IRRESISTIBLE COLOR: Every year some 35 million fish are harvested from coral reefs and exported to aquariums around the world.

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Cyanide fishing threatens many of the last pristine coral reefs in Southeast Asia. Will an ambitious program to clean up the marine aquarium trade be enough to save them?

Fishy BUSINESS

Cyanide is one of the fastest-acting poisons known to science. Once ingested, it cripples the body's ability to transport oxygen and begins asphyxiating tissues almost instantly. At higher dosages it slows the heart and even stops electrical activity in the brain. Given cyanide's lethal nature, it is difficult to imagine that squirting the substance at coral-reef fish is a good way to catch them alive. And yet that's common practice in the Philippines and Indonesia, whose collectors supply some 85 percent of the tropical fish that enliven the world's saltwater aquariums.

Disabling agile fish with cyanide makes it easier for divers to capture them before they hide among branches or crevices in the coral, but the consequences are severe. Some experts estimate that half of the poisoned fish die on the reef, and 40 percent of those that survive the initial blast are dead before they reach an aquarium. This startling mortality rate doesn't encompass the devastation to the living corals, invertebrates and nontarget fish in the path of the toxic plume.

Cyanide fishing is only one of several human activities—including poor forestry practices and industrial pollution—that are destroying coral reefs worldwide. But to many marine biologists, cyanide is one of the biggest dangers in Southeast Asian waters. The region harbors nearly 30 percent of the planet's coral reefs and boasts the greatest diversity of marine life anywhere—at least for now. According to two regional surveys published last year, only 4.3 percent of Philippine reefs and only 6.7 percent of those in Indonesia are still in excellent condition. And it is those reefs that live-fish collectors typically target.

BY SARAH SIMPSON • Photographs by Gary Braasch

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For nearly 20 years, efforts to reform destructive aspects of the aquarium trade have fallen primarily on the shoulders of the export countries, with limited success as a result. Now a new strategy is placing more opportunity for reef preservation in the hands of importers, retailers and consumers along the trade route. In an ambitious campaign that could help save some of Southeast Asia's last pristine reefs, an international nonprofit organization called the Marine Aquarium Council (MAC) is developing a method for guaranteeing that the marine fish sold in pet stores are collected in an eco-friendly manner. By this fall MAC officials expect to have the first "certified" fish for sale in the U.S.

"There has never been a system to define, identify and verify environmentally sound practices and products in this industry," says the council's executive director, Paul Holthus. "We are also labeling these products so that the consumers can reward those who are responsible."

Because only a handful of the prized fish species can be raised in captivity, the fate of the aquarium hobby lies in preserving the reefs. Aquarium owners know this, Holthus explains, and that is why he believes they will demand certified fish—if given the choice. Even today retailers have no way of knowing the exact origins of the fish they buy from importers. For most of the history of the aquarium trade, people's choices have been limited by scant scientific evidence and by conflicting anecdotes about the severity and exact locations of cyanide use and other destructive activities.

Tainted from the Start

CYANIDE USE in catching aquarium fish goes back nearly to the origins of the industry in 1957, when a Filipino entrepreneur shipped the first live fish to the U.S. in a tin can. Since the early 1960s, aquarium-fish collectors have squirted more than a million kilograms of cyanide onto Philippine reefs, according to estimates by the International Marinelife Alliance (IMA), a nonprofit organization founded in 1985 to fight the spread of destructive fishing practices in the region. Over the past 15 years, the organization has spent $1 million to train fishermen to use hand nets instead of poison. But progress is slow, explains IMA co-founder Vaughan R. Pratt, who directs the organization's operations throughout Southeast Asia. Adequate training can take several months, and until collectors become skilled with hand nets, they can earn more money using cyanide.

When news of cyanide fishing broke in the U.S. in the late 1980s, the gossip among hobbyists was that cyanide was a harmless anesthetic if used in the proper doses, Pratt says. Mortality rates of collected fish were often high, but for the most part aquarium hobbyists chalked that up to the notoriously fragile nature of the fish. Any number of problems along the trade route—poor water quality or too much time enclosed in a plastic bag, for example—can kill fish in transit.

