ANGEL C. ALCALA

When Porfirio Alcala, Sr., Angel C. Alcala's father, graduated from high school during the high noon of the American colonial period in the Philippines, he immediately embarked upon a career in teaching. In the town of Cauayan, on Negros Island in central Philippines, he courted and married one of his students, Crescenciana Chua. Together they moved to the small village of Calíling, on the sea coast about fourteen kilometers south of Cauayan. Crescenciana's mother, the wife (but not the First Wife) of a prosperous Chinese businessman, owned some property there and Porfirio took up a new line of work supplying fish fry to commercial fishpond operators in the northern towns of Negros Occidental. In time, Porfirio and Crescenciana had five daughters and five sons. Angel, their eldest child, was born on 1 March 1929.

The family home was simple. The roof was thatch and the floors, slatted bamboo. It had only two bedrooms; in one, as Angel Alcala remembers, the growing band of children slept "all lined up at night." After sundown, light came from kerosene lamps. Food was fresh and abundant. The family shared three hectares of land with Crescenciana's brothers, on which they grew rice, coconuts, and myriad other fruits and vegetables. Alcala's father maintained fishponds that yielded a dependable supply of milkfish, or *bangus*. Moreover, the family home faced the Guimaras Strait. In the reef just offshore lived a cornucopia of sea life. When the sun set and the tide was low, Alcala and his father and younger brothers explored the shallows. Using torches made from bundled coconut fronds, they harvested buckets full of crabs, shrimp, shellfish, lobsters, octopuses, and fish. "We would go out," he remembers, "and after a couple hours we'd come back and cook our food. And we would have a good supper and much more to spare for the next day."

Aside from these natural bounties, the family had few luxuries. Alcala's mother helped make ends meet by raising pigs and selling textiles to the local women. By assisting the neighbors in their rice harvests, she garnered for the family a small share of extra paddy. All the children had chores. As the family's "assistant cook," young Angel pounded the rice and prepared meals for his brothers and sisters when his parents were out.

The small community of Calíling had barely a dozen houses. The Alcalas purchased salt and sugar, vinegar and kerosene at a local

sari-sari store. But for other needs, to sell their fish and fish fry, and to visit relatives, the family had to journey farther afield. Once daily, buses plied the route to town and, beyond it, to the provincial capital of Bacolod, one hundred thirty kilometers away. Alcala often accompanied his father aboard the bus carrying earthenware jars full of fish fry. There were horses, too, to get from place to place. But very often, says Alcala, he and his brothers and sisters simply walked. He remembers countless expeditions when they set off barefoot along the sandy roads for journeys of several miles.

Indeed, this is how the children went to school. Caliling had no elementary school of its own. The nearest was in Cauayan, fourteen kilometers away. Luckily, a half sister of Crescenciana's lived there and was married to the mayor. Her large house became a home-away-from-home for the Alcala children and their cousins who attended school in town. About a dozen of them lodged there together, sleeping on mats and pillows on the hardwood floors of the bedrooms and dining together around a long table under the vigilant supervision of their uncle and aunt. Each Sunday afternoon, a party of school children departed Caliling bound for Cauayan bearing their schoolbooks and provisions. And each Friday afternoon, as Alcala remembers, they made their way happily home, "part walking and part running . . . and telling all kinds of jokes."

Young Alcala attended a public elementary school where the medium of instruction was English. When his parents first enrolled him in 1935, Alcala was still too immature to succeed. "I couldn't understand anything the teacher was saying," he says. He dropped out and began again the following year, after which he was routinely at the top of his class.

By the mid-1930s, the Philippines had achieved Commonwealth status under the United States. Flying above Alcala's simple schoolhouse in Cauayan were two flags: American and Philippine. He and his classmates sang two national anthems. Alcala remembers well the esteem he and his classmates felt for their teachers, who instructed them daily dressed in coats and ties despite the stifling tropical heat.

The Japanese Occupation of the Philippines interrupted Alcala's early education. Although the serious fighting occurred elsewhere, Japanese soldiers patrolled the coastal roads on Negros Island. Filipinos were frightened of them. To stay clear of danger, Porfirio Alcala moved his family into the forested hills south of Caliling where they cleared some land owned by Crescenciana's family. They built a rustic house and, recalls Alcala, "planted all the corn and rice we needed." Using coconut oil and lime, they made their own soap. Malaria was the great scourge of jungle life and Alcala's mother insisted that everyone sleep beneath a mosquito net. Even so, it was a miracle that only one member of the family, Alcala's uncle, contracted the disease during the war.

Lack of proper clothing was the single most aggravating problem of wartime life. No cloth was available and so the family had to make do with coarse, homespun abaca (hemp) garments or clothes made from sugar sacks discarded by the dormant mill some forty kilometers away. The latter were itchy when you first wore them, remembers Alcala, and, moreover, if not carefully laundered, became carriers of body lice, a common plague of the time. (Years later, as an enterprising young scientist, Alcala gathered up batches of these old wartime garments, which were still being worn in rural areas, to collect specimens of body lice for a biological supply house in the United States.)

By late 1944, the United States had begun its counterattack against Japan in the Philippine Islands. From their forest retreat, Alcala sometimes witnessed dogfights between Japanese and American pilots. Anticipating Japan's eventual defeat and fearing that his farms and fishponds would fall into ruin if abandoned for too long, Alcala's father decided to move the family back to Calíling, despite the risk. They spent the remaining year of the war restoring the family properties.

At war's end in 1945, sixteen-year-old Alcala immediately resumed his education. As the best student in his elementary school, he was awarded a scholarship to a private, interdenominational high school in the town of Kabankalan, forty kilometers away. For the next three years, Kabankalan Academy virtually became Alcala's home as he studied year-round to make up for lost time. He could easily have taken the bus to Calíling on weekends but, instead, he applied himself to his studies. Naturally competitive and acutely aware of his family's difficult financial circumstances—with nine more children to educate—he managed to keep his scholarship until graduation by topping his class every year. Still, there were room and boarding fees to pay and these his family continued to provide. For a time, his father took a job on an abaca plantation in Davao, in the southern Philippines, to help make ends meet. On his own rare visits home, Alcala earned extra money himself by harvesting coconuts from his mother's trees and making copra to sell.

