

Collecting Galápagos and the Pacific: How Rollo Howard Beck Shaped Our Understanding of Evolution

John P. Dumbacher¹ and Barbara West²

¹Department of Ornithology and Mammalogy, California Academy of Sciences, 55 Music Concourse Drive, Golden Gate Park, San Francisco, CA 94118; Email: jdumbacher@calacademy.org; ²Academy Library, California Academy of Sciences, 55 Music Concourse Drive, Golden Gate Park, San Francisco, CA 94118; Charles Darwin Foundation for the Galápagos, Quito Ecuador; Email: bbwest@alumni.reed.edu

Rollo Howard Beck, born in Northern California in 1870, became one of the most productive and accomplished ornithological collectors of all time. With less than an eighth-grade education, he learned to prepare scientific museum specimens of birds and eggs, learned the most modern photographic techniques, and became an accomplished sailor and expedition leader. He traveled along the western seaboard of both North and South America and throughout the islands of the South Pacific. His most important expeditions include the Webster-Harris Expedition and the California Academy of Sciences' Expedition to the Galápagos Islands, the Brewster-Sanford Expedition to South America and the Caribbean, and the Whitney South Sea Expedition. The birds he collected have become the basis for several important works, including David Lack's classic book on Darwin's finches, and Ernst Mayr's work on evolution in South Pacific birds. We focus here on his work as a young biologist in the Galápagos; however, we summarize his greater contributions to Ornithology and the importance of his life's work.

KEYWORDS: Ornithology, Galápagos, birds, collecting, Rollo Beck

Biologists often risk their lives to explore new places, document natural history, and amass the collections that provide a foundation for biological knowledge. Natural history collections offer the most tangible, complete, and permanent record of biodiversity on earth. These collections are the basis upon which species are named, species ranges are mapped and known, and variation within and among species can be studied. Other sources of information (field guides for example) gather species identification information primarily from natural history collections.

The collectors themselves have amazing stories to tell. In order to amass the collections found in today's natural history museums, individuals took great personal risk and years away from home. Creating these collections takes skill and care, oftentimes amidst drama and adventure.

Foremost among bird collectors stands Rollo Howard Beck. Beck is unrivaled in having produced large series of beautifully prepared birds from the Galápagos Islands, and these have contributed greatly to our understanding of evolution. Beck is also recognized for having been the world's pre-eminent seabird collector and one of the most productive ornithological field researchers and collectors of all time. Beck collected in the continental US, Mexico, Alaska, South America, Australia, and numerous Pacific and Caribbean Islands. Beck was innovative for being the first to chum for seabirds and designing a special toothed spoon for stripping fat from birds. He was an accomplished natural history photographer in the early days of photography, an amateur anthropologist, and an excellent sailor and expedition leader.

In 2009 we celebrated the bicentennial of Charles Darwin's birth and the contribution that Darwin and the Galápagos have made to our understanding of evolution. The Galápagos has been an excellent laboratory for studying evolution, in part because of the interesting biology and geology of the region, but also because of the massive natural history collections available for study. Although he first visited the Galápagos 62 years after Darwin, Rollo Beck, perhaps more than any other single person, has contributed to building Galápagos natural history collections.

This paper records the professional life and major expeditionary work of Rollo Beck, mentions some of the scientific impacts that his specimens and other work have had on biological thinking, and finally addresses some of the controversies that his work has created.

Beck's Early Collecting

Beck was born in Los Gatos, California on 26 August 1870, and grew up among the apricot and prune orchards of the Santa Clara valley (Beck 1936). There he spent a great deal of time outdoors and trapped gophers before and after school. He learned to identify birds, prepare skins, and mount specimens from his neighbor, Frank H. Holmes, who had trained with the ornithologist Theodore Sherman Palmer. In 1885, at age 14, Beck prepared the first of many birds, a Common Nighthawk (*Chordeiles minor hesperis*) that was sent to the Smithsonian. Although Beck left school before completing the eighth grade, he continued to study ornithology with his friends and joined the American Ornithologists' Union in 1894. He corresponded with many of the top ornithologists of the day, including Robert Ridgway and Captain Charles Bendire, whom the still-young Beck remembered for offering encouragement in exchange for information on birds and eggs of lesser-known California species. In 1894 Beck also joined the newly formed Cooper Ornithological Club, based in San Jose, California. Beck was an active member, and regularly went on collecting trips with fellow club members including Wilfred H. Osgood. On various occasions with Osgood, Holmes and others, Beck collected in the Sierra around Lake Tahoe and the Yosemite Valley, and in 1896 collected the first eggs and nests of the Hermit Warbler and Western Evening Grosbeak, of which he was very proud.

In June 1895, the 24-year old Beck traveled south to Santa Barbara and out to the Channel Islands, collecting. Again in the spring of 1897, he hitched up his horse to his spring wagon and drove 300 miles to Santa Barbara, this time to collect for the California Academy of Sciences. He made friends with a schooner captain, Sam Burtis, with whom he sailed among the northern Channel Islands of Santa Cruz, Santa Rosa, and San Miguel. He collected multiple specimens and records of birds while there, but Beck was most proud of his early records and descriptions of Island Jay eggs and nests, which he believed to be the first ever collected. With these specimens and reports of new findings, his reputation spread eastward. The experience of sailing and visiting these near-shore islands helped prepare him for an upcoming opportunity to join the Webster-Harris Expedition to the Galápagos Islands.

The First Trip to the Galápagos

The Webster-Harris Expedition was funded by Lionel Walter Rothschild, from Tring, England. Rothschild was the son of the wealthy European banking family and a lover of natural history. On his 21st birthday his family gave him money to erect a sizeable natural history museum in the English countryside. He sponsored many collectors and expeditions to bring him animals from around the world, with a special fondness for birds, butterflies, and giant tortoises. He leased Aldabra Atoll (part of the Seychelle Islands in the Indian Ocean) for many years in order to protect the endemic giant tortoises living there. In 1897 Rothschild contracted Mr. Frank Blake Webster of Hyde Park,

Massachusetts, to organize a large collecting expedition to the Galápagos Islands. Webster, who didn't accompany the expedition, hired Charles Miller Harris as the first taxidermist. The other men on board included Captain Samuel Robinson, Otis Bullock, James M. Cornell, and George Nelson. The party set sail from New York on 29 March 1897 aboard the Steamer *Valencia* bound for Panama, where they planned to secure a sailing vessel and launch the expedition to the Galápagos (Rothschild 1983). Once in Panama, they found it impossible to charter a seaworthy boat at a reasonable price. Other troubles plagued the team. Bullock turned out to be an unmanageable alcoholic and was subsequently sent home. Yellow fever felled Captain Robinson, who died in Panama and required an alarming proportion of their funds for doctors' fees and funeral arrangements. The three remaining team members decided to sail for San Francisco and look for a boat there, but Cornell and Harris both came down with yellow fever during the voyage. Cornell died on board, and Nelson deserted immediately after arriving in San Francisco (Rothschild 1983).

Harris, the taxidermist, recovered from his fever and took over the leadership of the expedition in San Francisco. With money from Rothschild and Webster, the 150-ton 95-foot two-masted schooner *Lila & Mattie* was chartered with captain and crew. Webster hired two new East Coast taxidermists, Galen D. Hull and Frederick Peabody Drowne, and was seeking an additional collector when the name of Rollo Beck was suggested (Rothschild 1899).

Unaware of the expedition, Rollo Beck had already left with his cousin for a field trip to the mountains. Just as they crested the Sierra near Lake Tahoe and passed the last stage station, they stopped to see if any mail had been sent for them. There was a telegram from Frank Blake Webster asking if Beck would join an expedition to the Galápagos. Beck immediately sent a telegram in return, answering "Yes," and turned his horse around to head back to the city. Beck was hired for \$25 per month without commission or rank. To save costs, Webster arranged for the collectors to arrive in San Francisco as close as possible to the departure date; they would sleep aboard the *Lila & Mattie* until departure. The trip was on.

Rothschild's instructions set the tone for the most systematic and complete collecting style. The expedition was to first visit the unexplored islands, as unknown species would be most likely to lurk in such places. As for creating the series of specimens, Rothschild continued, "you will carefully go over the entire ground of each island securing birds at least 50 of each kind." (Larson 2001:117). Until well after Darwin's *Origin of Species* was published, it had not been the practice to collect large series of a single species. After the acceptance of Darwin's views on species, large series became important to describe the variation within a species as well as between species. Rothschild's request reflected this change in focus, which Beck was more than happy to accommodate. These large numbers and complete series were especially demanded in the Galápagos, as Rothschild continued, "the slightest difference in bill or size while the bird in other respects be the same they would be different." (Larson 2001:117). As for tortoise, they were to collect every specimen that they could obtain, large or small, dead or alive. Rothschild's parting rally was that, "We look to you to outdo expeditions of Darwin, Baur, Agassiz and others. Believing that I have selected a party with nerve, backbone, and energy, I am yours very truly" (Larson 2001:117). This energy and philosophy of collecting were properly imparted to Beck, and Beck retained this spirit throughout his career.

Beck certainly learned many additional things while on this voyage. He collected seabirds in addition to land birds. Although most of the seabird collecting took place in rookeries rather than at sea, many seabirds are large and require special techniques for capturing and handling. Seabirds also often have significant fat reserves under the skin and often require special techniques for skinning and stuffing. Beck also learned about and practiced photography on the trip, as there were a camera and 144 photographic plates carried onboard. Some of the photos were used later to create

sketches for Drowne's published diaries (Rothschild 1899). Miriam Rothschild reported that the photos were all lost after arriving at Tring (Rothschild 1983); however some photos have survived at the British Museum of Natural History Archives and perhaps one or two others in Beck's personal collection, now in the California Academy of Sciences' Archives.

Beck's knowledge of sailing must have grown tremendously during this long open-ocean voyage. Sailing in the Galápagos is challenging — currents are strong and winds blow and fail fitfully, anchorages are often poor or lacking entirely — and in Harris's estimation the captain was overly careful. The harrowing stories of yellow fever from Harris probably impressed Beck during this trip too, and Harris's own "yellow" fevers came and went while in the Galápagos (which more likely indicates malaria rather than yellow fever). They prudently avoided landing in Panama or other tropical American ports as every other ship landing reported fever-related deaths of passengers, and Beck learned to do the same on future voyages. Lastly, Beck learned of a buried pirate treasure on Genovesa (Tower) Island (Beck 1936). Birds alone were enough to keep Beck collecting, but the rumor of buried treasure appears to have helped keep Beck's focus on the Galápagos. Beck apparently used the lure of buried gold to entice others to join him on future trips to the Galápagos.

Beck impressed Walter Rothschild and others with field skills as well as his drive and stamina. Miriam Rothschild related the difficulties of tortoise collecting with the following story, partially taken from Harris's diaries:

"By noon, we had just got the tortoises secured and were two miles from lunch and our water was short. Two men each took a tortoise lashed to a pole and started for the coast. It was the hardest work I ever did for my part and I guess that the rest thought the same. At 4 o'clock we got to shore above a high bluff. We tied them here for the night and started for the boat two miles across the island. This was very tough work. No dinner. No water. The sailor Charles was completely exhausted after reaching the boat at dusk." Beck, it seems, was made of sterner stuff, for he then "secured a rat." (Rothschild 1983:199).

Seven and a half months later, the Webster-Harris Expedition returned with 60 crates packed with 3075 bird skins, 400 bird eggs, 150 iguanas, 65 tortoises, 40 tortoise eggs, 13 seals and sea lions, 8 sea turtles, several hundred lizards and other miscellaneous zoological items (Rothschild 1983). One of the great discoveries was the Galápagos Flightless Cormorant (*Phalacrocorax harrisi*), named in honor of Harris. The volume and quality of specimens was impressive given that they had spent only about three and a half months in the Galápagos. When they returned, Harris was waylaid in San Francisco tending to the remaining live tortoises, and Rothschild was immediately soliciting Beck to return for more reptiles.

Back to the Galápagos Again and Again

While seeking a ship for another Galápagos trip, Beck wrote to Ridgway asking if the Smithsonian had any particular wishes for Mexican or Galápagos birds. Ridgway provided lists, and Beck sent him at least 92 skins from the next two trips down the Mexican coast and 86 skins from the Islands. After a failed 1899 attempt to return to the Galápagos (ending in a shipwreck in Magdalena Bay, Mexico), Beck again put together an expedition to Galápagos in November 1900 aboard the schooner *Mary Sachs*. Along the way, Beck collected on Guadalupe Island, and saw 11 Guadalupe Caracaras (*Caracara lutosa* then known as *Polyborus lutosus*). He collected 9 of them and shot at the remaining two that got away (Abbott 1933). Beck was the last person to see this species alive. The team spent two and a half months in the Galápagos before returning to San Francisco with about six dozen tortoises (including a male and female of the rare Pinta tortoise) and an

unknown number of bird skins, which were offered to Rothschild. Beck led another small expedition to the Galápagos in December 1901, via Mexico, Clipperton, and Cocos Island and was in the Galápagos for about four and a half months. Rothschild and Hartert were especially interested in these other islands as well, as the Webster-Harris Expedition had to abandon their plans of collecting on them due to the delays in Panama and expense over-runs. By this time Rothschild no longer wanted everything, and he provided Beck with a list of the things he sought as well as those he did not want, instructions which Beck followed only sometimes. During these years, Beck became more confident and experienced on the ocean and working with teams of collectors. He asserted his own independence as a trip organizer and leader.