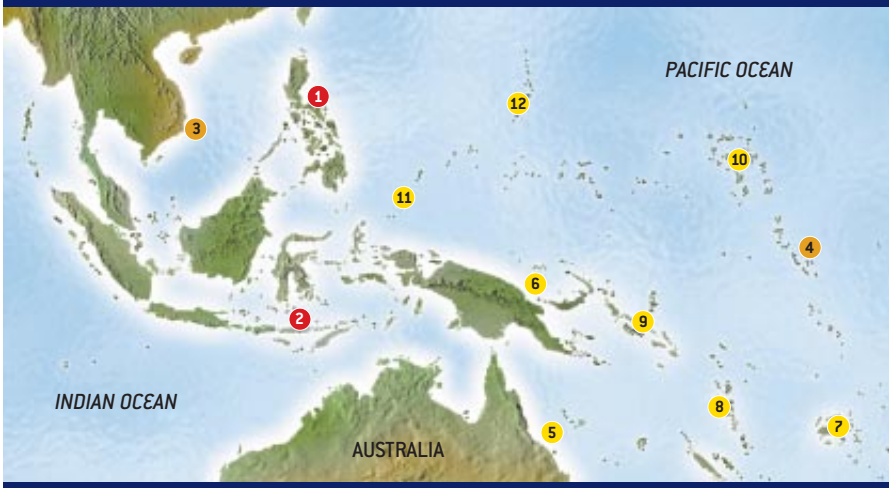
Meanwhile the marine aquarium hobby was flourishing in the U.S. and Europe. Innovations in aquarium technology and animal husbandry were improving people's ability to maintain diversified tanks. This success boosted demand not only for fish but also for corals, anemones and other live reef species. According to a 1999 report by the South Pacific Forum Secretariat, an estimated 700,000 American households were keeping marine aquariums by 1992—a 60 percent rise in two years.

In the face of this increased demand for live fish—and because many Philippine reefs had been destroyed—cyanide fishing had spread to the northernmost island of Indonesia by the early 1990s. The most recent observations of IMA workers implicate nearby Vietnam and Kiribati as well [*see box at left*].

For decades, reef-conservation workers on the front lines in the Philippines did not have the cooperation of the import countries to back their efforts. That is exactly what the Marine Aquarium Council has to offer. This past spring a

Exporters of Marine Aquarium Fish

ABOUT 85 PERCENT of the world export of marine aquarium species comes from the Philippines and Indonesia. Together these two countries also make Southeast Asia the world leader in cyanide use for the collection of live fish. The practice originated with the Philippine aquarium trade in the early 1960s and spread to northern Indonesia in the early 1990s.



1 PHILIPPINES
2 INDONESIA
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4 KIRIBATI
5 AUSTRALIA
6 PAPUA NEW GUINEA
7 FIJI
8 VANUATU
9 SOLOMON ISLANDS
10 MARSHALL ISLANDS
11 PALAU ISLANDS
12 GUAM

MAP BY LAURIE GRACE; SOURCES: MARINE AQUARIUM COUNCIL, INTERNATIONAL MARINELIFE ALLIANCE

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REFORMED CYANIDE FISHERMAN near Bagac, Philippines, bags his live catch for shipment to an export warehouse in Manila.

60-member MAC committee made up of representatives from industry, conservation, government agencies and academia outlined standards for managing the fish and the reefs in a sustainable way. The idea is to forge a reliable chain of custody in which fish are handled appropriately at each step of the trade route, from reef to retailer. One team is spending the summer motivating a string of collectors and exporters in the Philippines to comply with MAC standards, and another group is soliciting support from importers and retailers in the U.S.

Forging an Unbroken Chain

A PROMISING POINT of origin for a certifiable trade route is the city of Bagac, about 90 miles west of Manila. This community of some 21,000 residents lies nestled between the South China Sea and the checkerboard pattern of bright green rice paddies along the flanks of Mount Bataan.