In Kabankalan, Alcala's busy life revolved almost entirely around school, where he joined the debating team. He was also a member of the local Boy Scout troop, with whom he went hiking and slept beneath the stars. But Alcala also used these years to resolve a matter of a spiritual nature. His mother was Roman Catholic and was thus a member of the vast religious majority of Filipinos. There was no Catholic church in their village, however, and she worshiped formally only when visiting her family in Cauayan or when the priest came to Calíling at fiesta time. Alcala's father was a Protestant who attended services regularly at a local Baptist chapel. The parents fought over religion when Alcala was small and from an early age he had tried to sort out the differences. "Finally," he says, "I decided to

become a Protestant with my father because the Protestants taught that man's salvation comes only through Jesus Christ who died for our sins. I thought Protestantism was more logical, more reasonable. But I was not baptized." In Kabankalan, Alcala was befriended by the pastor of the local Protestant church and he was baptized at last, in the Kabankalan River. (Subsequently, Alcala's mother also became a Protestant.)

One of the pleasures of school life was competitions and exchanges with other schools. Kabankalan Academy had a particularly active interaction with the high school at Silliman University, a Presbyterian school located in Dumaguete on the southeast coast of Negros Island. The two schools competed in basketball and debating and took turns hosting games and tournaments. As a member of Kabankalan Academy's debating team, Alcala became acquainted with students from Silliman and visited its bucolic seaside campus. During his senior year, he met the American William R. Hamme, a former superintendent of public schools who now taught history at the university. Professor Hamme befriended Alcala and encouraged him to pursue his college education at Silliman—instead of, say, Central Philippine University, a Baptist college in nearby Iloilo. Alcala attributes to Professor Hamme's friendly and positive influence his decision to attend Silliman University, which he entered in June 1948.

Silliman was founded in 1901 by an early wave of Presbyterian missionaries in the newly established American colony. Originally an elementary school and later a Bible college, Silliman had achieved full university status by 1938. During World War II, the campus was taken over by the Japanese and used as an army base and internment camp. After the war and the onset of Philippine independence in July 1946, Silliman reopened and embarked upon a period of vigorous growth with several new faculty members recruited from the United States. "I had the privilege of taking courses with them," says Alcala, "English courses, literature courses, history courses." However, Alcala's primary interest at Silliman was not the humanities but the sciences. Having grown up surrounded by the wonders of the sea, Alcala had long ago developed an interest in the natural world. In elementary school, his principal, Jose Cordova, a kindly old teacher, stoked his interest in elementary biology and taught him to dissect frogs. In high school, he set his sights on medicine, an ambition that his family heartily endorsed.

At Silliman, therefore, Alcala chose the premedical course, a two-year Associate in Arts degree that led directly to medical school. He moved brightly through the initial courses in general and vertebrate zoology and, by 1950, was the lone member of his class to be accepted into the College of Medicine of the University of the Philippines, the country's premier medical school.

But now, Alcala says, "I reflected on the condition of my family and the fact that I had nine other siblings." Realizing that his parents could not possibly afford medical school, he decided instead to stay on at Silliman and complete a Bachelor of Science degree in biology. This was a practical option since he was already employed as a teaching assistant there, aiding junior students with their elementary zoology lessons and in the laboratory. But it was also attractive intellectually. Under the guidance of Professor Dioscoro Rabor, an ornithologist and mammalogist, and other mentors, Alcala was beginning to discover the pleasures of investigative science. On his own, he was studying a species of toad called *Bufo marinus* that had been introduced into the Philippines from South America. (It was, in fact, the species Silliman used for classroom dissections.) "I was interested to find out how its habits would differ in its new home."

Alcala completed his B.S. degree in 1951, *magna cum laude,* and took a job teaching biology in a small school in Marbel, Cotabato, on the island of Mindanao. He had barely finished his first term there, however, when Silliman invited him to return as an instructor in the biology department. He was delighted to do so. Stopping off for a vacation at home before returning to Dumaguete, Alcala became reacquainted with a childhood friend and now budding beauty named Naomi Lusoc, whose family lived some three kilometers from the Alcalas. Naomi had just earned her teacher's certificate in Bacolod and was teaching elementary school in Cauayan. Somewhat impetuously, the two decided to marry. "She was one of the good-looking ladies in that area," says Alcala, "so I thought I would claim her first before returning to Silliman."

The wedding was held on 21 April 1952. Their first child, a daughter they called Estrilda (named after a bird genus), was born in Dumaguete City in September 1953. Subsequently, five other children were born to Angel and Naomi, three sons and two more daughters: Angelo, Grace, Moses, Emily, and Ely. Naomi eventually took a master's degree at Silliman University and taught elementary school science until she retired at the age of sixty.

As a junior instructor at Silliman in the early 1950s, Alcala taught four courses each term, mainly laboratory classes but also basic courses in physiology, embryology, and other related subjects. He leavened this heavy teaching load with his own study of Philippine amphibians, using weekends and the country's many public holidays to conduct field research and to collect specimens for himself and Professor Rabor.

In 1955, Silliman received its first Fulbright professor in the sciences. Walter C. Brown, a former United States serviceman who had served in New Guinea during the war, was a newly minted Ph.D. from Stanford University. His field was herpetology and he had come

to the Philippines to conduct research on amphibians and reptiles. He found a bright and enthusiastic partner in Alcala, who was soon swept up in Brown's ambitious fieldwork expeditions to mountains and rainforests throughout the islands, some of which lasted months at a time. Brown mentored Alcala in research and included him as an investigator in grants he acquired from the National Science Foundation. He listed him as junior author in scientific papers they published jointly and encouraged and helped him to publish his own research. Their first joint paper, "Observations on Amphibians of the Mount Halcon and Mount Canlaon Areas," appeared in the *Silliman Journal* in 1955.

