Kathmandu. Accessed from the private collection of R. Larkin.
- ⁷³ Schneider Electric Company, 2019. A periodmeter is a device that measures the time between two events. Thus, the duration of a wavelength or the time between two sound wave maxima, could be measured, thereby determining wavelength and frequency. At least in 2019, the resolution available permitted detection of time intervals as short as 0.01 msec.
- ⁷⁴ David Pye's work has been discussed primarily in Volume One - Chapter 11, Part 2, section. "The Shape of an Ear ... or Antenna," including the Text Box, "David and Ade Pye ... and Bat Detectors." Also in Part 2 are excerpts from a poem by David Pye, "On the Variety of Hearing Organs in Insects."
- ⁷⁵ M. Brock Fenton, personal communication, June 22, 2021. ZOOM interview. Unless otherwise specified, the descriptions of Don Griffin's work with kytoons and microphones are taken from this Zoom interview.
- ⁷⁶ DRG, 1958, *Listening*, p. 85-86. Around 1958, Griffin was using a Western Electric ^{640AA}.
- ⁷⁷ M. Brock Fenton, personal communication, June 22, 2021. Zoom interview.
- ⁷⁸ Geoirg Neumann, n.d.
- ⁷⁹ DRG August 29, 1980 letter to R. Larkin.
- ⁸⁰ The mysterious "thief" was alive at least as of March 24, 2021.
- ⁸¹ M. Brock Fenton, 1982.
- ⁸² DRG & Thompson, 1982b, p. 305.
- ⁸³ DRG October 11, 1980 letter from Cairns, Australia to R. Larkin.
- ⁸⁴ DRG & Thompson, 1982b, p. 304.

- ⁸⁵ M. Brock Fenton and DRG, 1997. .
- ⁸⁶ M. Brock Fenton, personal communication, March 24, 2021 and April 15, 2021. Zoom interview.
- ⁸⁷ Gary F. McCracken, 1996. The information about the collaboration between Griffin, Gauthreaux and McCracken derives from this publication.
- ⁸⁸ Gary F. McCracken, 1996.
- ⁸⁹ Erin H. Gillam et al, 2009.
- ⁹⁰ Christa Lesté-Lasserre, February 4, 2021.
- ⁹¹ M. Teague O'Mara et al., 2021.
- ⁹² M. Teague O'Mara et al., 2021.

PART FOUR ENDNOTES BEGIN HERE

- ⁹³ D. Diderot, 1749, cited in DRG, 1958, *Listening*, p. 301.
- ⁹⁴ Charles T. Wolfe, 2013.
- ⁹⁵ DRG, 1958, *Listening*, p. 303.
- ⁹⁶ S. P. Hayes, 1935. Cited in DRG, 1958a, *Listening*, p.299 as “an excellent review of the literature” about blind humans’ obstacle avoidance abilities.
- ⁹⁷ DRG, 1958 in 1974 edition of *Listening*, p. 299-300.
- ⁹⁸ DRG, 1958 in 1974 edition of *Listening*, p. 303.
- ⁹⁹ Other information suggesting that Griffin was not involved in the human echolocation research was that the first journal article (1944) had already been accepted for publication in Sept 1, 1942, (Supa et al, p. 133.) and Griffin arrived in the Cornell Zoology Department in 1943.
- ¹⁰⁰ Michael Supa, Milton Cotzin, and Karl M. Dallenbach, 1944, p. 183.
- ¹⁰¹ D. R. Griffin and Robert Galambos, 1941.
- ¹⁰² Robert Galambos and D. R. Griffin, 1942.
- ¹⁰³ Michael Supa, Milton Cotzin, and Karl M. Dallenbach, 1944, p. 183.
- ¹⁰⁴ Philip Worchel and Karl M. Dallenbach, 1947.
- ¹⁰⁵ DRG, 1983, p. 84. [RU Sci & Ed 1981-83].
- ¹⁰⁶ DRG, 1944.
- ¹⁰⁷ I do not know anything more about “Glenis.”
- ¹⁰⁸ DRG letter to Ronald Larkin, July 17, 1973. Accessed from private collection of R. Larkin.
- ¹⁰⁹ Charles E. Rice, Stephen H. Feinstein, and Ronald J. Schusterman, 1965. The best detection was 1.5 inches detected at about 2 feet; the group’s mean auditory angle was 4.63 degrees.
- ¹¹⁰ Charles E. Rice, 1967. Rice reviews the state of knowledge about human echo perception, from research conducted by himself and others.
- ¹¹¹ See Chapter 11.
- ¹¹² DRG, 1983, p. 33-34. [RU Sci &Ed 1981-83].
- ¹¹³ DRG, 1977, p.1. [RU Sci &Ed 1976-77].
- ¹¹⁴ DRG, 1980, p. 36. [RU Sci &Ed 1979-80].
- ¹¹⁵ For further description of this conference, see Volume Three - Chapter 16, Part 5, “Back to Bats,” section, “2003 - The End of Field Seasons/ Last Conferences,” subsection, “ ‘Acoustical Society of America (ASA) Meeting’ - Austin, Texas (November 2003).”
- ¹¹⁶ DRG, 2003, MDPOWERPOINT, computer file.
- ¹¹⁷ Andrew J. Kolarik et al., 2014.