Of the city's 2,500 fishermen, perhaps 30 are aquarium-fish collectors who live with their families in a beachfront cluster of thatch and wood buildings. This group of men (only men fish here) has been collecting fish without cyanide for the past seven years. Before that, cyanide fishing was all they knew. The turning point for them was meeting IMA's Philippines field director Ferdinand Cruz.

Cruz, who is also a member of MAC, knows the aquarium trade in the Philippines as well as anyone. He was drawn to the fishing communities shortly after he and his sister and mother opened an aquarium-fish export business in Manila in 1984. Almost immediately the family was perplexed by the high death rate of the fish. "We thought our facility was at fault at first," Cruz recalls. When he visited his collectors, they hid their cyanide because it was illegal. Those who admitted to using the poison reasoned that the practice was a harmless way to catch fish alive.

Cruz wasn't convinced. He went out in the boats with the cyanide users and saw dead fish floating in buckets, dead fish on the seafloor and fish convulsing after being squirted. "Six months later I noticed that reefs that had been sprayed were dying and full of algae," he says. "I kept going back to the areas where cyanide was used and made my own opinion that it was a very damaging chemical" [see "How Cyanide Kills," on the next page].

Cruz worked for several years trying to keep his export warehouse cyanide-free, but he finally deemed that goal impossible to achieve. In 1993 he decided to abandon the business and began to work full-time for IMA. Since then, he has helped train some 2,500 of the estimated

Half of the fish squirted with sodium cyanide typically die on the reef, and 40 percent of those that survive the initial blast won't live to see an aquarium.

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How Cyanide Kills

ALTHOUGH THE INTENTION of cyanide-wielding fish collectors is merely to stun their targets, the technique gives new meaning to the word "overkill." The most harrowing estimates suggest that half of the poisoned fish die on the reef, and many more die of health complications before they reach an aquarium.

Divers typically crush one or two white tablets of sodium cyanide into a plastic squeeze bottle. They then squirt the milky fluid—dissolved hydrogen cyanide and particles of the tablets—directly into the corals where the fish hide. The animals within reach of the plume ingest the cyanide ions through their mouths or the soft membranes of their gills. Once inside the fishes' bodies, the poison instantly begins disabling enzymes such as cytochrome oxidase, which accounts for significant oxygen uptake in living cells. The resulting asphyxiation stuns some fish and sends others into spasms, making them easy to grab by hand or net.

The poison tends to accumulate in the blood-rich liver, but studies conducted on freshwater fish also reveal acute damage to the spleen, heart and brain. Researchers point out that marine fish retain fluids in their bodies longer than their freshwater cousins do, giving cyanide more time to do harm before it is metabolized and excreted. Hydrogen cyanide concentrations of five milligrams per liter have proved lethal to certain fish—an exceedingly weak dosage considering that the Nature Conservancy seized cyanide bottles in 1998 that contained concentrations greater than 1,500 milligrams per liter.

Most evidence of cyanide damage to corals is anecdotal, but a handful of scientific studies show that these animals don't fare much better than the fish. Marine biologist James M. Cervino, now a doctoral candidate at the University of South Carolina, witnessed destruction of corals in Southeast Asia when he was working with the Global Coral Reef Alliance, a nonprofit group based in Chappaqua, N.Y. During six years of fieldwork, Cervino grew tired of hearing people claim that cyanide does not kill corals; in response, he set out to garner laboratory evidence of the poison's ill effects.

In a series of experiments completed last year, Cervino exposed 10 species of coral to cyanide concentrations thousands of times lower than those that cyanide fishermen use. Eight of the coral species died immediately; the other two died within three months. The worst news was that the *Acropora* and other branching corals—the most important reef builders—were the most vulnerable. "If you're a little fish, you're going to hide among the branching corals," Cervino points out—which means that fish collectors will squirt those corals more often.

The cyanide disrupted the symbiotic relation between the coral host and its zooxanthellae. These algae give the coral animals their vibrant color, nourish them via photosynthesis and convert their waste into amino acids. Even the lowest cyanide dose (only 50 milligrams per liter) caused the zooxanthellae to erupt out of the corals in a glob of mucus, a process known as bleaching. And although the nonbranching corals proved more resistant to the poison, Cervino says, their outer tissues eventually began sloughing off like the skin of a burn victim.