In the very same issue of the *Silliman Journal*, Alcala published a scientific article under his own name for the first time, a life history of a Negros Island frog species, the *Rana erythraea*. He published articles on a yearly basis thereafter, both singly and together with Brown. The collaboration would eventually yield twenty-three joint papers.

Under Walter Brown's tutelage, Alcala began "to read very critically." He quickly grasped the fact that earlier research from the 1920s about Philippine amphibians was appallingly inadequate. The definitive books, such as *Philippine Amphibia* by E. H. Taylor, the American herpetologist, were not definitive at all. A world of important research remained to be done and he longed to take part in it. In 1959, therefore, with Brown's encouragement and assistance, Alcala entered Stanford University to pursue his master's degree. He was thirty.

To pay for his studies in the United States, Alcala applied for and received a Fulbright/Smith-Mundt Fellowship and a supplemental grant from the United Board for Christian Higher Education in Asia. Even so, he did not have enough money to take his family with him. Naomi and the children—there were three by then and another on the way—remained in Dumaguete. The Fulbright program arranged for Alcala to spend some time with a host family in Lyme, Connecticut, before embarking on his formal studies. He therefore flew first to the East Coast and enjoyed a month of acclimation and travel before venturing on to Palo Alto, California, the home of Stanford. Once there, he found inexpensive lodging with an aging widow, a Mrs. Long, for whom he cleaned the toilets and floors and performed other housework.

As part of his academic program, Alcala was obliged to take a notoriously difficult undergraduate genetics course. He found the Stanford students exceptionally bright and the professors intimidating. Yet he was determined to meet the competition. A mediocre grade on the first test spurred him to improve and on the next test he earned nearly a perfect score. He got an "A" in genetics, which gave him a boost, and from then on it was smooth sailing. Fortunately for Alcala, Walter Brown was on the faculty of nearby Menlo College. He and his wife Jan were ever ready with concrete help

and encouragement. And so was the small community of Filipinos resident in Palo Alto.

Alcala was able to complete his master's degree in just one year. This was possible because virtually all of the data for his thesis had already been collected in the Philippines as part of his research projects with Walter Brown. "I was leading expeditions to the mountains in Mindanao, the mountains in Mindoro, the mountains in Negros," he recalls. "And I had a wealth of data." With Brown's editorial assistance, Alcala shaped his data into a first-rate thesis. In it, he introduced three hitherto unknown species of frogs whose newly laid eggs develop directly into froglets, not tadpoles. This and similar revelations were important contributions to herpetology, and Alcala's thesis was almost immediately published as "Breeding Behavior and Early Development of Frogs of Negros, Philippine Islands" in *Copeia*, a respected American journal.

Alcala was determined to earn a Ph.D. from Stanford. But he was now obligated to return to Silliman and resume teaching. Again with Walter Brown's help, he devised a plan to continue his scientific investigations as a member of the Stanford Research Program in the Philippines. In this way, he could gather data for what would eventually become his doctoral dissertation.

Back in Dumaguete, Alcala threw himself into a new round of teaching and research. As an assistant professor, he taught the more advanced courses and his research took a new direction. He was eager to branch out into other areas of herpetology and to experiment with new research methods, especially statistical methods. His new project addressed the population dynamics of certain species of Philippine lizards using the mark-recapture method. In this method, animals are captured, "marked," and released back into their natural habitat so that their behavior and life history patterns can be traced. Once again, his weekends and holidays were spent on expeditions to the rainforests, observing reptiles and collecting data.

By 1964, Alcala was ready to return to Stanford. As a research assistant to the Stanford program, his tuition and fees were remitted and a grant from the John Simon Guggenheim Memorial Foundation provided him ample funds for his stay in California. Again, he lived simply. Lodging with another Filipino graduate student in the home of a medical school professor, he bicycled daily to the university. "I had just one jacket and shirt and washed my own clothes," he remembers. By economizing in these ways, he was able to send a large portion of his monthly fellowship to Naomi, who remained at home in Dumaguete with their six children. Alcala remained in close touch with Walter Brown in nearby Menlo Park and, at Stanford, he worked under the direction of a committee headed by Professor George Meyers who, he recalls, "was very difficult to see." Left largely on his own, Alcala steeped himself in statistics and population studies and indulged in the workshops, seminars, and guest lectures

that occurred almost daily at the university. "I took advantage of all of these, just to round out my knowledge," he says. He passed his comprehensive examinations with flying colors and, thanks to the research he had already conducted in the Philippines and Professor Brown's unflagging assistance, went on to complete his Ph.D. in biological sciences in just two years. In 1966, he returned to Silliman University as an associate professor. By then, he had published sixteen scientific papers and was already his country's foremost herpetologist.

Alcala now resumed his life of teaching and research and continued his collaborative studies with Walter Brown. In two years' time, he was named full professor and chair of Silliman's biology department. Thus, Alcala's role at the university changed. From then until his retirement twenty years later, he would never again be free of administrative duties. Indeed, he became an essential member of the institution's executive team. In 1969, for example, while he was serving as department head, Alcala was named director of the University Research Center, a post he held until 1975. In 1970 he became dean of the College of Arts and Sciences, a position he held until 1977. Beginning in 1972, Alcala also assumed the position of acting vice-president for Academic Affairs, a post he held until he was named vice president for Research, Extension, and Development in 1975. By this time, he had become adept at wearing many hats. And a good thing, too: he was in that year, *simultaneously,* professor of biology; director of the University Research Center; dean of the College of Arts and Sciences; vice-president for Research, Extension, and Development; and director of Silliman's Environmental Center and Marine Laboratory—a new facility that he had personally established the previous year.

As Alcala's administrative responsibilities mushroomed, he had less and less time for classroom teaching. But he did manage to remain active as a research scientist. Working with Brown and several Filipino collaborators, he produced a steady stream of new studies on Philippine frogs, lizards, snakes, bats, and birds; one sample was his article on "The Foraging Deployment of Velvet-Fronted Nuthatches and Elegant Titmice," written in 1969 with R. B. Gonzales. In 1975, Alcala published, also with Gonzales, a laboratory manual for general zoology, followed the next year by his single-author college textbook, *Philippine Land Vertebrates: Field Biology*. During the same busy years, however, Alcala branched out into the field of marine biology. In a fresh series of articles beginning in 1970, he reported the results of new investigations into crabs, fish, algae, and mollusks.