On these subsequent trips to Galápagos, Beck also did a great deal of photography and further developed his skills. He published several of his photos in the *Condor* (Beck 1904) along with life history notes. His abilities as a field collector clearly impressed Rothschild, and after this second trip, Rothschild invited Beck to bring the entire consignment in person to London – complete with a live Barn Owl, six land iguanas and about 60 tortoises. The amounts Rothschild paid for the specimens made a lasting impression on Beck (Beck 1936), and were probably instrumental in helping Beck realize that he could make collecting a lucrative profession.

The California Academy of Sciences and the 1905-06 Galápagos Expedition

Back in San Francisco, Beck began working for Leverett Mills Loomis, then the Director of the California Academy of Sciences. Loomis was interested in seabirds in the order Procellariiformes (albatrosses, petrels, and shearwaters), and he hired Beck to collect them from 1903 through 1910. Beck collected mostly around Monterey Bay but also took two longer coastal trips — one to the Santa Barbara Islands and another to the Revillagigedo Islands, off the coast of Mexico, in 1903. By this time, Beck was experimenting with chum to attract seabirds, and later became famous for finding birds at sea that even long-time sailors had never seen (Murphy 1936). His work in Monterey provided many interesting records, including the first West Coast records of Flesh-footed Shearwaters, and documented the presence of Pomarine Jaegers, Sooty Shearwaters year round, and Parakeet Auklets wintering.

Now 34 years old, Beck's next big opportunity came when Loomis conceived of another large collecting trip, this time to the Galápagos. The California Academy purchased the decommissioned schooner *Earnest* from the US Coast Guard, and refitted her for a large ocean collecting trip, renaming her the *Academy*. Loomis was personally interested in seabirds, but as museum director, he sought the most authoritative collections from every taxonomic group. In addition to Beck, the team included two ornithologists (Edward Winslow Gifford and Joseph Hunter, who also worked on mammals), two herpetologists (Joseph Slevin and Ernest King), an entomologist (Francis Xavier Williams), a malacologist and geologist (Washington Henry "Doc" Ochsner), and a botanist (Alban Stewart). Not only was Beck hired as a collector, he was appointed head of the expedition. A navigator was hired to pilot the ship, and although Beck often referred to him as "Captain" in his field notes and log, it was clear that Beck was in charge. Never one to waste money, Loomis had all but Beck sign on as seamen as well as collectors, thus enabling him to save on seamen's salaries.

Loomis planned to out-collect Rothschild, much as Rothschild had out-collected Darwin, Agassiz, Baur and others. Fears had grown, and Beck's photos had documented (Fig. 1), that the wildlife was being decimated by whalers, sailors, and locals at an alarming rate so a race was on to document Galápagos species before they disappeared entirely. Rothschild had predicted that the tortoises would be extinct in less than three years, regardless of scientific collecting and had written to the herpetologist Albert Günther as early as March 1898:



FIGURE 1. Beck took this photo showing the devastation the oil hunters wrought. Probably 1901. (G11, Rollo Beck Collection, California Academy of Sciences Archives.)

It was lucky they [the Rothschild-financed Galápagos expedition in 1897-98] went last year; in 3 years time there will not be a living giant Land Tortoise of any kind on the Galápagos Islands. What a damnable shame, is it not? (*Letter in collection of the Natural History Museum, London, courtesy of Michele Welck, CAS Archives*)

Loomis mobilized the press, and there was much fanfare. Celebrations were held on board, the boat was christened, and the newspapers covered the events. Just hours before their departure, the steam schooner *Argo*, coming into harbor collided with the schooner *Academy*, and ruptured three boards above the water line on the schooner's port beam. The damage was sufficient to require cargo to be shifted to starboard to prevent taking on water, and repairs were immediately begun. With the repairs completed in two days, the schooner *Academy* was taken out the Golden Gate by tugboat on 28 June 1905.

The voyage was challenging from the start. Most of the men were immediately seasick, and the main peak block was carried away within hours of being at sea, requiring repair before the mainsail could be used again. Showing his skill as a sailor and documenting one challenge of sailing the schooner, Beck recorded in his journal "Ship [down by] stern, & keel not far enough forward, makes it difficult to sail on wind." (Beck, 6 July 1905, field journal, Rollo Beck Collection, California Academy of Sciences Archives). Throughout the trip, there was often mention of minor repairs that were required to keep the schooner sailing. During the voyage the *Academy* was careened, its bottom scraped and repainted, and sails were removed, repaired and "bent on" (remounted), all impossible without the help of the collector-seamen. The bunks were small and space was tight (Fig. 2), as much of the ship was converted to storage for specimens. It was a con-

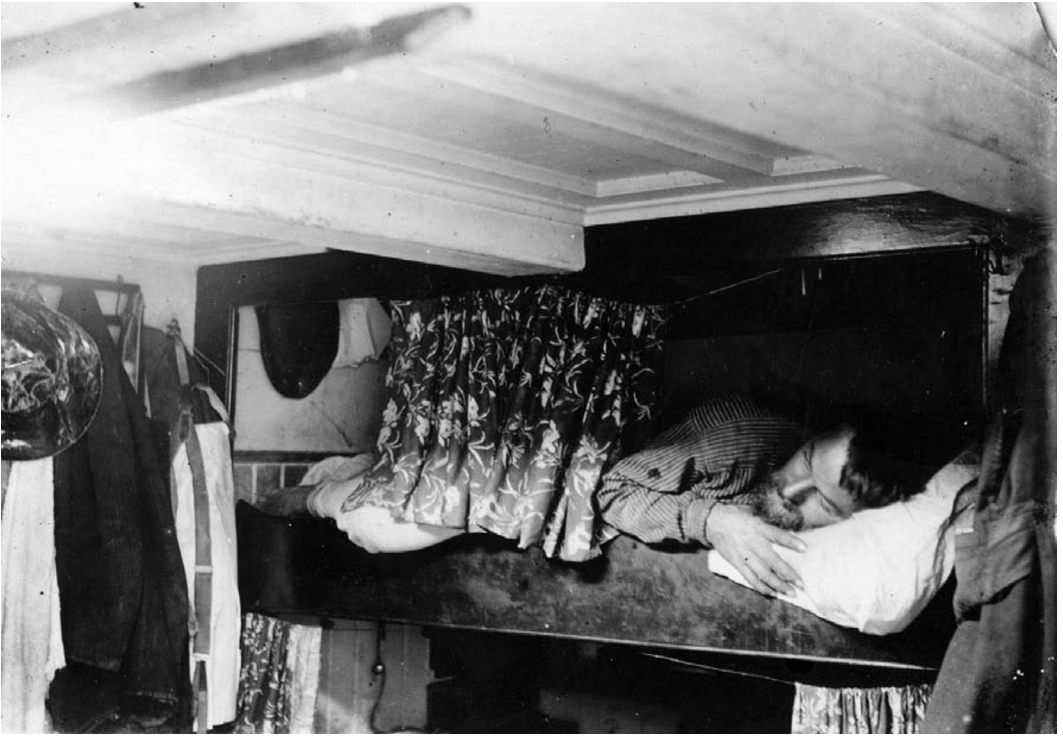


FIGURE 2. Beck “off watch” in a bunk typical of early expedition schooners. Beck was only 5’8”; note his bent legs. (G161, Rollo Beck Collection, California Academy of Sciences Archives.)

stant battle to keep the cockroaches and bedbugs under control. Beck wrote “Used cyanide, potassium, 6 oz., & other dope to kill bedbugs, etc. Killed most mosquitoes & cockroaches but no bedbugs.” (Beck 14 Jan 1906, field journal).

Beck the Collector and Leader

In Beck’s diaries and letters, we gain insight into the type of leader he was. He was fit and tough, and led largely by example. He clearly did not ask anything of the men that he would not do himself, and for the most part he contributed as much labor and at least as many specimens to the endeavor as the others, all the while accomplishing the extra duties required for leadership. He often landed on his own, slept under the stars on the ground (reporting being fed on by ticks and insects), collected and skinned, always helping the others with tortoises. From the journals it appears that the men got along quite well, and this too speaks highly of his leadership abilities. Although the expedition lasted over 17 months and involved grueling work, only a couple of fights were reported, and these were mentioned only in Beck’s diaries. About one argument, Beck remarks laconically “no official knowledge” (Beck, 22 January 1906, field journal). After the navigator had given several demonstrations of incompetence, poor judgment, and picking fights with Slevin and Ochsner (at least), the collectors signed a letter asking for either J.J. Parker’s resignation or theirs, and delivered it to Beck. Beck handled this too with utmost care and professional formality. Parker was dismissed and later left on Albemarle Island. Afterward Beck assumed complete control of the vessel as well as the rest of the expedition.

The diaries also offer some hint of Beck’s personality. Early in the expedition, while crossing



FIGURE 3. This was the *Academy's* first stop on the way to Galápagos. Note that one person is circling his creel around his head to ward the birds off; the other has hold of a frigate bird by its feet. San Martín Island, Mexico, 1905. (G173, Rollo Beck Collection, California Academy of Sciences Archive.)

the equator, one reads, "Crossed the line. Neptune came aboard but was overpowered & ray necks kept from getting shaved." (Beck, 18 September 1905, field journal). This refers to the sometimes violent tradition of one of the seasoned sailors dressing up as the god Neptune and hazing the new timers. We assume that it was Beck who played Neptune on 18 September 1905, and apparently he was overpowered by the new-timers and collected several bruises and a cut at the edge of his eye.

On one occasion, he with three others found themselves at the shoreline with a small skiff, trying to transport three large tortoises to the schooner *Academy* through heavy seas (Beck, 17 March 1906, field journal; *Slevin Log* [1931]). The skiff overturned, and subsequently was smashed to smithereens, leaving the men a swim to shore and a two-mile walk in the dark over a lava, to the place the *Academy* was anchored. Beck had lost his shoes so made this walk barefoot. He says "I had on stockings



FIGURE 4. Hunter and Beck in a frigate bird colony. Note the young frigate in the lower left. 1905. (G174, Rollo Beck Collection, California Academy of Sciences Archive.)

... I stepped on cactus leaves & spines several times & cut finger falling on a lava boulder in grass.” (Beck, 17 March 1906, field journal.) Slevin, somewhat less stoic and missing only his shirt, said “As we walked through the brush in the dark, I felt as if there was not a cactus or thorn bush on all Albemarle Island that I missed running into. However, I wouldn’t have traded places with Beck for anything.” (Slevin 1931:92.)

On another occasion, Beck found a small finch “on back on ground, tangled up in some sticky burrs, feebly struggling, a dove or two watching. Evidently feeding & burrs fell on back & stuck. I pulled out a lot from back & wing & neck & bird hopped

off. Would pull out himself viciously all he could reach, feathers & all.” (Beck, 27 October 1905, field journal). One wonders whether this release was whimsical mercy or a specimen too damaged to be collected.

As trip leader, he was more concerned with food than the others, and so he often mentioned when animals were collected for the larder. These included “doves for breakfast,” “cakes with turtle eggs very good” and “tern eggs very good baked or in cakes or scrambled” among many other references. Many of the foods eaten included introduced species, especially pigs and goats (Fig. 5). Beck also mentions horses, burros, wild dogs, and other introduced species that the team encountered. These records now provide excellent information about the distribution of introduced species on the islands during that time. They also illustrate the necessity of finding food to sustain such an expedition, and hence the practice of introducing species such as goats – a practice that Beck employed in the South Pacific and for which he was later criticized. The 1905-06 expedition for the California Academy of Sciences was Beck’s fourth trip to the Galápagos. By the end he established himself as the preeminent Galápagos collector, hands down. Not only did he know where to find a particular bird or tortoise, but he also knew where the anchorages were, when it was safe to use one, as well as a good deal about the winds and currents. The success of the expedition also established him as a capable expedition organizer, leader, sailor, and natural historian.

The success of the expedition also re-established the Academy after the great earthquake and fire of 1906:

The Galápagos Expedition put the Academy ‘on its feet’ as far as materials for a new museum is concerned. This Expedition left San Francisco on June 28, 1905, returning Thanksgiving Day, 1906, with some 5000 reptiles, 38000 shells, 1000 tertiary invertebrate fossils, about 13000 insects, about 10000 plants, 8688 birds, about 2000 eggs, many nests, and about 120 mammals. (Gifford 1908:95).



FIGURE 5. Nelson, mate on the *Academy*, contributes a boar to the larder. Cocos Island 1905. (G223, Rollo Beck Collection, California Academy of Sciences Archive.)

The precision in the number of birds reflects Gifford's interests; according to his collecting journal he collected 3409 of the 8688 birds (of which 3072 made it into the CAS collection). Beck contributed about 2100 to the CAS collection, and Joe Hunter contributed another 2200 or so.