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CHAPTER 12 - A TROPICAL PARADISE, A BUCOLIC FIELD STATION, AND EARLY YEARS AT ROCKEFELLER UNIVERSITY

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CHAPTER 15 - BEFORE THE COGNITIVE REVOLUTION (Griffin Lab Life and Research)

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THE AUTHOR:

Dr. Carolyn A. Ristau is a Cognitive Ethologist who had the privilege of working in Donald R. Griffin's Rockefeller University lab. Those were the times when he was ardently working to develop the new field of Cognitive Ethology he had just created, while also enthusiastically continuing his studies of avian migration and bat echolocation. Carolyn Ristau was impressed by his ideas and dedication. She wanted others to know more of their development, hence this broad-based biography.



Dr. Carolyn A. Ristau, Churchill, Manitoba

Among Dr. Ristau's projects are extensive reviews of the ape and other species' language and cognition research. She explored "injury-feigning" and other parental behaviors of plovers, designing field experiments to investigate the cognitive aspects of such activities, previously considered largely reflexive. Her field sites included the Eastern US shores, the grasslands of Colorado, the tundra of Churchill, Manitoba and the Arctic, as well as studies of chimpanzees in Africa. She brings her earlier education in physics to elucidate the technical aspects of echolocation and her later work in developmental and social behavior to inform the animal communication and behavioral studies. Her students at Barnard College of Columbia University and several other universities appreciated her enthusiastic and in-depth teaching in the fields of Psychology and Animal Behavior.

THE BOOK:

This book is more than a biography. It is a tale of a revolutionary scientist who faced not merely opposition, but outright hostility towards his radical ideas about the existence of bats' echolocation, birds' use of the sun and moon and other sights and sounds as cues in migration, and his proposition that animals are conscious, can think and experience emotions. One scientist was so incensed over Donald Griffin's proposition of animal mentality that he publicly termed a Griffin book, the "Satanic Verses of Animal Behavior." Griffin was repeatedly accused of setting science back, but, of course, he wasn't; he was initiating new approaches to animal behavior studies.

In this book, we find insights and anecdotes about the animals Don Griffin studied and first-hand reports of field studies and their hardships, frustrations, and exhilarating accomplishments. Forty friends and scientists lend their remembrances and expertise to the narrative. We learn of the research conducted by others in Griffin's "net" and update the studies. We read previously unpublished writings by Griffin, from his youthful naturalistic journals to his adult musings and research plans about animal consciousness. And we are privy to tales with which Don Griffin, the storyteller, entertained his associates.