This new departure was prompted, Alcala says, by the sense that "there was something lacking in my research. What was the significance to our people of my research?" he asked himself. Besides, Silliman University was located by the sea. It was a pity not to take

advantage of the school's favored natural position. (The first stanza of the college song refers to "the white sands and the corals" and "the dark blue southern seas.")

Alcala's senior administrative positions at the university enabled him to advance his new interest in marine studies. In the early 1970s, the university received a large grant from Germany, which allowed it to modernize its science facilities. As a new building was going up, old ones were being torn down. Alcala insisted that materials salvaged from the old buildings—cupboards, kitchen sinks, roofing materials, wood beams—be saved to build a marine laboratory that would become the center of a new university program in marine biology. Silliman's president, Quintin S. Doromal, supported Alcala's plan and a $15,000 (Canadian) grant from the United Church of Canada made the new laboratory a reality. It was inaugurated in 1974 with Alcala as director.

The new facility was not fancy—a library, an office, classrooms, a few simple aquariums and tanks—but from it came an important new body of knowledge about Philippine sea life. Since his youth, Alcala had been fascinated by the beauty and abundance of coral reefs. Now, in collaboration with an old friend, marine biologist E. D. (Ed) Gomez, Alcala and his Silliman team participated in a national survey of Philippine coral reefs that Gomez was conducting with a government grant. In the south and southwestern parts of the country, Alcala soon learned, "the reefs were badly battered . . . plundered!" This was due to predatory fishing practices such as dynamiting and *muro ami* fishing. In the latter, small boys swimming underwater smash the coral with stones to frighten fish into waiting nets. It was obvious to Alcala that these damaged reefs did not compare with the ones he remembered from his youth, which yielded such a spectacular variety and quantity of seafood. This observation led him to a groundbreaking series of experiments involving questions such as: Just how productive is a healthy coral reef? What is the relationship between the health of coral reefs and the health and size of marine life populations generally? And how can damaged reefs be restored to their former productivity?

Sumilon, a coralline island of some twenty-three hectares, lay just off the southern coast of nearby Cebu´Island, about an hour's boat ride from Dumaguete. Surrounded by fifty hectares of coral reefs, the coconut-fringed island offered near ideal conditions for Alcala's research. Sumilon fell within the legal jurisdiction of the mainland town of Oslob. Alcala approached the town's mayor and municipal council about establishing a marine park on the island. By resolutions of the council in 1974 and 1975, a 750-meter-long swath of Sumilon's reef on the island's west side was declared a protected reserve to be monitored and managed by Silliman University; here, no fishing of any kind was permitted. According to the agreement between the university and the town, the rest of Sumilon's reef area

and coast would be open to fishermen, but only to those using traditional, non-predatory methods such as bamboo traps, gill nets, spears, and hooks and lines. Dynamiting and *muro ami* fishing were expressly prohibited.

Having thus protected the reef, Alcala set out to measure its productive capacity and to test an important hypothesis. He reasoned that if a portion of a reef was declared completely off-limits to fishing, the sequestered area would serve as a breeding ground and replenishment area for the surrounding seas. Without predators, healthy coral would proliferate in the sanctuary and sea life would reproduce in such abundance that it would overflow into the adjacent fishing grounds—where yields would actually increase. Alcala patiently explained to local fisherfolk why they would benefit by observing the fishing ban. He assigned a caretaker to the island to monitor local fishing and to encourage everyone to respect the sanctuary. Almost every weekend, even during the stormy monsoon season, Alcala visited the sanctuary himself, crossing the Tañon Strait between Negros and Cebu in a motorized outrigger "to follow up on my research . . . and to hide from the administration." Donning his scuba gear and gliding soundlessly through the reef's underwater wonderland, he found the perfect release from the steady round of work at the university.

With his younger brother Lawton as his trusted assistant, Alcala conducted a systematic survey of the catch by local fishermen in waters adjacent to the Sumilon sanctuary. Lawton and his assistants tracked the fishermen. How long did you fish today? Where, exactly? How many fish did you catch, and what kinds? Using what sorts of fishing methods? How much did the fish weigh? And so on. Working nights and weekends, Alcala organized and interpreted the raw data.

In a few years' time, he came to a startling conclusion: A healthy coral reef is capable of yielding between fourteen and twenty-four tons of fish per square kilometer per year! This figure was five times higher than estimates commonly cited in the scientific literature of the time. "I myself was surprised that I got such high figures," Alcala says, "and I began to doubt it. So I began to test some of the observers. I checked myself. The data was correct."

With Ed Gomez, Alcala presented his conclusions to the Fourteenth Pacific Science Congress in 1979, held in the Soviet Union. Their findings were greeted with astonishment. He remembers being challenged by the other scientists. "We are getting only four to five tons per square kilometer per year," said his American counterparts from the University of Rhode Island. "How come you are getting more than that?" Alcala was not certain what the reason was. Perhaps the Caribbean and Pacific reefs (where most of the research, to date, had been carried out) were simply less productive than Philippine reefs. In any case, he had no doubt about the facts of Sumilon.

In 1981, he published his conclusions in the research bulletin of the National Research Council of the Philippines. This article, "Fish Yields of Coral Reefs of Sumilon Island, Central Philippines," triggered attempts by other marine scientists around the world to duplicate Alcala's results. (The reefs of Samoa came closest.) Meanwhile, Alcala kept measuring and, in 1984, he recorded at Sumilon Reef an annual fish yield of 36.9 tons per square kilometer!