The materials from this trip are well preserved. Each collector on board kept a journal, all of which are held in the California Academy of Sciences Archives. They have been transcribed by the generosity of Matt James and colleagues and subsequently edited into publishable form by Barbara West. In addition, Beck and Gifford left a wonderful series of about 350 photographs (plus another 120 photos from Beck's earlier visits). Much has been written about the history of the schooner *Academy* expedition (see James, this volume). In addition, some 20 papers were published in the California Academy of Sciences *Proceedings*, plus five in other journals and about 12 books.

After the Galápagos Expeditions

After the 1905-06 Academy expedition, Beck continued to work for Loomis in Monterey and northern California (Fig. 6) rebuilding the collections that were lost in the 1906 San Francisco earthquake and fire (Beck 1910). By 1907, Loomis began talking about a possible expedition to Hawaii, again with Beck in charge. Beck was interested, but was also working on his personal life. He asked Ida Menzies of Berryessa to be his wife and join him on this — and future expeditions. They were married 9 August 1909. But when Beck asked Loomis for a raise — a reasonable request based upon his experience and past successes working with the California Academy, and probably also having to shoulder the extra responsibility of being married — Loomis denied him the raise, purportedly due to lack of funds. At the age of 40, Beck left the California Academy of Sciences after seven years (1903–1910) of individual and expedition collecting for them.

Beck quickly took up with Joseph Grinnell of the University of California's new Museum of Vertebrate Zoology (MVZ) located in Berkeley. Beck conducted two solo expeditions collecting seabirds (Monterey Bay, 1910–11) and water birds (Los Baños, 1911–12) of northern



FIGURE 6. Beck at home in his workshop, shortly after returning from the CAS Galápagos Expedition. (N29755, Rollo Beck Collection, California Academy of Sciences Archive.)

California. Grinnell was interested especially in the distribution of California birds and how geography and local habitat led to differentiation. Beck's collections were targeted to answer specific questions about species boundaries — both according to geography and niche.

Beck's fame as a collector continued to spread. In 1911 Beck received a letter from Dr. Leonard Sanford of New Haven, offering considerably more money to collect for him. Sanford was a wealthy professor at Yale medical school and a dedicated collector of birds. He was also by then a good friend of Frank M. Chapman, curator of birds at the American Museum of Natural History (AMNH) in New York. Chapman offered Sanford an office space at the American Museum next to his own. Sanford accepted and brought his substantial personal collections and helped fund additional collectors working for the American Museum bird collections, including Rollo Beck. This was a valuable connection, as Sanford's money and connections would facilitate Beck's later work around South America and in the Pacific.

In 1911, under Sanford's and the AMNH's sponsorship Beck accompanied Arthur Cleveland Bent and Alexander Wetmore for a five and a half month collecting trip to the Aleutian Islands and the area around Nome, Alaska. Bent was working on his large series *Life Histories of North American Birds* for the Smithsonian Institution, and he was interested in bird specimens as well as eggs and nests. Alexander Wetmore, who would become famous for his work with the US Biological Survey and the Smithsonian, was along on the trip as well. Beck now had worked with leading ornithologists of the American Museum and the Smithsonian, the two most wealthy and powerful museums in America.

When Beck returned from the Alaska trip and was once again working for Grinnell, Sanford continued to send requests for various specimens, particularly a rare shearwater, and funded a short trip by Beck to Guadalupe Island, Mexico, in August 1912, followed by more collecting around Monterey. In a September 1912 letter Sanford said, "We will probably start you southwards early in October. So make ... a special attempt to get the rare shearwaters." In an October 5 letter Sanford says "Regarding Mrs. Beck suit your own convenience. I appreciate perfectly your position and would want under similar circumstances to do the same. I thought it would be more comfortable [if she followed later]. But do as you please. I am hoping to hear that you picked up the two rare shearwaters." We don't know if Beck got the shearwaters that Sanford so badly wanted, but we do know that Beck made preparations to bring his wife, Ida, on his next big adventure.

Brewster-Sanford Expedition — South America and The Caribbean

On 4 December 1912 Rollo and Ida Beck departed by steamer to South America. Dr. Sanford had proposed a two-year trip along the South American coast. It was extended to nearly five years, included collecting in the Andes and in much of the Caribbean, and was ultimately funded by another wealthy AMNH benefactor, Frederick F. Brewster. The Becks alternated between commercial vessels and chartering smaller boats to take them where there was no commercial traffic.

They spent the next eight months in Peru, about two-thirds of the time along the coast, the rest of the time in the Andes, hiking up to 16,000 feet. It was when Beck was in Peru that Murphy (1936) later told the famous story about Beck's prowess as a collector:

When Mr. Rollo H. Beck, a veteran student of marine birds, was collecting for The American Museum of Natural History in Peru, he chartered a coasting sloop under command of an experienced native skipper and sailed several days' journey off shore. The subsequent enlightenment of the Peruvian sailors was related to me by my friend of the Chinchas, Captain Charles Niehorster, who was a member of the crew.

One quiet morning early in the course of the voyage, Beck remarked that he would like to lower a boat for birds.

'But there are no birds here, señor,' said the skipper, waving an arm around the circle of blank water.

Nevertheless, a skiff was sent down, and Captain Charlie manned the oars. For two miles or more he pulled straight ahead, while Beck methodically tossed flecks of oil and grease and scraps of meat in the boat's track. Then they doubled on their course, and to Charlie's amazement the long food-line was soon dotted with unfamiliar, dainty sea-sprites, which skipped and danced like butterflies along a blossoming hedge-row. A series of many birds, including specimens of Hornby's Petrel, was brought back to the sloop, and displayed before the doubting crew.

'But we have never before had such birds as these in Peru, señor,' insisted the Captain. And his men unanimously agreed. (Murphy:1936:8).

Almost another year, August 1913–July 1914, was spent continuing down the coast of Chile with a side trip to the Juan Fernandez ("Robinson Crusoe") Islands, arriving in Punta Arenas, Chile, in Tierra del Fuego, in the dead of the austral winter (Figs. 7–8). A month was spent collecting locally, then they headed north on a steamer from Punta Arenas and spent three months collecting around Mar del Plata, Argentina, "waiting for the summer to begin at Cape Horn."

In early November 1914 they headed south again, spending the next six months around Tierra del Fuego. Although storms would last for days at a time, Beck would collect on whatever island he could get to. On 22 December 1914 they rounded False Cape Horn, on the 29th the true Cape Horn, thus fulfilling a dream of Beck's. But he was never one to say "Enough!" so they sailed another 10 miles south before the weather turned on them, and they fled back to the closest shelter. They continued to move from anchorage to anchorage as the weather allowed, and Beck collected both on land and on the water. On 1 September 1915, near Rio Gallegos, Beck laconically recorded "in chasing a couple of wounded geese through a pond had to



FIGURE 7. This shows the Beck's route around South America and through the Caribbean. Brewster-Sanford Expedition, 1912–1917. See Fig. 8 for details of Tierra del Fuego routes. (Route map compiled by J. Woram).

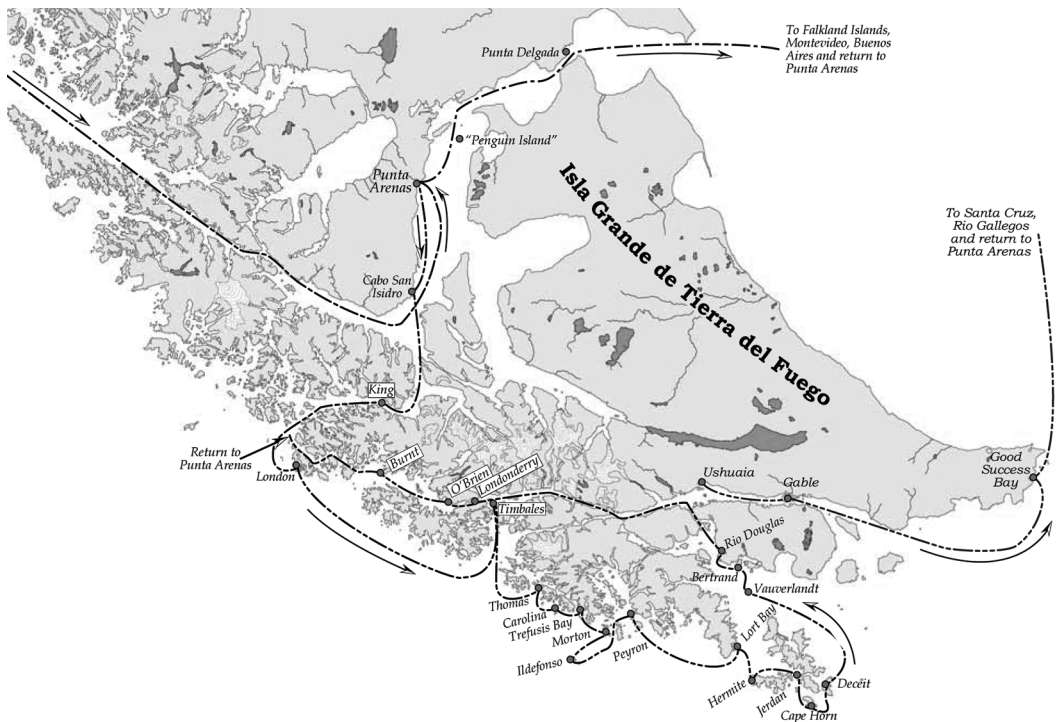


FIGURE 8. The Becks crossed back and forth through the Tierra del Fuego, spending eight and a half months in this region, twice fleeing back to Rio Gallegos, Argentina, to escape the worst of the austral winters. July 1914–October 1915. (Route map compiled by J. Woram; base map courtesy of S. Zagier).

break the ice with my bare feet.” After about 10 months around Tierra del Fuego, on 11 October 1915 they returned to Punta Arenas, their headquarters for this period. The next stop was the Falklands where they spent three months collecting (Fig. 9).

Finally, in February 1917, they turned north for the last time. They spent several months along the coasts of Argentina and Brazil waiting for collecting permits that never came. Then from August 1916 to August 1917 they collected in the Caribbean, including St. Thomas, Dominica, Santo Domingo, Haiti and Cuba.

A wire from AMNH bid them return to New York City where they arrived in early September, thus ending four and three-quarter years of collecting.

In 1919, Dr. Sanford, for AMNH, asked Beck to return alone to Alaska, to collect along the



FIGURE 9. The Becks in the Falklands with a few thousand of their closest rockhopper friends while on the Brewster-Sanford Expedition. November 1915–January 1916. (Courtesy of the Library, American Museum of Natural History).

North Pacific coast. He started in Kodiak on 12 August, passed through Seward and Juneau, and finished in Sitka on 8 October. The letter asking him to make this Alaska trip dangled another temptation before him. "I am particularly anxious to have you return from [Alaska] in season to get a good rest for a possible South Sea Island expedition within a year." (Rollo Beck correspondence, California Academy of Sciences Archives).

Whitney South Sea Expedition

The "possible South Sea Islands expedition" became the Whitney South Sea Expedition (WSSE), sponsored by AMNH and funded by Harry Payne "Jock" Whitney. Whitney was a businessman, horse racer and member of the prominent and wealthy Whitney family of New England. He was a friend of Sanford and Chapman, and Sanford effectively persuaded Whitney to give over \$100,000 for the South Sea Expedition, which paid for the first five years. Like the Brewster-Sanford South America Expedition, the Whitney South Sea Expedition was supposed to last two years. It became a 9-year voyage for the Becks and a 20-year overall effort for AMNH. Ida and Rollo took a commercial vessel to Tahiti, arriving 25 September 1920. The intent was to use cargo and fishing vessels to get around the South Pacific islands but, as was true for the South American expedition, the result was a great deal of time lost, waiting for a boat going the right place. By 1921 Beck had convinced AMNH that it would be better to purchase a sailboat with an engine. It took nearly a year but finally a vessel was found which fit both the requirements and the budget. The log of the *France* started 1 February 1922, as the Becks with two other collectors left Papeete to explore other parts of the Society Islands.