This figure was all the more astonishing because Sumilon's fishing grounds lay beyond the sanctuary, the richest part of the reef. Not only had Alcala shown that a healthy coral reef could produce sea life in far more abundance than had been previously known, he had also shown scientifically that a well-protected reef sanctuary, far from reducing fish yields to local fisherfolk, actually increases them. From the Sumilon experiment, he derived a practical formula for reef management: "the 25 percent solution." If 25 percent of a reef is protected, the remaining 75 percent will provide an abundant and sustainable supply of fish, that is, so long as non-predatory forms of fishing are used.

From a scientific point of view, Alcala's research on Sumilon was a brilliant success. Alas, Silliman's sequestration of the island bred resentment among some local people who were accustomed to the "anything-goes" approach to fishing common to the islands. In 1984, a businessman who financed *muro ami* operations in the area was elected mayor of Oslob. He quickly abrogated the town's agreement with Silliman University and abolished Alcala's precious sanctuary. *Muro ami* fishermen now descended upon the sanctuary and surrounding reefs and harvested fish without restraint. Dynamite fishermen also plundered the area.

Alcala responded to this catastrophe in two ways. Caught in a political power struggle that was not immediately resolvable, he transferred much of his research efforts elsewhere. "There were many other islands and there were people clamoring for community development," he says. He chose Apo Island, a two-hour boat ride south of Dumaguete on the east coast of Negros Oriental, to establish a new reef management program based on the "25 percent solution." At the same time, he continued collecting data on Sumilon in order to test the consequences of the destruction of the sanctuary. The results were appallingly dramatic. Eighteen months after the opening of the preserve, the annual "catch" from Sumilon had dropped from nearly forty metric tons per square kilometer to about twenty, even though the entire reef area was now being exploited. Not surprisingly, the greatest declines occurred among the highly prized varieties such as lutjanids (snappers) and lethrinids (emperors). If there was a silver lining to the Sumilon catastrophe it was that the post-sanctuary data from Sumilon provided, as Alcala later wrote, "the first unequivocal demonstration that closing areas to fishing enhanced yields to fishermen."

Alcala and his team turned to Apo Island with a new approach born of their bitter experience on Sumilon. It was now obvious that if reef conservation was to succeed, the local people would have to become willing partners in the undertaking—all the more so on inhabited islands like Apo. As vice-president of Silliman, Alcala was, at the time, promoting several university outreach programs. "We were running extensive programs in hinterland communities, helping them with agriculture, cooperatives, health care. You organize the group so they will see their own problems, think about them, and devise their own solutions. I suddenly realized," he recalls, thinking of Sumilon and Apo, "that this was the way to do it, to empower the people."

As he set about establishing the Apo sanctuary, therefore, Alcala assigned a young sociologist to live full-time on the island. It was her job to nestle into the local community, and simultaneously learn valuable information about local conditions from the people and teach them about the reef and the importance of the sanctuary. Although local fisherfolk were knowledgeable about different kinds of coral and the fish associated with each kind, they did not know that the corals were themselves alive and that the reef waters teemed with millions upon millions of essential microorganisms. Villagers needed to know that if the corals died, the fish would also die.

In addition to educating local people about the need for a sanctuary, Silliman's outreach team also helped them enhance their livelihoods during the brief initial period when the sanctuary was declared out of bounds and their "catch" would inevitably fall off. They introduced cottage industries based on shells and mat weaving and helped local farmers diversify their subsistence plots of corn and cassava with fruit trees and legumes. All the while, Alcala and his partners worked hand-in-hand with the local political authorities.

Just a year after initiating the project, Apo islanders formed a marine management committee to take responsibility for the sanctuary. One year later, the university formally withdrew, leaving the Apo Island Marine Reserve a self-governing entity. By this time, the islanders had a huge incentive to sustain Alcala's sanctuary; since its establishment, fish yields had nearly doubled.

The reef projects at Sumilon and Apo Islands were comprehensive in their utility. Not only could Alcala use them to study the big questions of reef capacity and management (often done in collaboration with Garry R. Russ of James Cook University in Townsville, Australia), but he could also use them to study individual marine species that occupied or relied upon reef habitats. Working from Silliman's marine laboratory and with other coresearchers, Alcala conducted several such research projects during the 1970s and 1980s. These included investigations concerning three endangered species: the Pacific hawksbill turtle, the giant clam, and the Philippine crocodile.

The eggs and flesh of the hawksbill turtle are relished by Filipinos of Central Visayas and its shell decorates the walls of many a home in the Philippines and abroad, turtle shells having long been a favorite tourist souvenir. Fisherfolk are therefore delighted to find a sea turtle trapped in their nets and, as Alcala reported, the animals are "rarely released alive." (Some commercial fisherfolk believe that killing turtles is bad luck, however, so a few do escape.) The hawksbill prefers to feed and rest in coral reefs, making it easy to find. Moreover, the fact that it lays its eggs on land at the same nesting sites over and over again makes the female especially vulnerable to capture. Indeed, Alcala believes that "most, if not virtually all, nesting turtles in the Central Visayas end up on the table and in souvenir shops."

Little formal research on the hawksbill in Philippine waters had ever been done, so Alcala's research addressed some very basic questions. To estimate populations and identify nesting sites and habitats, he collected data from fisherfolk and divers from several sites in the Visayas, including Sumilon. To map their comings and goings, he captured, marked, and released some three dozen turtles. To study their diets (and, thereby, their favorite feeding grounds), he dissected several dead turtles offered by fishermen. And to study their growth rates and early life cycle, he hatched over one hundred turtle eggs in captivity and observed the young survivors along with other captured turtles in tanks and ponds at the Silliman marine laboratory. In presenting his findings, Alcala called for a halt to the commercial exploitation of turtle shells, the establishment of protected nesting sites, and the conservation of coral reefs populated by turtles. And he warned that unless such protective steps were taken, the hawksbill would disappear from Philippine waters "within a few years."

The giant clam presented a similar set of problems. Like the sea turtle, the giant clam (family Tridacnidae, of which seven species are found in the Philippines) is a favorite of shell collectors and food harvesters. The largest bivalve in the world, it sometimes grows to five hundred kilograms; its huge shells are widely used to decorate homes and for baptismal fonts as well as for more pedestrian uses such as animal-feeding troughs and washbasins. Filipinos in the Central Visayas find the clams a tasty supplement to their regular fare and the tender adductor muscles of the giant clam *Hippopus hippopus*—which Alcala says taste "just like abalone"—were formerly exported as a delicacy to China.