By July 1923, the Becks had spent three much enjoyed Bastille Days in Papeete and Beck had collected French Polynesia to his satisfaction (Fig. 10). The first three assistant collectors had left and been replaced by three others. The Cook Islands and Samoa occupied another 10 months, Fiji and adjacent islands (Fig. 11) another 12 months. By June 1926 the *France* reached Tonga with

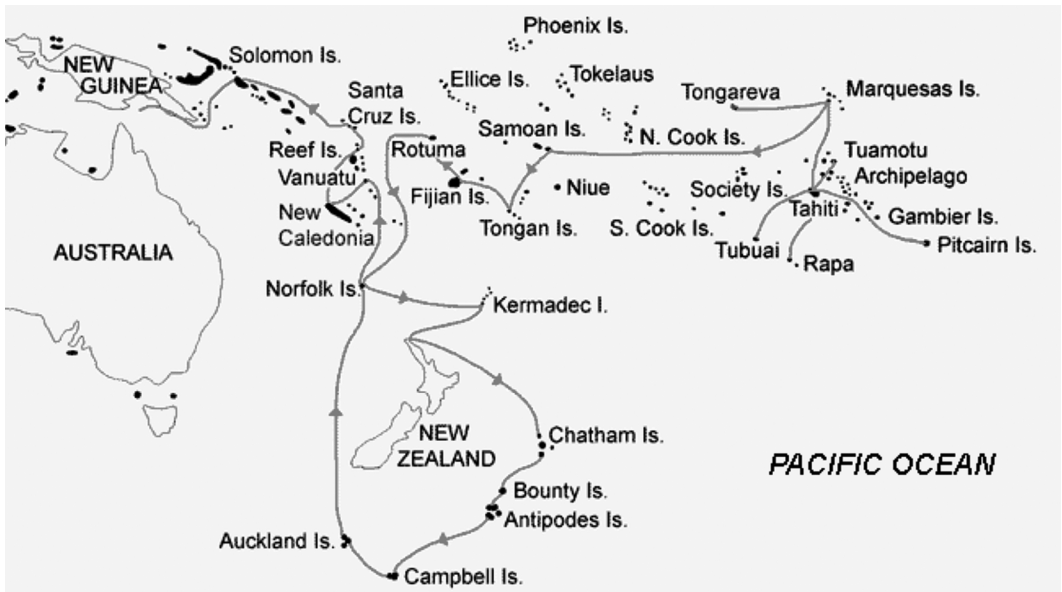


FIGURE 10. This roughly shows the Beck's route through the South Pacific. They arrived in Tahiti on a commercial steamer and worked west from there. Whitney South Sea Expedition 1920–1928. (Compiled by Dept. Anthropology, California Academy of Sciences for a web exhibit on Rollo and Ida Beck).

Beck and one other collector, José Correia with his wife, where they spent two months. After a relaxing collecting stop in New Zealand, Beck and the *France* went to the Australian Great Barrier Reef where the Correias rejoined him in January 1926. They subsequently backtracked to the islands off the east and south of New Zealand during February and March 1926 and then proceeded to the Vanuatu archipelago. In mid-December the Correias left the expedition, and in mid-June 1927, F.P. Drowne, who had been one of Beck's fellow collectors on the 1897-98 Rothschild trip to the Galápagos, joined the expedition. By the end of the month they were in the Solomon Islands group, where they remained until the end of December 1927. Two additional collectors, Guy Richards and Hannibal Hamlin joined the *France* in mid-October. In January-February 1928, Drowne, Richards, and Hamlin collected on Bougainville Island while Beck collected alone in the Bismarck Archipelago. In mid-February 1928, the Becks left the *France* in the command of Hamlin, and taking the log book, they started for Sydney, Australia, from which they expected to return to California.

However, a telegram caught up with the Becks while at sea on the way to Australia. George F. Baker, a trustee of the AMNH offered to support them, separately from the Whitney South Sea Expedition, on a collecting expedition to the large island of New Guinea. Beck agreed, and after he and Ida spent a couple of months in Sydney they returned to New Guinea, arriving on 5 August 1928 and staying until 29 April 1929. Beck concentrated his collecting inland on the north coast of Papua New Guinea around Madang (Figs. 12–14). In his collecting journal, Beck reports one of the aggravations of collecting: “continued to collect about Madang, getting 6 species had not taken before but hotel cat climbs up in wardrobe and picks two small specimens from top shelf, leaving only the hind legs of each with label attached” (December 12–27, 1928). He also updated his observations about malaria: “heavy continuous . . . doses malaria kept me near skinning table this week so I conclude quinine is steadily needed” (April 18, 1929). Today AMNH lists 1741 skins collected by Beck on this New Guinea Expedition.

As was his practice, Beck asked the locals to bring birds to him and he purchased those of interest. “Gorgeous birds are blacktailed [*Astrapia rothschildi*, a bird of paradise] as collar in front

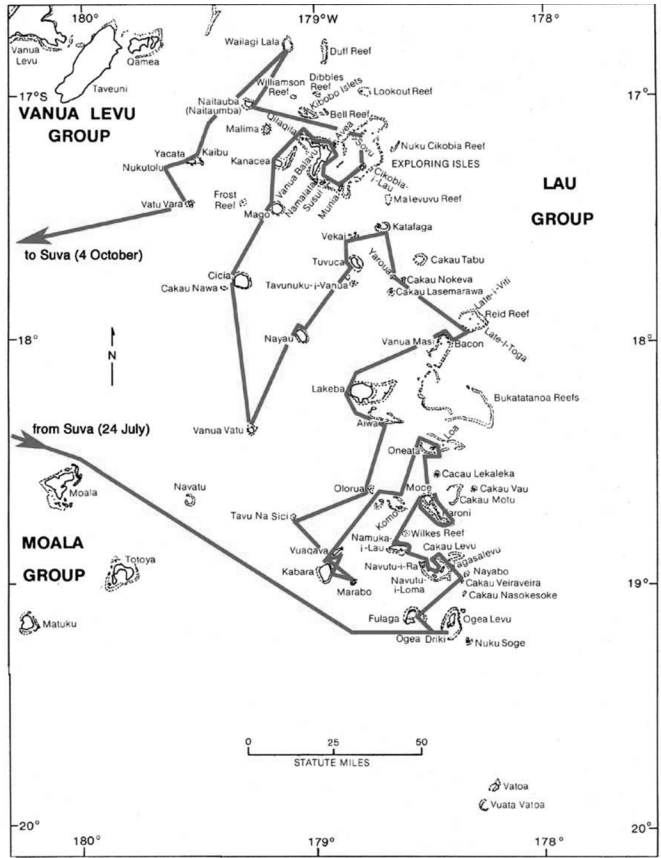


FIGURE 11. Their actual route was much more complicated. This is the detail of the route of the *France* through the Lau island group, 1924. (Map from Evenhuis 2007, map 2 [courtesy Bishop Museum]).

glows like golden fire with purplish sheen ... breast and lower part deep green with brown band reddish gold about lower throat and the neck of long extremely soft black feathers, these reaching nearly to tip of bill.... I have been hunting two or four times a week for five weeks where these birds occur without seeing one of these adult males.” (March 24, 1929). Although this bird (Fig. 16) was apparently new to Beck it was not new to the world, having been described and named in 1906.

While in the South Pacific, Beck wrote about his travels and experiences there for *Natural History Magazine*, the popular magazine of the American Museum. In one of Beck’s last WSSE articles published, he recalls discovering Baker’s Bowerbird (Fig. 17) in the mountains above Madang town, Papua New Guinea (Beck 1929).

After his world travels

On their way home from Papua New Guinea and the South Pacific, the Becks returned to Australia, and then set out for California via Lahore, where Rollo’s sister was an M.D., married to a Methodist missionary. From there, they traveled to Egypt, England, Ontario province, where Ida was born, New York City, Washington D.C., and finally back to their farm in Planada, California by early 1930. Here they settled down for the next 20 years. Members of his family have said that in the early to mid-1930s Rollo was diagnosed with cancer, perhaps of the throat or neck. He



FIGURE 12. Ida Beck looking at birds brought by a local woman. (Negative no. 115711 [photo by Rollo Beck], courtesy of the Library, American Museum of Natural History).



FIGURE 13. This was taken in the Solomons. On the right, Ida Beck in jodhpurs and pith helmet, talks with four local young women. The man standing next to her is probably her guide. (Negative no. 115367 [photo by Rollo Beck], courtesy of the Library, American Museum of Natural History).

was treated with radiation, apparently successfully, because this did not appear to have any bearing on his later health.

During these years Rollo continued to observe and collect birds. He reported primarily to the state Fish and Game Commission, which now required permits to collect, and he offered his specimens to the local museums. His energy focused on variation in species and subspecies of local birds, including especially red-winged blackbirds (all vermin in his view) and the perplexing variation in dowitchers. Although having no formal training in ornithology, let alone taxonomy, Beck kept up with the literature and followed up when he saw something that didn't match his collecting experience. In 1932, William Rowan published an analysis of dowitcher taxonomy, separating the long-billed (*Limnodromus scolopaceus*) and short-billed species (*L. griseus*), and named a new inland subspecies (*L. g. hendersoni*) (Rowan 1932). There was much disagreement among ornithologists about the California representatives — for example, Robert Orr of the California Academy of Sciences and Joseph

Grinnell of UC Berkeley Museum of Vertebrate Zoology lumped these all into a single species, and synonymized *L. g. griseus* and *L. g. hendersoni* (Orr 1940; Grinnell and Miller 1944). Beck collected “a couple dozen,” and later “a few hundred” dowitchers and presented them to Grinnell, asking him to reconsider Rowan's suggestion. Grinnell and Robert Orr both looked at the problem over the next several years but Beck was not assuaged and kept collecting (as long as the California Division of Fish and Game would give him a collecting permit) and observing. In 1946, Beck was still pushing the issue.

What Beck had observed and others had not, was that the short-billed species occurred mostly in a salt-water environment while the long-billed species occurred primarily in freshwater environments. In 1950, Frank Pitelka published a definitive monograph (Pitelka 1950). Pitelka inspected over 2900 *Limnodromus* held in various North American collections and concluded that Rowan

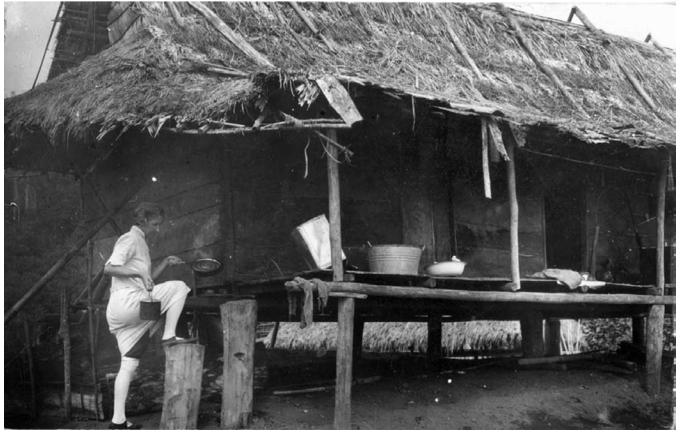


FIGURE 14. Ever the helpmeet as well as fellow collector and preparator, Ida seems to be bringing lunch for Rollo and herself. Papua New Guinea. (Rollo Beck Collection, California Academy of Sciences Archives, with permission from American Museum of Natural History).

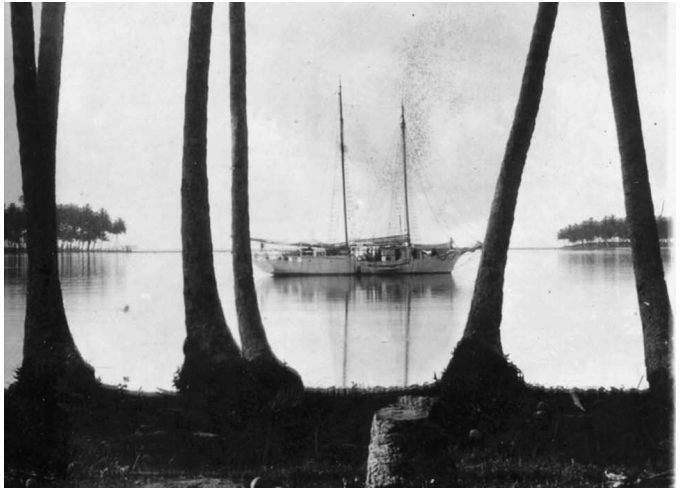


FIGURE 15. The *France* at anchor, Vella Lavella Islands, Solomons group. (Negative no. 115392 [photo by Rollo Beck], courtesy of the Library, American Museum of Natural History).

was mostly right, but that Beck's observations provided key insights into the ecology and taxonomy of the dowitchers. In the monograph, Pitelka gave an amazing tribute to a man who hadn't finished eighth grade, saying "This study owes its origin to the perspicacity and efforts of the veteran bird collector Rollo H. Beck of Planada, California." (Pitelka 1986:387). Later genetic analyses have supported the observations of Beck and Pitelka, showing that the Long-billed and Short-billed Dowitchers are clearly distinct species (Awise and Zink 1988).

During the 1930s and 1940s Beck had a box of fresh fruits from his farm delivered each year to Grinnell and later Alden Miller and the staff of the UC Berkeley Museum of Vertebrate Zoology, and often to the California Academy of Sciences as well. All recipients were delighted both by the thoughtfulness and by the deliciousness of the apricots and figs.

In November 1950, Rollo Beck died at the age of 80, having been active as a farmer and collector until the late spring of that year. Ida remained on the Planada farm for several years, then went to live with a niece and her family until her death in 1970.

Ida Menzies Beck

Rollo Beck's wife and companion, Ida Menzies Beck, was of Scottish descent and born in Ontario, Canada. She moved to California when she was young, and we are not sure how Ida and Rollo met, possibly as childhood friends or possibly through the Methodist Church, to which they both belonged. Ida was good-natured, quick to laugh, and she adored Rollo. Ida and Rollo were married in 1909 by a relative of Rollo's, and they never got the Hawaiian honeymoon that they had hoped for. After being separated for a long time when Rollo worked with A.C. Bent in Alaska, Ida and Rollo decided that they would never again be apart for so long, and that Ida and Rollo would travel together on all of their future expeditions. Together they climbed to the high Andes and Lake Titicaca, and they sailed throughout the Pacific to New Guinea. By all accounts, Ida was tough as nails. She suffered terribly from sea sickness, and like Darwin, she never really got over it, yet this



FIGURE 16. Ellis Rowan, Rothschild's Bird-of-Paradise, or Rothschild's *Astrapia* (*Astrapia rothschildi*), Papua New Guinea, 1917 (nla.pic-an6633368 PIC R1949 LOC 6561, National Library of Australia).

did not prevent her from traveling. Photos typically show Ida in nice dresses and shoes not typical of field attire. Unfortunately, relatively little is written about her role on the expeditions, but it is clear that she assisted in a variety of ways, including those typical of a female companion from that era. She also helped with collecting, prepared specimens, and she knew her birds well. It also appears that her presence helped make peaceful connections in many of the remote outposts and villages that they visited, and that she probably kept the *France* and various field camps up to a livable standard. In their early years in California when Rollo would take a small skiff out into Monterey Bay alone, she would often wait for him onshore, well after dark, to ensure that he made it back safely. Rollo and Ida had no children, and Ida lived for another 20 years after Rollo's death. During her later years living with Rollo's niece, Ida often regaled the family with tales from their travels and work abroad.

Collectors, Then and Now

To appreciate better what Beck accomplished in his lifetime, we ask what it takes to be a successful natural history collector. Obviously the requirements have changed over the centuries, but what did it take a century ago, when Beck was a master of the art?

Foremost, field collectors needed to know significant natural history in order to spot rapidly a different flight pattern, an aberration in color, size, or geographical range, and immediately recognize its importance. Collectors were also skilled hunters and were required to collect a series of each slightly different bird species. They needed an aesthetic sense, so that each specimen could be beautifully and uniformly skinned and stuffed so that shapes and colors were clearly visible and reflected the appearance of the live bird. The specimens needed to document precisely those characters that caught the collector's interest, including notes about its behavior and ecology.

Especially in Beck's time, to work successfully in field conditions the collector needed robust



FIGURE 17. Beck referred to this as Baker's Bower Bird (*Xanthomelus bakeri*), although it is more commonly known as Adelbert Bowerbird; adult and young males. Rollo Beck discovered this bird in the Adelbert mountains in northern New Guinea. Beck 1929. (Reprinted from *Natural History Magazine*, 1929; Image # 5838 American Museum of Natural History Library, with permission.)

physical health and stamina. Physical health required several things, including a cast-iron digestive system for any traveler. The collector needed to withstand sea-sickness, drink local water sources, and stomach *E. coli* and other standard infections. When carrying or finding food and water in the field, they had to tolerate a variety of sources, some of which were questionable. Other diseases such as malaria, yellow fever, or dengue could compromise an expedition or one's life. Clearly some degree of tolerance was genetic, but collectors like Beck survived by constant vigilance, by continually making wise and healthy choices.

A degree of mental health and stamina was also necessary for the collector. Beck needed to tolerate difficult conditions, including the extremes of working alone a long way from help, or alternatively, piled atop one another for several months in a cramped ship. He needed to have patience, tolerance, flexibility, and be able to maintain his focus on his work despite the many hardships and challenges.

In addition, Beck needed the skills of expedition leadership. Planning and logistics of large, remote expeditions were overwhelming. Gathering food, supplies, medical equipment, and balancing personalities all required considerable organization and skill. Difficult judgment calls were endlessly required. Keeping the staff healthy, happy, and working hard was challenging, and Beck clearly led his collectors with his own hard work.

Today, many facets of field collecting have changed. Collectors often enjoy many modern comforts and better medicines in the field. Tools such as field guides, recorders, cameras, computers, and internet all make biological information more accessible and easier to collect. Ethical expectations have also changed considerably. Collectors today are held to very different standards, largely because of our knowledge that collecting can adversely affect natural populations. Thus, collecting must be done cautiously using all that we know about the existing populations and their breeding cycles while doing our best to reduce population impact. This largely means reducing the number of specimens collected, and making use of "salvage" – that is, animals that have already died (road kill, window strikes, oil spills, wildlife hospitals, etc.). With fewer specimens, there is increased pressure for more data or material per specimen, including more measurements, notes on soft part colors and on behavior, skins with full or partial skeletons, tissues, stomachs and contents, etc. The esteemed ornithologist Elliot Coues suggested that "fifty birds shot, their skins preserved, and observations recorded is a *very* good day's work." [*italics original*] (Coues 1903). Today an experienced skinner and collector might only expect to prepare (with notes, tag, and associated materials) one bird per hour (Winker 2000) as compared with one every ten to fifteen minutes in Beck's time.

Navigating complex permit and record-keeping requirements is another facet of modern collecting that was much less burdensome in Beck's age. Today, depending upon where one collects and where specimens finally reside, permission is required from multiple authorities, including permission from landowners or land managers, US Fish and Wildlife Service, state and local departments of fish and game, US Department of Agriculture, and Center for Disease Control, plus any overseas permits for collecting, using firearms or mist-nets, Convention for International Trade in Endangered Species (CITES), import-export documents, and even some perpetual responsibilities are owed to foreign permit bodies. Typically materials are shipped or carried as luggage in planes, so additional laws regulate hazardous materials, packing and shipping requirements, biosafety and potential pathogen issues. Many would-be collectors are discouraged by these complex, poorly documented, and ever-changing bureaucratic requirements. Even many already-dead salvage birds are discarded because of the permit uncertainties or the lack of time or expertise to comply with all of the various agencies. In part for these reasons, our generation's record of the modern biodiversity is lacking in comparison to that of a century ago.

The Impact of Rollo Beck on Ornithology

Beck had a tremendous impact on ornithology, primarily through his collections. The sheer number of his collections is very impressive. At the time of this writing, it has become relatively easy to search museum catalogs online and to compile the numbers from the major collections. Table 1 tallies Beck's specimens from several of those major collections. Both the Smithsonian and the American Museum, due to their massive collections, are still digitizing their data, and so some specimens are likely missing from the tallies. AMNH has graciously estimated the collections attributable to Rollo Beck based upon summary accession cards and concluded that approximately 44,000 of their specimens are attributed to Beck.

To put these numbers into perspective, other major collectors have made the history books for adding 10,000 to 40,000 specimens to various museums (Mearns and Mearns 1998). Today, most ornithologists do relatively little collecting, and even those who do find it difficult to achieve the speed at which Beck was able to skin (Winker 2000). Beck was legendary for being able to cut open, skin out, close and finish a songbird skin in approximately five minutes.

But it is not only the numbers in his collections that make them important, but the way in which they were collected. He was guided in his collecting efforts chiefly by questions about natural variation, species limits, evolution and biogeography. Those he collected for, including Rothschild, Loomis, Grinnell, Chapman, and Murphy, each made clear the scientific questions driving the collections, and Beck made sure that the material was sufficient to answer the questions.

Beck's collections and their impact on our understanding of Galápagos finch evolution.— The history of Galápagos finch taxonomy is an excellent example of Rollo Beck's impact on ornithology. Before Beck's first trip to the Galápagos with the Webster–Harris expedition, ornithologists were unsure how many finch species inhabited the islands or how they were distributed among the islands, although it was becoming clear that this was key to understanding their origin and history, and perhaps evolution in general. Charles Darwin had only collected 65 bird specimens in the Galápagos (Steinheimer 2004), and these were worked up and formally described primarily by John Gould (Gould and Darwin 1839). It was Gould, not Darwin, who first realized that the small dark passerines belonged to a single group of finches. Darwin noted “the most curious fact is the perfect gradation in the size of the beaks in the different species of *Geospiza*, from one as large as that of a hawfinch to that of a chaffinch, and (if Mr. Gould is right in including his sub-group, *Certhidea*, in the main group), even to that of a warbler” (Darwin 1845:379). Darwin furthermore suspected “that certain members of the series are confined to different islands; therefore, if the collection had been made on any one island, it would not have presented so perfect a gradation” (Darwin 1839:475). Darwin also wrote, “*Geospiza*, *Camarhynchus*, and *Cactornis* belong to one type, but with regard to *Certhidea*, although Mr. Gould confidently believes it should also be referred to the same division...he would by no means insist upon the above view being adopted, until the matter shall have been more fully investigated.” (Darwin 1941:105.)

The next significant collections of Darwin's finches were made by Habel in 1868 and reported by Sclater and Salvin (Salvin 1876). Salvin disagreed with Gould and believed that the genera *Camarhynchus* (tree finches), *Geospiza*, (ground finches), and *Certhidea* (warbler finches) differed significantly and represented three lineages (*Geospiza*, *Camarhynchus*, and *Certhidea*) that independently invaded the Galápagos (Salvin 1876).

The productive Smithsonian curator Robert Ridgway also had an interest in Galápagos birds, and published a large monograph in 1896 based upon the expeditions of the *Albatross* and collections made by Baur and Adams in 1891. Despite having larger collections, Ridgway noted that, “Not a single island of the group can be said to have been exhaustively explored, and few of the

species are known in all their various phases; in fact, many are known only from a few specimens in female or immature dress.” (Ridgway 1896:459). The sampling was still better than what was previously available, but “owing to the gradual transition from one form to another, and the almost perfect resemblance between them in coloration, I have found it impossible to construct an analytical ‘key’ to the species after the usual plan.” (Ridgway 1896:509). Ridgway goes on to construct a taxonomy with genus and species names, but it is clear that he considers these to occur along a continuum, and that hard stops do not truly exist in the islands. By Ridgway’s reckoning, there were 36 species of finch, plus another 8 species of *Certhidea*, thereby recognizing 44 species of what we would consider today as 13 Galápagos finch species.

In 1899, Lionel Walter Rothschild published a monograph on the Galápagos avifauna (Rothschild 1899) and focused a great deal of attention on the finches. His work was based largely on the collections produced by Baur and Adams in 1891, which he had purchased, but these were now augmented by the Webster-Harris Expedition that Beck participated in and Rothschild privately funded. He proudly concluded that “This material is perhaps larger than any material ever brought together from any area of similarly small dimensions,” (Rothschild 1899:136) and argued that it can indeed begin to reveal the evolutionary history of the islands and speciation in general. Yet, he only draws a single major conclusion — that the entire island’s fauna is derived from the Americas. (His second “conclusion” was that it is uncertain whether there has ever been a land connection among the islands or between the islands and continental America.)

Rothschild’s taxonomy disagrees in various aspects with Ridgway’s. To examine the classic examples, Ridgway recognized eight mockingbird species in the Galápagos; Rothschild recognized eleven. With the exception of *Certhidea*, Rothschild groups all of the finches into the single genus, *Geospiza*, and comments extensively on Ridgway’s unjustified splitting of the genera and some species. Rothschild recognized 33 taxa in the genus *Geospiza* and another nine taxa in the genus *Certhidea*. Like Salvin, he did not recognize that *Geospiza* and *Certhidea* were close relatives.

Rothschild also determined that the Cocos Island Finch (*Pinaroloxias inornata*) was actually a thin-billed relative of *Geospiza* (Rothschild 1903). This proved to be a critical link in helping later associate the Warbler Finch, *Certhidea*, with *Geospiza*. (Rothschild additionally reported on a nice age series of Galápagos boobies that allowed Rothschild and Grant to determine that one that had been formerly described as the adult of the *Sula variegata* was actually a new taxon, the Nazca Booby [*Sula granti*] and Beck was “warmly congratulated.”)