Alcala began monitoring clams at Sumilon in 1979, but it was only in 1985 that he launched the Giant Clam Project. This collaborative research venture with John Lucas of James Cook University involved the Marine Science Institute of the University of the Philippines and other laboratories in Papua New Guinea and Fiji and was supported by the Australian Centre for International Agricul-

tural Research. Surveying giant clam populations in fifty-six reef areas in the Visayan and Cagayan Islands and around Palawan, Alcala discovered that the largest species (*Tridacna gigas* and *Tridacna derasa* and one species of *Hippopus*) were already endangered due to overcollection. In fact, he declared *Tridacna gigas*, the largest, extinct. Certain smaller species, in contrast, seemed to be holding their own. With other scientists at the Silliman University Marine Laboratory (SUML) and the University of the Philippines (among them Sally N. Alcazar, Erwinia P. Solis, J. A. Onate, and M. R. A. Naguit), Alcala then studied the breeding habits of the larger clams and developed techniques for spawning them in captivity at SUML. By 1990, tens of thousands of Silliman-bred juvenile clams had been distributed to cooperating fisherfolk throughout Central Visayas where, Alcala hoped, raising them for food and trade would provide an additional incentive for local people to protect and conserve coral reefs. As project researchers advised the newly established clam-growing cooperatives and monitored the survival and growth rates of the transplanted juveniles, the beautiful once-near-extinct giants began making a comeback in Philippine waters.

Crocodylus mindorensis, or the Philippine crocodile, once ranged widely throughout the islands, but by 1980 it was represented by only a few residual populations on Negros, Mindanao, and Mindoro Islands. In that year, with financial support from the World Wildlife Fund, Alcala set up a crocodile-breeding facility at Silliman's marine laboratory consisting of a 175-square-meter pen with a large brackish-water pond. Rare male and female specimens were introduced into the breeding pen and Alcala and his partners, including his younger brother, a sister, and his youngest son, observed their subsequent behavior as they mated and the female hatched her eggs. Writing with his son E. L. Alcala and C. A. Ross, Alcala provided the first scientific account of the Philippine crocodile's breeding habits and early life. In subsequent years, additional females were added to the facility and a small cohort of surviving juveniles (twenty-one in 1987) were carefully nurtured for future breeding stock and for eventual release into the wild.

In the midst of these projects, Alcala somehow found time to join his old mentor Walter Brown for some new research on Philippine frogs. In 1982, they published their twenty-third joint paper titled "Reproductive Biology of Some Species of *Philautus* (Rhacophoridae) and Other Philippine Anurans."

But it was the reefs that truly preoccupied him and, during the same years, Alcala launched his pathbreaking experiments with artificial reefs as a means of reestablishing fish habitats in places where natural coral reefs had been completely destroyed. "Fish," says Alcala, "like heterogeneity in their environment, . . . structures where they can hide and reproduce." This is one reason they love natural reefs. And whereas artificial reefs cannot substitute

for natural reefs, they can provide suitable habitats for small fish populations and, more importantly, they can serve as "the substratum for coral larvae to attach to." Beginning in 1977, and building upon prior experiments with artificial reefs in Taiwan, Japan, and elsewhere, Alcala and his SUML team built two new "reefs" off the coast of Negros Island: one, Bantayan Reef, near the marine laboratory at Dumaguete, and the other, some seven kilometers to the north at Ajong. (A third experimental artificial reef was constructed by researchers from the University of the Philippines in northern Philippines off Bolinao, Pangasinan.) Alcala's two reefs, made of hundreds of cast-off rubber tires, were monitored regularly by SUML scuba divers. Alcala recorded the rising population of fish that colonized the faux-reefs and noted that only four to five months were needed to create a harvestable crop, as long as harvesting was kept at a sustainable 3 to 5 percent level. He also carefully monitored seven genera of stony coral that began to grow on the discarded tires underwater alongside several species of mollusks.

Although the new corals grew slowly and unevenly, in just a few years, Alcala and his partners were able to issue enthusiastic conclusions about the efficacy of artificial reefs in the Philippines. They began promoting the new reefs by issuing "how-to" pamphlets in local dialects. Since then, many have been established around the islands. Further experiments, however, have now persuaded Alcala that rubber tires (and other cast-off materials such as junk automobiles) are problematic materials for artificial reefs because pollutants exuded by resins, oils, and metals are eventually borne by algae and reef animals into the human food chain. Concrete, although expensive, is better, he says, because it is inert and because young corals thrive on its rough, porous surface.

Alcala advanced in the administrative ranks of Silliman University, serving in the early 1980s simultaneously as vice-president for Academic Affairs *and* for Research, Development, and Extension—and, briefly, on two occasions, as acting president. Through all this, he was able to advance the work of the university's marine laboratory. By the 1980s, the facility included not only the main laboratory building, with its tanks, aquariums, and specimen collection, but also a library and office building as well as a fully-equipped dive shop, which was a converted soybean factory. SUML also maintained several field stations on Sumilon and Apo Islands.

Although it still bears a somewhat improvised appearance and a relaxed ambience—with researchers working to the noise of blaring radios—Silliman's marine laboratory has long since become a center for serious teaching and world-class research. Grants from a variety of funders, including the Asia and Filipinas Foundations, United States Agency for International Development (USAID), World Bank, Australian Centre for International Agricultural Research, International Development Research Centre (Canada), World Wildlife

Fund, and Tohoku University (Japan), among others, enabled Alcala and his colleagues to conduct research along several important fronts at once. The grants also provided Silliman's marine complex with the tools of the trade: VHF radios, echo sounders, microscopes and stereoscopes, electrophoresis equipment (which aids researchers in ascertaining the molecular composition of solutions and living matter), plankton nets, pumps and meters of all kinds, an incubator, freezer, refrigerator, furnace and oven, underwater cameras and a darkroom, as well as several computers and a small fleet of motorized outrigger boats and land vehicles.