After the California Academy of Sciences’ 1905–06 expedition led by Beck, sufficient numbers of specimens were now available to provide definitive taxonomic resolution and answers to several evolutionary questions. Based upon these specimens, a half dozen important monographs were published, including Gifford’s field notes on the land birds of Galápagos and Cocos (Gifford 1919), Loomis’s monograph of the Procellariiformes (Loomis 1918), and Swarth’s monograph of Galápagos avifauna (Swarth 1931). Some of the impacts included Gifford’s copious notes on avian behavior, including the first published observations of tool use in the Woodpecker Finch (*Camarhynchus pallidus*), Swarth’s creation of the Galápagos finch family, Geospizidae (Swarth 1929), and a relatively definitive taxonomy for Galápagos birds and phylogeny for the finches (Swarth 1931). Swarth published a version of a finch phylogenetic tree as seen from the roots looking up into the branches, and with obvious lack of resolution at the base but he clearly delineated the different groups and recognized the close relationships between the Warbler Finch (*Certhidea*), the Cocos Island Finch (*Pinaroloxias*), and the other geospizid finches (Fig. 18). For the most part, he understood the relationships among species and depicted them well in that figure. Swarth estimated 35 taxa, all of which he considered species, but he grouped them together much as we do now. Today, we recognize 13 valid species of Geospizidae living in the Galápagos. With sub-

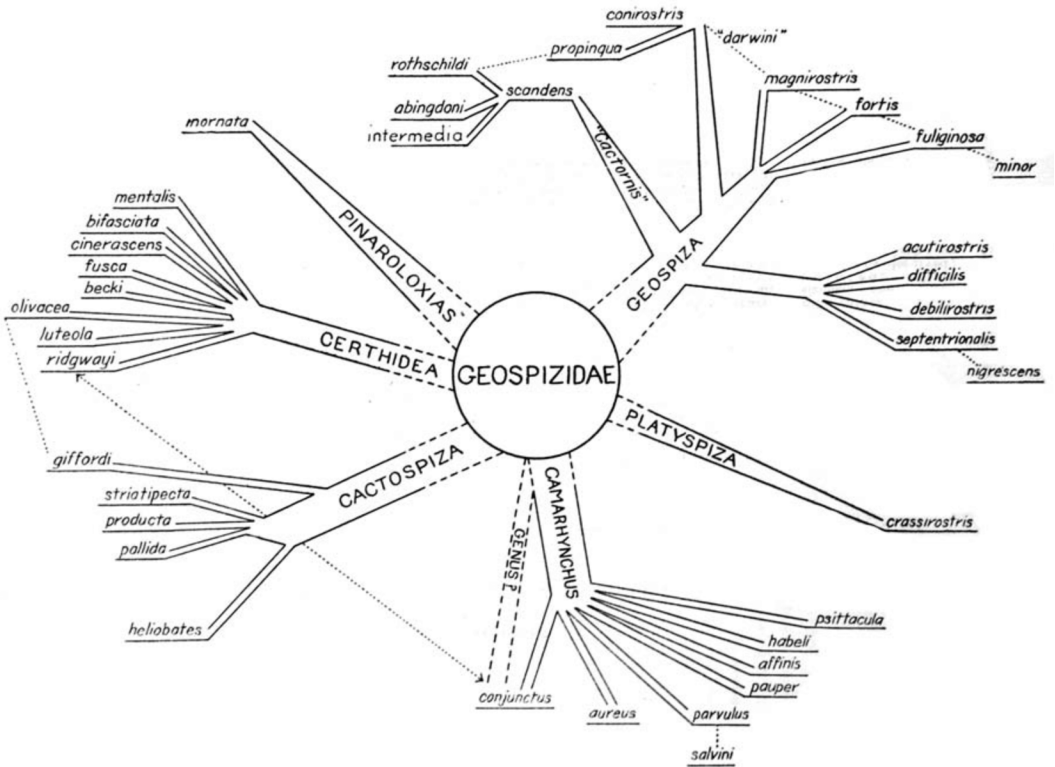


FIGURE 18. Whyte's drawing of the Geospizidae evolutionary tree. (Swarth 1931:139, fig. 19).

species, there are a total of 32 recognized unique taxa. An additional genus and species, the Cocos Island Finch (*Pinaroloxias inornata*) makes the final, 14th species in the avian family Geospizidae (Dickinson 2003). When Swarth's 1931 monograph was written, Swarth had not yet been to the Galápagos, so his work was based solely on specimens from Beck's and others' trips to the those islands.

The next person to make exceptional use of Beck's Galápagos finch specimens was David Lack. Lack traveled the Galápagos from 14 Dec 1938–3 April 1939, and studied the behavior and life histories of the Galápagos Finches. He made copious field observations that are written up in two major published works (Lack 1945, 1947). From the Galápagos he came to the USA and performed thorough examinations of morphology in the collections, especially those of the California Academy of Sciences, Rothschild's collections as well as others at the American Museum, Smithsonian Institution's National Museum, Stanford University (Hopkins-Stanford Expedition (12/1/1898-6/10/1899) and others. Lack's monograph of 1945 has become a classic work in numerical taxonomy, and his second monograph (Lack 1947), a classic work in evolutionary ecology.

There is a fascinating story to be told here, because although the data are basically the same in both of Lack's volumes, the conclusions vary considerably. Lack (1945) quotes Darwin (Darwin 1888):

But how is it that many of the immigrants have been differently modified, though only in a small degree, in islands situated within sight of each other, having the same geological nature, the same height, climate, etc? This long appeared to me a great difficulty: but it arises in chief part from the deeply-seated error of considering the physical conditions of

a country as the most important; whereas it cannot be disputed that the nature of the other species with which each has to compete, is at least as important, and generally a far more important element of success. (Lack 1945:117.)

But afterwards Lack (1945:117) goes on to say, “There is no evidence of Darwin’s suggestion. In fact, there is no evidence whatever, in any of the island forms of Geospizinae, that their differences have adaptive significance.” Lack is satisfied that isolation and genetic drift are sufficient to explain how differences might arise, and considers less how such differences might persist. He presents a beautiful series of figures (Lack 1945, figs. 5–26) presenting morphological measurements of various species occurring in sympatry, uses the differences among the populations and the gaps between them to diagnose the species, and he discusses the ratios of measurement among species and their ecological significance. His conclusions are that three major circumstances shaped the evolution of the finches: 1) the almost complete absence of food competitors, 2) the almost complete absence of predators, and 3) opportunity for temporary isolation of different island forms (Lack 1940).

After several years to think about and discuss the data with friends, Lack (1961:Preface) reverses course and concludes that selection has indeed played a fundamental role. The same data from these same collections of finches are used, and Lack’s figure (1947, fig. 17) sums up beautifully how the presence of one species has led to shifts in the mean measurements of sympatric species (see Fig. 19). Lack became convinced that bill size was related to food taken and that differences in bills reflected differences in foraging niches. With Galápagos finches as the example, he showed that 1) interspecific competition is a powerful force that structures communities of species, and 2) ecological isolation is as important as reproductive isolation for species to co-exist. Lack used these two ideas and his data on finches from various islands to construct a model of how finches likely radiated into many species. Lack’s 1947 book, *Darwin’s Finches: An Essay on the General Biological Theory of Evolution*, has become a classic volume in evolutionary ecology for its insights into interspecific competition, natural selection, and speciation. The later work of Robert Bowman from San Francisco State University has further demonstrated the adaptive values of beak differences (Bowman 1961) and the tremendous life-long work of Peter and Rosemary Grant and their students have shown how this natural selection works in wild Darwin’s finch populations (Grant 1986; Grant and Grant 2007 and this volume).

The impact of Beck and the WSSE on Ernst Mayr and the New Evolutionary Synthesis.— The Whitney South Sea Expedition helped launch the career of the renowned evolutionary biologist and ornithologist, Ernst Mayr. In 1927, Mayr was an assistant at the Berlin Museum working with Erwin Stresemann. Stresemann recommended Mayr to Ernst Hartert (Lord Rothschild’s curator of vertebrates) and to Leonard Sanford at AMNH for a joint collecting trip to New Guinea. Mayr was sent to collect birds in Dutch New Guinea (now Papua, Indonesia) from April 1928. He then crossed the border to Mandated Territory of New Guinea (now the northern half of Papua New Guinea) in December 1928, where he collected for another five months. While Mayr was in the field for Stresemann, Robert Cushman Murphy of the AMNH solicited Mayr to assume leadership of the Whitney South Sea Expedition after Beck’s retirement. Being in the field so far from communications, Mayr received and then complied with the invitation too late. By the time he arrived at Samarai Island, Milne Bay Province, Papua New Guinea, to lead the expedition, William Coultas had already assumed leadership at Murphy’s request. Mayr still joined the expedition in July 1929, and traveled on the *France* for eight months through New Guinea and the Solomon Islands, eventually returning to the Berlin Museum in February 1930 (LeCroy 2005).

Due to mounting pressure on the AMNH to demonstrate tangible results from the WSSE, Mur-

phy again hired Mayr for one year beginning in 1931 as a visiting Research Associate in the Department of Ornithology at AMNH to work up the material collected during the WSSE. During this year, Mayr published six papers from the South Pacific specimens. In 1932, Lord Rothschild sold his bird collection to the AMNH, and Mayr was permanently hired as curator of birds and tasked with the enormous job of unpacking and cataloging the Rothschild collection as well as curating the continually growing WSSE collection (Rothschild 1983; LeCroy 2005). With the combined collections of Rothschild and the AMNH, Mayr had access to an incredibly expansive and thorough bird collection from the southwestern Pacific, and probably the most complete from any part of the world.

In the coming years, Mayr published 41 papers based upon the WSSE materials, only four of which were coauthored (LeCroy 2005). Mayr also published the definitive monograph on the birds of the southwest Pacific

(Mayr 1945) and the checklist of the birds of New Guinea (Mayr 1941). These empirical studies provided the foundation for Mayr's understanding of geographic variation and speciation, especially his ideas concerning the role of allopatry in speciation. These ideas were later compiled in his classic book, *Systematics and the Origin of Species* (Mayr 1942). This volume is now a classic in evolutionary biology and was an integral element of the "modern evolutionary synthesis" that melded Darwinian evolution with early 20th century understanding of genetics (Larson 2004). Incidentally, Lack wrote his first monograph on Galápagos finches in 1939, published in 1945 (Lack 1945) and then a second monograph (Lack 1947). Mayr's 1942 book certainly was read by Lack between his two monographs. Other major contributors to the synthesis offered mathematical theories of genetics (Sewall Wright and R.A. Fisher) and laboratory studies of evolution (Theodosius Dobzhansky), but Mayr contributed a deep understanding and numerous examples of evolution in natural populations, inspired largely by his work on South Pacific birds (Schodde 2005).

Although they both collected in New Guinea at the same time and both were deeply involved with the WSSE, Beck mentions Mayr only three times in his log, only one of which indicates that

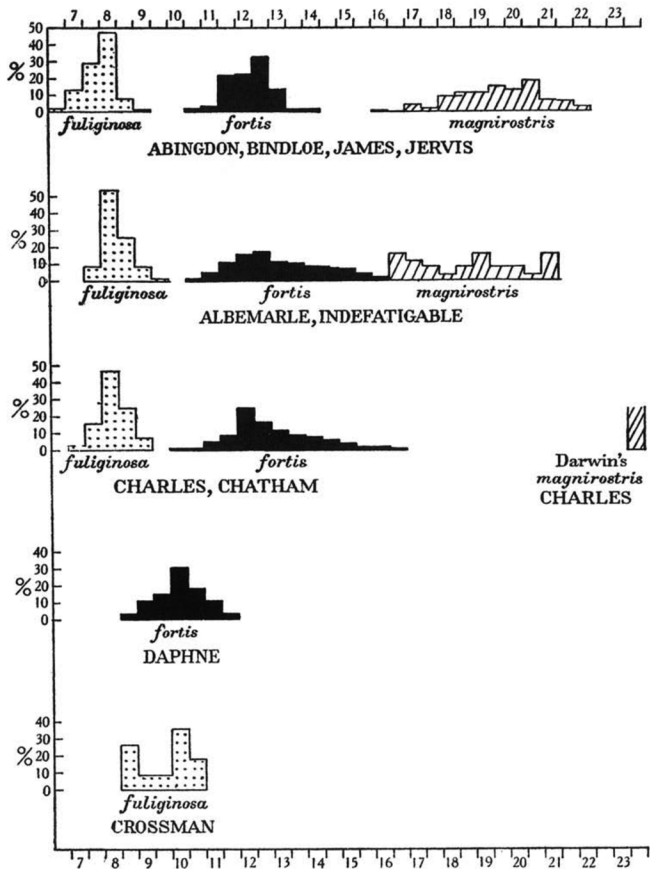


Fig. 17. Histograms of beak-depth in *Geospiza* species.

FIGURE 19. Lack's careful measuring of beak-depth in *Geospiza* produced these figures showing how different Galápagos islands had variants of beak-depth in the same species (Lack 1947:82). (Reproduced with permission from David Lack's Estate).

Beck and Mayr actually met on the Huon Peninsula. At that time neither had any reason to think that Mayr would be invited to join the Whitney Expedition (personal communication from M. LeCroy). Nonetheless, Beck's collections and the work of the WSSE significantly influenced Mayr. It was also the strong start of the WSSE that provided the momentum for it to continue for several years after the Becks departed.

Criticisms of Rollo Beck

Many people who have worked with Beck's specimens have sung his praises, particularly the scientists who benefitted from his work. But Beck was not universally liked, and negative reviews sometimes came from other collectors who worked under him in the field. Beck had high expectations for himself and others, and pushed his workers as hard as he pushed himself. Inevitably after a few months of difficult conditions, workers would express some irritation with their expedition leader. Some of these concerns can be found in field journals of Beck's companions. Both Slevin (1931) and Quayle (WSSE, about 1921) complained bitterly that Beck would not give them sufficient time to document specimens (measurements, colors of soft parts, the ecology of the location). Beck's response, as they each relayed it, was basically, 'Collect! That's what you're being paid for!' Hunter, also on the 1905-06 expedition, saw a woodpecker finch fashion a tool from a twig, to dig grubs out of a limb. Hunter communicated this observation to Beck, and Hunter reports in his journal, "Beck reports having seen this same performance gone through with, two years ago. He is such a liar that I do not know whether to believe him or not." (Hunter field journal, January 4th, 1906, California Academy of Sciences Archives.) José Correia, originally from the Azores and very much admired as a collector by Robert Murphy, worked under Beck during the WSSE trip. Later, in a diary kept while collecting for AMNH on São Tomé and Príncipe, he told of his anger and frustration at Beck's treatment of him and his wife, Virginia. Correia sarcastically noted that one Christmas Beck presented him with 10-cent neckties, somewhat insulting and worse than useless presents in the Pacific islands. One lovely morning in Príncipe reminded him of the South Pacific "but these idea allways bring Beck to my mind and I hate him! I detest him forever so some times I hate south sea islands and they people but Beck's roten reputation is the cause of these." (José Correia field notes, São Tomé and Príncipe, 15 March 1928, Library, American Museum of Natural History.) Indeed Beck's WSSE journals don't indicate that he was either patient or tolerant.

Even Beck's AMNH employers lost confidence in him toward the end, agreeing that he had been at sea and in command far too long, and that the best thing for both him and the expedition was to get him off the *France*. Pressure was applied, Beck finally wrote a letter of resignation and the Becks departed for Australia.

A career as long and productive as Rollo Beck's could not be without controversy either. Among these, Beck has been blamed for over-collecting birds and tortoises, for having collected without permits, and for introducing species to oceanic islands. Most prominent among these accusations is the possible extinction of two Galápagos tortoise subspecies.

The first species is the Fernandina tortoise, *Geochelone nigra phantastica*. Beck found it on 4 April 1906. He certainly had known that no tortoises had ever been collected from Fernandina, and he must have expected that it would be special. He finally encountered a single large male tortoise on the mountain top. He collected the specimen and spent a long moonlit night alone preparing it while fending off hundreds of ticks and eventually sleeping on the hard lava under an oil cloth. The next day, Beck carried the partially prepared carcass down the mountain most of the way himself. He summoned Joseph Hunter, who was off collecting cormorants along the coast, to help retrieve and finish preparing the tortoise specimen. The specimen was unusual — the shell was thin, it had

a distinctive “saddle-backed” shape, and it was the first specimen ever collected from Fernandina. They immediately suspected it was an undescribed species. (From the field journals of Beck, Hunter, Slevin, 3–7 April 1906.) Indeed it was undescribed and no other specimen had ever been collected before or since. Thus, Beck found and collected the only known member of its species, and the only evidence that a unique tortoise ever walked the lava-studded island of Fernandina.

There is greater hope for the second species as it still teeters on the brink of extinction. The Pinta tortoise, *Geochelone nigra abingdonii* has at least one remaining surviving individual. Notorious as “Lonesome George,” he has no known female to mate with except from other *Geochelone nigra* subspecies, and his race appears doomed unless one can be found.

When the Webster-Harris Expedition traveled to Galápagos in 1897, it failed to find any Pinta tortoises for Rothschild. At Rothschild’s beckoning, Rollo returned to Galápagos in 1901 to collect more tortoises, and this time Beck managed to find two Pinta specimens — one old large male that Beck skinned onshore, and a smaller individual that Beck collected alive (Nicholls 2006). Of course males, dead or alive, are no help to Lonesome George. Although it is not certain, the smaller tortoise was likely a female — it was smaller and had a simpler shell that was typical of females. Beck found this female trapped on an isolated beach, with several injuries due to a fall. Beck suspected that she would not make the trip to Tring, England, alive, and that Rothschild would prefer a scientific specimen to no specimen at all. He killed and skinned it and prepared the specimen. It is believed to be the only scientific specimen of any female in any museum collection (Nicholls 2006).

In September 1906, the California Academy’s Galápagos Expedition collected four additional tortoises from Pinta, including three live male specimens; the fourth (CAS 8113) consisted only of a shell found relatively intact. Even in 1906, Slevin’s field notes attested to the excellent tortoise habitat and that they found individuals almost immediately. This suggests that there were more tortoises on Pinta in 1906 when Beck and his team visited. Lonesome George is estimated to be between 60–80 years old. In recent years, another likely Pinta male was found in a Prague zoo. This individual was estimated to have hatched around 1960, so at least one pair must have lived until then. Researchers are now genetically testing all living Galápagos tortoises of unknown origin, looking for, among others, females that might have come from Pinta. Unfortunately none has been found so far; however, 39 half-Pinta half-other tortoises were repatriated to Pinta Island in May 2010, to resume their role as large herbivores in the ecology of the island.

The greatest destruction to the tortoises was wrought by whalers and fisherman who harvested tortoises by the hundreds for food, and later by goats introduced up until the mid-1900s that decimated their habitat (Van Denburgh 1914; Slevin 1959). Feral donkeys have trampled nests, and feral cats and dogs have depredated young. The Charles Island tortoise disappeared by the mid-1800s, presumably at the hands of hungry sailors. No laws were being written or enforced to protect the wildlife, so some feared that these species would disappear without any proper documentation. Beck had recorded the carnage in the killing pens himself with photographs from his early trips to the Galápagos, and these photos only inspired Rothschild and Loomis to fund trips to record the wildlife before it was gone. Even though Beck’s specimens are among the last collected for scientific purposes, they were certainly not the last killed. Tortoise harvesting on the islands continued for decades afterwards.

The Guadalupe Caracara (*Caracara lutosa*) was a scavenging bird of prey and a relative of the falcons endemic to the small island of Guadalupe off Baja California, Mexico. Farmers on the island persecuted the caracara because they believed that they were killing goats. Ornithologists and collectors had a few in collections, and in the late 1890s, a fisherman arrived in San Diego with six of them for sale (Abbott 1933). Beck visited the island in December of 1900, and he encoun-

tered 11 individuals. He shot 9, but the other two got away. Based on their lack of fear and how many he saw in so short a time, Beck assumed they were common (Abbott 1933). But in 1906 when W.W. Brown and H.W. Marsden collected on Guadalupe, they found no trace of the caracaras despite tremendous effort (Thayer and Bangs 1908). Clinton Abbott (1933) assumed that Beck was probably the last person to see them alive.

During Beck's years leading the Whitney South Sea Expedition, numerous complaints were lodged with the American Museum, and rumors began to grow. In 1934, the Marquess of Tavistock, an aviculturist interested in rare parrots, wrote a scathing letter to the *Auk* criticizing the American Museum and Beck for over-collecting endangered island birds (Tavistock 1934). Frank Chapman, Curator of Ornithology at the AMNH responded swiftly with actual collection records, arguing that the allegations were exaggerated and that the fears were unfounded (Chapman 1934). Eventually Chapman wrote a letter to *Science* (Chapman 1935) to squelch the rumors, but also to demonstrate the value of the ornithological work being done. The Whitney Expedition was among the first to document the avifauna of many of the islands, and already 44 publications had appeared based upon the collections. Chapman and others realized that these islands could reveal how birds evolve. He also realized that countless human practices were wiping out birds regardless of Beck's collecting, and that documenting the species and their ranges was key to understanding their status, even for conservation. Chapman was correct on every count. The Whitney collections remain the most complete record of Pacific Island birds ever made. They now represent the "baseline" for conservation work, and what we can compare with our present-day distributions. The number of publications stemming from those collections is astounding. The collections provided a fertile ground for the young Ernst Mayr who launched his lifelong work in evolutionary biology. Chapman effectively defended Beck, who appears to have operated under the necessary permits and within the ethical guidelines of the time.

New Uses for Old Collections

Precisely because these specimens were collected a century ago, they are extremely valuable to science. Each specimen carries a tag on which valuable data are written — the collector's name, field number, date, locality, and a variety of other information that cannot be gleaned from the specimen itself. Thus, the specimens themselves are the most tangible and complete record of those species from those times and places. The specimens become a source of information about the time and place as well as for descriptions of the species.

Researchers are now discovering a variety of new types of information that can be obtained from these old specimens. These include extracting DNA samples from feather or skin fragments, collecting pollen from the facial feathers of nectar feeders, analyzing stable isotope signatures from feather or bone fragments, or even surveying environmental contaminants or pollutants from feathers and eggshell.

The Galápagos finches are no exception. Workers have successfully extracted DNA from Beck's Galápagos birds for studies of the mockingbirds (Arbogast et al. 2006; Hoeck et al. 2009), Galápagos Hawk (Bollmer et al. 2006), and Darwin's finches (Tonnis et al. 2005). Patricia Parker from University of Missouri at St. Louis and her colleagues have demonstrated not only the ability to retrieve bird DNA from these 100-year old specimens, but they have also reliably recovered avian poxvirus DNA. This is allowing her research group to investigate the spread of diseases through finch populations and throughout the islands.

When these collections were made, some over 100 years ago, DNA was not yet discovered and genetics were largely unknown. No one could have anticipated these uses for their specimens. This

remains equally true today; we can only imagine what researchers 100 or 500 years from now might be capable of studying. For them, it will be important not only to preserve these old specimens that record the previous century, but also to create and preserve specimens from today's populations. If we continue to accumulate specimens from various time slices, future researchers may also be able to see evolution unfolding or document climate change and its impact on species.

SUMMARY AND CONCLUSIONS

Rollo Howard Beck spent some 65 years of his life collecting birds and contributing in various ways to ornithology, working from Alaska to Tierra de Fuego in North and South America, the Caribbean, and specializing in birds on Pacific Islands. The ornithological collections he built are among the largest contributions from any single collector. The large series and thorough collections have made possible the classic work by David Lack on Galápagos finches, and by Ernst Mayr on Southwest Pacific birds, just to name two of the most influential. He has been remembered in several obituaries and biographies, but mostly by the amazing series of beautifully prepared ornithological specimens in museums throughout the world.

ACKNOWLEDGEMENTS

We would like to thank a large number of people who contributed in various ways. G.H. and A. Parsons, G. Fellers, D. Fellers, and other relatives of Rollo Beck shared and even collected data and information about Rollo and Ida. The CAS library and archives staff, including D. Castronovo, R. Morin, J. Farrington, L. Currie, and others, helped care for and give access to many of papers and photographs studied and published here. Matt James was a tremendous source of knowledge about Beck, especially regarding the 1905-06 expedition. Many museum curators and collections managers were tremendously helpful: M. LeCroy, T. Trombone, and others at the AMNH helped provide stories about and critical data from Beck's collections. Additional collections data were provided by J. Dean at the Smithsonian, J. Trimble from the Harvard Museum of Comparative Zoology, D. Willard from the Field Museum of Natural History, J. Geary from the San Jose State University collection, and M. Flannery at the California Academy of Sciences. We additionally thank R. Banks from Smithsonian for help tracking down various stories about Beck, S. Zagier for the base map of Tierra del Fuego, and J. Woram for creating the route maps of Beck's travels during the Brewster-Sanford Expedition to South America. We would like to thank K. Berge, M. Ghiselin, M.R. Lewin, and A. Tye who provided feedback on earlier versions of the manuscript.

LITERATURE CITED

- PUBLICATIONS ABOUT THE ACADEMY EXPEDITION.— Between 1907 and 1928, twenty papers based on the 1905–05 Galápagos expedition were published in *Proceedings of the California Academy of Sciences*, Fourth Series (Van Denburgh 1907; Williams 1911; Stewart 1911, 1912a, b; Van Denburgh 1912b, a; Gifford 1913; Van Denburgh and Slevin 1913; Van Denburgh 1914; Dall 1917; Loomis 1918; Wheeler 1919a, b; Gifford 1919; Brues 1919; Hebard 1920; Williams 1926; Dall and Ochsner 1926a, b.)
- ABBOTT, C.G. 1933. Closing history of the Guadalupe Caracara. *Condor* 35:10–14.
- ARBOGAST, B., S. DROVETSKI, R. CURRY, P. BOAG, G. SEUTIN, P. GRANT, B. GRANT, D. ANDERSON, AND M. SORENSON. 2006. The origin and diversification of Galápagos mockingbirds. Pp. 370–382. *Evolution* 60(2):370–382.
- AVISE, J.C., AND R.M. ZINK. 1988. Molecular genetic divergence between avian sibling species: King and