Alcala's early studies in herpetology had permitted him, professionally speaking, to dwell peacefully in the realm of pure science and to remain largely undistracted by the economic and social forces at work in the larger society. But marine biology was another matter altogether. From the moment Alcala began surveying the Philippine reefs in the early 1970s, he was confronted with brutal acts of ecological destruction, which had their roots in social and political forces that violated the serene world of pure research, just as they violated the reefs themselves. These could not be ignored. As the damning evidence mounted, therefore, Alcala felt compelled to contribute to public debates on the Philippine environment, something that by virtue of his training he was uniquely qualified to do. Disinclined to polemics, however, he entered the fray gingerly, always building his arguments upon the hard facts of research.

Muro ami fishing was his first target. In scientific experiments in the early 1970s, he demonstrated just how destructive this crude form of fishing can be and took a public stand against it by publishing the results. Privately, he complained to the Bureau of Fisheries and Aquatic Resources about *muro ami* operators and their predatory practices. Later, he helped produce and appeared in a widely circulated video film for the British Broadcasting Corporation titled "The *Muro Ami* Dilemma," which drew international attention to the practice. Finally, he introduced his findings into Philippine Senate hearings that led to a national ban on traditional *muro ami* fishing in 1992. (A new form of *muro ami,* in which boy divers drive the fish from the coral with air bubbles instead of stone, is still permitted. Up until now, Alcala warns that government and fishing communities must be vigilant in preventing the return to the older method.)

In a related matter, Alcala published (with Ed Gomez) in 1987 a powerful study describing the effects of dynamite fishing on coral reefs. In so-called blast fishing, fishermen literally drop bombs on schools of fish; they then collect the dead or stunned animals into sacks, while swimming freely along the sea bottom. Blast fishing is extremely dangerous to humans, as Alcala noted when he pointed out the common "presence of men with only one arm in Philippine coastal localities." And it is a deadly weapon against fish, especially species with air bladders that school near coral reefs. It also kills or

wounds indiscriminately any living creatures that happen to be near the blast. As for the reefs themselves, Alcala and Gomez reported that, "A bomb the size of a beer or coke bottle exploding at or near the bottom will shatter to pieces all stony corals in an area with a diameter of three meters, while a gallon-sized bomb will destroy an area about ten meters in diameter. . . . Heavily damaged reefs . . . are practically reduced to rubble." In their conclusion, the authors called for restrictions on the sale of blasting chemicals, the criminalization of possession of blasting materials, special dynamite-fishing law enforcement teams, and a campaign to educate "all classes of people" about the "deleterious effects of dynamite fishing on fish production."

For several years beginning in the late 1970s, Alcala and his SUML colleagues studied the impact of commercial effluents discharged into a bay north of Dumaguete. Wastewater from sugar and paper mills in the area, they discovered, was high in organic matter that absorbed oxygen from the water, making it unlivable for many local fish. Wastewater from the sugar mill also contained mercury (residues from an abandoned process), which endangered shellfish and, of course, humans. In a later series of investigations from 1988 to 1989, Alcala's team studied the impact of dumping mine tailings into the water off Marinduque Island by the Marcopper Mining Corporation. The results showed that the copper tailings were literally smothering the reefs and, moreover, that in mine-polluted waters nearby, fish yields in artificial reefs were significantly less than in waters not affected by mine wastage. Such facts weighed heavily in the efforts of Philippine environmentalists as they campaigned for stricter environmental laws and for greater public awareness of the high cost of habitat destruction to the livelihoods of the common people.

In the early 1980s, Alcala successfully challenged plans by the Philippine National Oil Corporation (PNOC) to build a small hydroelectric dam in the waterway connecting the twin lakes of Lake Balinsasayao in southern Negros—a project that had the blessing of the minister of energy. The new dam, Alcala pointed out, was unnecessary; a 112-megawatt geothermal plant operating nearby already yielded more than enough electricity for the entire island. Moreover, construction of the new dam would involve the destruction of one of the few remaining stands of virgin rainforest in Central Visayas. Through his research and advocacy, Alcala was able to convince the public and even PNOC officials that, in the long run, conservation of the rainforest was more important than a few extra megawatts of electricity. Some time later, Alcala mobilized opposition to, and successfully blocked, a proposed road around the lake favored by local politicians to encourage tourism.

More recently, Alcala played a key role in advocating the creation of a national marine reserve in the massive 32,500-hectare

Tubbataha Reefs. The reefs rest in the middle of the Sulu Sea, some 160 kilometers from land in all directions. In Alcala's opinion, they are the last remaining good reefs in the country. As such, they are already heavily exploited by small-scale fisherfolk from adjacent island groups. "If experience in other parts of the Philippines is any guide at all," he wrote, "they will be reduced to rubble during the last decade of the present century." Despite their great distance from land, Alcala argued that the Tubbataha Reefs are essential breeding nurseries for the waters off Palawan Island and others on the Sulu rim; fish larvae from Tubbataha can easily float with the sea currents to these rich fishing grounds. They are, in short, a giant sanctuary contributing a sustained supply of larvae, eggs, and fish over a vast area.

In an influential position paper, Alcala pointed out that the Tubbataha Reefs represented a rare atoll formation, "a unique kind of coral reef that reached its present state only after thousands of years of development." Aside from serving as a critical reservoir for fish species, the reefs represented a unique opportunity for scientific research with "practical application to fishing development programs." Human beings (i.e., dynamite and cyanide fishermen, seaweed farmers, industrial polluters) represented the greatest danger to the reefs, he said. He concluded with the call, "Let us, therefore, preserve Tubbataha Reefs for future generations." In 1988, President Corazon Aquino officially designated Tubbataha as the Philippines' first national marine park.