- Clapper Rails, Long-billed and Short-billed Dowitchers, Boat-tailed and Great-tailed Grackles, and Tufted and Black-crested Titmice. *The Auk* 105:516–528.
- BECK, R.H. 1904. Bird life among the Galápagos Islands. *Condor* 6:5–11.
- BECK, R.H. 1910. Water birds in the vicinity of Point Pinos, California. *Proceedings of the California Academy of Sciences*, ser. 4, 3:57–72.
- BECK, R.H. 1929. A collector in the land of the Birds of Paradise. *Natural History* 24:563–578.
- BECK, R.H. 1936. Autobiography of Rollo Beck. Pages 3–8 in R.C. Murphy, ed. *Oceanic Birds of South America*, vol. 1. American Museum of Natural History, New York, New York, USA. 640 pp, 38 pl.
- BOLLMER, J.L., R.T. KIMBALL, N.K. WHITEMAN, J.H. SARASOLA, AND P.G. PARKER. 2006. Phylogeography of the Galapagos hawk (*Buteo galapagoensis*): A recent arrival to the Galapagos Islands. *Molecular Phylogenetics and Evolution* 39:237–247.
- BOWMAN, R.I.. 1961. *Morphological differentiation and adaptation in the Galápagos finches*. Charles Darwin Foundation for the Galápagos Islands and University of California Publications in Zoology, vols. 1 and 58 respectively. Palais des Académies and University of California Press, Brussels, Belgium and Berkeley, California, USA. vii + 302 pp., illus.
- BRUES, C.T. 1919. A new species of the Hymenoptera genus *Scleroderma* from the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 2:309–310.
- CHAPMAN, F.M. 1934. Excessive collecting: Rebuttal. *The Auk* 51:429–430.
- CHAPMAN, F.M. 1935. The Whitney South Sea Expedition. *Science* 81:95–97.
- COUES, E. 1903. *Key to North American Birds. Volume I*. Dana Estes and Company, Boston, Massachusetts, USA. 535 pp.
- DALL, W.H. 1917. Preliminary descriptions of new species of Pulmonata of the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 2:375–382.
- DALL, W.H. 1924. Note on fossiliferous strata on the Galápagos Islands explored by W.H. Ochsner of the expedition of the California Academy of Sciences in 1905–6. *The Geological Magazine*. 61:428–429.
- DALL, W.H., and W.H. OCHSNER. 1928a. Landshells of the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 17:141–185, 2pls.
- DALL, W.H., and W.H. OCHSNER. 1928b. Tertiary and Pleistocene mollusca from the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 17:89–139, 6 pls.
- DARWIN, C.R. 1839. *Narrative of the Surveying Voyages of his Majesty's Ships Adventure and Beagle Between the Years 1826 and 1836, Describing Their Examination of the Southern Shores of South America, and the Beagle's Circumnavigation of the Globe*. Journal and Remarks 1832–1836. Henry Colburn, London, England.
- DARWIN, C. 1845. *Journal of researches into the natural history and geology of the countries visited during the voyage of H.M.S. Beagle round the world*. 2nd ed. John Murray, London, England. 519 pp.
- DARWIN, C. 1888. *On the Origin of Species by Means of Natural Selection, or the Preservation of the Favored Races in the Struggle for Life*. 6th ed. John Murray, London, England. 458 pp.
- DICKINSON, E.C., ed. 2003. *The Howard and Moore Complete Checklist of the Birds of the World*. Princeton University Press, Princeton, New Jersey, USA. 1039 pp.
- EVENHUIS, N.L., ED. 2007. Field notes of E.N. Bryan, Jr., on the Whitney South Seas Expedition (February–November 1924). Bishop Museum Technical Report 37. Bishop Museum, Honolulu, Hawaii, USA.
- GIFFORD, E.W. 1908. The rehabilitation of the California Academy of Sciences. *The Condor* 10:95–96.
- GIFFORD, E.W. 1913. The birds of Galápagos Islands, with observations on the birds of Cocos and Clipperton Islands (Columbiformes to Pelicaniformes). *Proceedings of the California Academy of Sciences*, ser. 4, 2:1–132, 7 pls.
- GIFFORD, E.W. 1919. Field Notes on the land birds of the Galápagos Islands and of Cocos Island, Costa Rica. *Proceedings of the California Academy of Sciences*, ser. 4, 2:189–258.
- GOULD, J., AND C. DARWIN. 1839. *The Zoology of the Voyage of the H.M.S. Beagle, under the Command of Capt. Fitzroy, R.N., during the years 1832–1836. Part 3: Birds, with a notice of the habits and ranges, Issue 1–5*. No. III of Part III. Smith, Elder, and Co., Cornhill, London, England. 56 pp.

- GRANT, P.R. 1986. *Ecology and Evolution of Darwin's Finches*. Princeton University Press, Princeton, New Jersey, USA. xiv + 458 pp., 8 pp. of col. plates.
- GRANT, P.R., AND R. GRANT. 2007. *How and Why Species Multiply: The Radiation of Darwin's Finches*. Princeton University Press, Princeton, New Jersey, USA. xix + 218 pp., 32 pls.
- GRINNELL, J., AND A.H. MILLER. 1944. *The Distribution of the Birds of California*. Cooper Ornithological Club, Berkeley, California, USA. 608 pp., 1 pl.
- HEBARD, M. 1920. Dermaptera and Orthoptera. *Proceedings of the California Academy of Sciences*, ser. 4., 2:311-346, 1 plate, 11 figs.
- HOECK, P.E.A., M.A. BEAUMONT, K.E. JAMES, R.B. GRANT, P.R. GRANT, and L.F. KELLER. 2009. Saving Darwin's muse: evolutionary genetics for the recovery of the Floreana mockingbird. *Biology Letters*, pp. 1-4.
- LACK, D. 1940. Evolution of the Galápagos finches. *Nature* 146:324-331.
- LACK, D. 1945. The Galápagos Finches (Geospizinae): A study in variation. *Occasional Papers of the California Academy of Sciences* (21):1-152.
- LACK, D. 1947. *Darwin's Finches: An Essay on the General Biological Theory of Evolution*. Harper Torchbooks, New York, New York, USA. x + 204 pp., 3 pls.
- LARSON, E.J. 2001. *Evolution's Workshop: God and Science on the Galápagos Islands*. Basic Books, New York, New York, USA. xiii + 320 pp., 16 pls.
- LARSON, E.J. 2004. *Evolution: The Remarkable History of a Scientific Theory*. Modern Library Chronicles, New York, New York, USA. xiv + 337 pp.
- LECROY, M. 2005. Ernst Mayr at the American Museum of Natural History. *Ornithological Monographs* 2005:30-49.
- LOOMIS, L.M. 1918. A review of the albatrosses, petrels, and diving petrels. *Proceedings of the California Academy of Sciences*, ser. 4, 2:1-187, 17 pls.
- MAYR, E. 1941. *List of New Guinea Birds: a systematic and faunal list of the birds of New Guinea and adjacent islands*. American Museum of Natural History, New York, New York, USA. xi + 260, fold.
- MAYR, E. 1942. *Systematics and the Origin of Species*. Columbia University Press, New York, New York, USA. xiv + 334 pp.
- MAYR, E. 1945. *Birds of the Southwest Pacific*. Macmillan, New York, New York, USA. xix, 316 pp., 3 plates.
- MEARNS, B., AND R. MEARNS. 1998. *The Bird Collectors*. Academic Press, New York, New York, USA. xviii + 472 pp., 1 pl, maps, and photos.
- MURPHY, R.C. 1936. *Oceanic Birds of South America*. American Museum of Natural History, New York, New York, USA. 2 vol., xx + 1245 pp., 110 pls.
- NICHOLLS, H. 2006. *Lonesome George: The Life and Loves of the World's Most Famous Tortoise*. Palgrave Macmillan Ltd, New York, New York, USA. xviii + 231 pp.
- ORR, R.T. 1940. An analysis of the subspecific status of Dowitchers in California. *Condor* 42:61-63.
- PITELKA, F.A. 1950. Geographic variation and the species problem in the shore-bird genus *Limnodromus*. *University of California Publications in Zoology* 50:1-108.
- PITELKA, F.A. 1986. Rollo Beck — Old school collector, member of an endangered species. *American Birds* 40(3):385-387.
- RIDGWAY, R. 1896. Birds of the Galápagos Archipelago. *Proceedings of the United States National Museum* 19:459-670.
- ROTHSCHILD, M. 1983. *Dear Lord Rothschild: Birds, Butterflies and History*. Hutchinson, London, England, UK. xx + 398 pp., 106 pls.
- ROTHSCHILD, W. 1899. A review of the ornithology of the Galápagos Islands. With notes on the Webster-Harris Expedition. *Novitates Zoologicae* 6:85-205.
- ROTHSCHILD, W. 1903. Notes on Birds of the Galápagos and Cocos Islands. *Bulletin of the British Ornithologists' Club* 13:6-7.
- ROWAN, W. 1932. The status of the dowitchers with a description of a new subspecies from Alberta and Manitoba. *The Auk* 49:14-35.
- SALVIN, O. 1876. On the avifauna of the Galápagos archipelago. *Proceedings of the Zoological Society of London* 9:447-510.

- SCHODDE, R. 2005. Ernst Mayr and Southwest Pacific birds: Inspiration for ideas on speciation. *Ornithological Monographs* 58:50–57.
- SLEVIN, J.R. 1931. Log of the schooner “Academy” on a voyage of scientific research to the Galápagos Islands, 1905–06. *Occasional Papers of the California Academy of Sciences* (17):3–162.
- SLEVIN, J.R. 1935. An account of the reptiles inhabiting the Galápagos Islands. *Bulletin: New York Zoological Society* 38:2–24.
- SLEVIN, J.R. 1959. The Galápagos Islands: A history of their exploration. *Occasional Papers of the California Academy of Science* (25):1–150.
- STEINHEIMER, F.D. 2004. Charles Darwin’s bird collection and ornithological knowledge during the voyage of the H.M.S. “Beagle”, 1831–1836. *Journal of Ornithology* 145:300–320.
- STEWART, A. 1911. A botanical survey of the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:7–289, pls. 253–289.
- STEWART, A. 1912a. Notes on the botany of Cocos Island. *Proceedings of the California Academy of Sciences*, ser. 4, 1:375–404, pls. 395–404.
- STEWART, A. 1912b. Notes on the lichens of the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:431–445.
- STEWART, A. 1915. Notes on the forms of *Castela galapageia*. *American Journal of Botany* 2:279–298.
- STEWART, A. 1916. Some observations concerning the botanical conditions on the Galápagos Islands. *Transactions of the Wisconsin Academy of Sciences, Arts, and Letters* 18:272–339.
- SWARTH, H.S. 1929. A new bird family (Geospizidae) from the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 18:29–43.
- SWARTH, H.S. 1931. The Avifauna of the Galápagos Islands. *Occasional Papers of the California Academy of Sciences* (18):1–299, map.
- TAVISTOCK, M.O. 1934. Alleged excessive collecting. *The Auk* 51:428–429.
- THAYER, J.E., AND O. BANGS. 1908. The present state of the ornithology of Guadalupe Island. *The Condor* 10: 101–106.
- TONNIS, B., P. GRANT, B.R. GRANT, AND K. PETREN. 2005. Habitat selection and ecological speciation in Galápagos warbler finches (*Certhidea olivacea* and *Certhidea fusca*). *Proceedings of the Royal Society Biological Sciences, Series B*, 272(1565), April 22, 2005:819–826.
- VAN DENBURGH, J. 1907. Preliminary description of four new races of gigantic land tortoises from the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:1–6.
- VAN DENBURGH, J. 1912a. The geckos of the Galápagos Archipelago. *Proceedings of the California Academy of Sciences*, ser. 4, 1:405–430.
- VAN DENBURGH, J. 1912b. The snakes of the Galápagos islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:323–374, pls. 356–374.
- VAN DENBURGH, J. 1914. The gigantic land tortoises of the Galápagos Archipelago. *Proceedings of the California Academy of Sciences*, ser. 4, 2:203–374, 123 pls.
- VAN DENBURGH, J., AND J.R. SLEVIN. 1913. The Galapagoan lizards of the genus *Tropidurus*; with notes on the iguanas of the genera *Conolophus* and *Amblyrhynchus*. *Proceedings of the California Academy of Sciences*, ser. 4, 2:133–203, 4 pls.
- WHEELER, W.M. 1919a. The Ants of Cocos Island. *Proceedings of the California Academy of Sciences*, ser. 4, 2:299–308.
- WHEELER, W.M. 1919b. The ants of the Galápagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 2:259–298.
- WINKER, K. 2000. Obtaining, preserving, and preparing bird specimens. *Journal of Field Ornithology* 71:250–297.
- WILLIAMS, FRANCIS X. 1911. The Butterflies and Hawk-Moths of the Galapagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:289–322, 2 plates.
- WILLIAMS, FRANCIS X. 1926. The Bees and Aculeate Wasps of the Galapagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 2:347–357.

TABLE 1. Numbers of specimens in Ornithology collections that are attributed to R.H. Beck. An additional 842 herpetology specimens can be found in California Academy of Sciences and other institutions.

Museum Collection	Specimens
American Museum of Natural History*	36782
California Academy of Sciences	9526
Museum of Vertebrate Zoology, U.C.	4674
U. Michigan Museum of Zoology	923
Smithsonian	596
Museum of Comparative Zoology, Harvard	547
Other ORNIS	541
San Jose State University	354
Delaware Museum of Nat. History	261
Field Museum	165
Pacific Grove Museum of Natural History	118
Western Foundation of Vertebrate Zoology	44
Total	54,351

* Note that many museums are not yet fully digitized, so this number represents only Beck's specimens that have been duly documented and are easily searched. The AMNH is still entering their data from the Brewster-Sanford Collections and earlier, so these numbers represent a partial list of AMNH specimens collected after mid 1913. This is certainly an underestimate of the specimens worldwide that are attributed to Beck. AMNH accession cards suggest, however, that the full number for their collection may be as high as 44,204 (giving Beck a minimum number of documented specimens of around 62,000.) Some specimens are also attributed to multiple people (e.g., R.H. Beck and Assistants, R.H. Beck and E. Quayle, etc.) so we cannot say with certainty how many were skinned by Beck alone.