Not long thereafter, Shemberg Marketing Company proposed to convert nearly three thousand hectares of the reef into a huge Eucheuma seaweed farm, the end product of which is the ever-useful and profitable carrageenan. Shemberg's plan called for introducing some thirty thousand people into the reef area, where they would dwell on its few exposed atolls. Alcala's reaction was powerful. He wrote position papers opposing the seaweed farmers for Haribon Foundation, the Philippines' largest environmental advocacy organization. And in lectures, public forums, and press releases, he lent his voice to a well-orchestrated public outcry to save Tubbataha. Covering the shallow reefs with bamboo seaweed platforms and introducing thousands of seaweed workers and their families into the fragile reef habitat, he argued, spelled destruction for the ecosystem. In the end, the government listened, and the Philippine Department of Environment and Natural Resources (DENR) drove the interlopers away.

Alcala noted, however, that the government was slow to act and that each day of inaction brought further destruction to Tubbataha. This is why he continues to visit the reef personally from time to time. "The government monitors," he says, "but I also monitor."

In this regard, Alcala has concluded that the local stewardship of citizens is vastly more important than the actions of government in

protecting the environment. As he frankly put it to the Department of Environment and Natural Resources on the subject of Tubbataha Reefs, "The less DENR personnel are involved in its day-to-day management . . . the greater the probability of success. The more the people of the Sulu Sea are given responsibility in environmental protection, the better the results."

By 1988, when Alcala had worked a full thirty-five years for Silliman University (the maximum permitted under its rules), he retired. Leaving university employment for the first time since 1952, he moved to Los Baños, Laguna, to accept an appointment by President Aquino as deputy executive director of the Philippine Council for Aquatic and Marine Research and Development (PCAMRD). As a government council attached to the Department of Science and Technology, PCAMRD's mandate is to plan and coordinate all the country's marine-related research and development. The council, Alcala says, "is really a planning and evaluation body. We gave all kinds of advice, but we had little money."

As the number two official at PCAMRD, he traversed the country and worked directly with local governments, universities, and nongovernmental organizations, as well as with fisherfolk and fishfarmers themselves, helping them survey their coastal resources and advising them about how to exploit those resources sustainably. In Zambales and Batangas Provinces, he aided the Haribon Foundation in setting up community-based coral reef protection programs. Here and there he provided small grants to promote the rehabilitation of marine-life habitats. The work permitted him to apply nationally many of the lessons he had been learning over the years from his base in Dumaguete. So, even though PCAMRD had few financial resources, Alcala feels that as a consequence of his efforts there "the awareness of conservation has been heightened a little bit."

In 1991, the trustees of Silliman offered Angel Alcala the presidency of the university. Despite his long, felicitous association with the school, he was reluctant to accept. Twice during the 1980s, he had served as acting president. The experience had not been altogether satisfactory, in large measure, he says, because of differences with certain board members. Now, however, the Silliman trustees reminded Alcala of his long and fruitful association with the university. He thought of all the opportunities it had brought him, "the connections, the fellowships, and all the happy events of my life." And he accepted.

Today, Angel Alcala is busy preparing Silliman University for its one hundredth anniversary in 2001. Of the school's eight thousand students, two hundred are graduate students pursuing master's degrees in a wide range of disciplines; a few are earning Ed.D.'s in education, the only field in which Silliman offers a doctorate. The rest are undergraduates. Most of Silliman's students come from the Visayas, but Alcala would like the university to become truly na-

tional, drawing students from all corners of the Philippines. As one of many hundreds of colleges in the country, Silliman operates in a highly competitive environment. Alcala is acutely aware of this, all the more because, as a Protestant university, it draws potentially from a smaller pool of students than most other schools in a predominantly Catholic country like the Philippines. He is therefore especially committed to keeping Silliman abreast of today's rapid advances in knowledge and technology and to modernizing its facilities.

At the same time, President Alcala is deeply concerned about the ethical content of the school's curriculum. Silliman, he emphasizes, is a mission-oriented school dedicated to inculcating positive human values such as "being true to your word, forthright, patient, and forgiving. We are committed to a strong religious undergirding." (Indeed, Alcala's youthful awakening to Protestant teachings has remained with him and he often frames discussions about environmental conservation in terms of Christian stewardship.)

Like many college presidents, Alcala spends much of his time traveling to recruit new students and to raise money. He is optimistic on both counts, in part because he can draw upon the famous loyalty of Silliman's far-flung alumni—three hundred of whom, for example, now live in Los Angeles, California, where Alcala recently met with them during a fund-raising trip to North America.

Alcala's children are now grown and scattered, from Dumaguete, where his daughter Grace teaches nursing at the university, to New Jersey, where son Moses is an environmental geologist. Alcala reports on his other children: "Estrilda completed a master's degree in insect physiology at the University of the Philippines, Los Baños; Angelo became a Doctor of Medicine at West Visayas State College in Iloilo City; Emily earned a bachelor's degree in biology at Silliman; and Ely, a degree in veterinary medicine at the University of the Philippines, Los Baños." Naomi, the belle of Cauayan whom he married in 1952, recently retired after having taught elementary school science for thirty-five years. The marine laboratory Alcala founded is today in the good hands of his chosen successor, Dr. Hilconida Calumpong, a marine botanist and expert in sea energetics, trained at the University of California at Berkeley—the staunch rival (he likes to point out) of Stanford, his own alma mater.

Alcala himself carries on in his usual fashion, devoting his days to the multifarious affairs and problems of the university he heads, and his evenings and early mornings to research. He still steals away on the weekends to dive and to monitor his precious reefs, where on Apo, for example, the people flock to see him. Despite his many years as an administrator, science still forms the mainstream of his life. The flow of articles has never stopped. There are now well over one hundred.

The rampant destruction of the Philippine reefs in his lifetime, Alcala believes, need not be permanent; the sea itself may yet bear

the seeds of its own revival. The lesson is clear: people must learn to be stewards of the seas. If they do so, *if they do so*, he stresses, the reefs can recover. Free flowing currents bearing precious larvae from one reef to another are the reason. Unlike the land, where intervening barriers of humans prevent seeds from moving freely from one stranded forest to the next, he says, "it is easier in the sea." In time, the reefs will replenish one another.

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Manila
J.R.R.

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