RIGHT WAY TO FISH: A diver uses a hand net to trap fish that he herds into a large barrier net, which hangs just above the heads of coral.

WRONG WAY TO FISH: A diver simulates the technique of cyanide fishing by using a squeeze bottle filled with milk, which is harmless to the blue tang fish and staghorn coral in the vicinity.

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4,000 aquarium-fish collectors in the Philippines. Cruz teaches them to set up barrier nets in canyons or deep fissures between coral heads and then herd the fish toward the net. Like most collectors in Southeast Asia, those in the Philippines breathe underwater through long, flexible plastic hoses called hookahs, which typically deliver air from an old compressor on board the fisherman's canoe. The diver holds the hookah in his teeth and often uses the bubbles from his exhalations to flush fish out of crevices in the coral and into the waiting nets.

Trained net fishermen are critical to a sustainable aquarium trade, but exporters also play a key role in MAC's plan. Most of the exporters, who constitute the next step in the chain of custody, are based in Manila. There, in warehouses filled with tanks, new arrivals typically mix with fish collected elsewhere around the country, many of them with cyanide. To make certification work, export warehouses will be required to quarantine fish that come from certified collectors.

At the warehouses, some fish can also be tested for cyanide exposure. Thanks in part to the efforts of Pratt and other IMA workers, cyanide detection laboratories are already in place. In 1991 the Philippines Bureau of Fisheries and Aquatic Resources contracted IMA to begin testing random samples of confiscated fish. The first detection laboratory opened near the Manila airport in 1991, and by early this year six laboratories around the country had tested more than 32,000 fish.

No current test can detect cyanide in living fish, so an unlucky few must be sacrificed. Chemists inspect and weigh each fish and liquefy it in a blender. The fish mush is distilled in a strong, hot acid so that any cyanide is liberated as hydrogen cyanide gas and then absorbed by a solution of sodium hydroxide. Electrode probes select for cyanide ions in the solution, enabling technicians to calculate cyanide levels in parts per million. Between 1996 and 1999, for example, workers saw the proportion of cyanide-tainted fish drop from 43 to 8 percent—a sign that IMA's investments are paying off.

Based on the considerable challenges of forging a certifiable chain of custody in the Philippines, Holthus says, the standards should be easy to maintain in Hawaii, Australia and other regions that already have high-quality operations in place. Once a chain of custody is certifiable in the export countries, it's up to importers and retailers in the U.S. to choose to buy those certified fish—and to live up to the MAC guidelines for their own handling practices. Even with the cooperation of importers, turning the poison tide in Indonesia, where fewer collectors are properly trained, will not be as easy. "If certification fails or only half-succeeds in the Philippines," Cruz cautions, "MAC standards will not take off in Indonesia."

Peter J. Rubec, who co-founded IMA with Pratt and works as a fisheries biologist with the Florida Marine Research Institute in St. Petersburg, hopes that the efforts of IMA and MAC will "provide the scientific evidence needed to convince the industry that net-caught fish are a viable economic alternative to cyanide-caught fish." Some retailers aren't so sure. "The pressure in the marketplace today is for lower prices, not higher ones," says James A. Bennett, owner of an aquarium retail store in Portland, Ore. "If MAC's plan increases the cost of the fish, that's not going to work."

Holthus hopes that certification will not actually cost the consumer any more. If the system works, he says, then the money saved by reducing fish mortality could offset any increased costs of certification. The MAC standards require that no more than 1 percent of each species die at any given point in the chain of custody. Achieving this goal, Rubec believes, would be a tremendous feat. He estimates that at least 10 percent of cyanide-caught fish die at each step in the trade route.

What is more, the fish grow considerably in value from one end of the trade route to the other. An orange-and-white-striped clownfish bought from a Filipino collector for about 10 cents, for instance, will sell for $25 or more in an American pet store. With that kind of markup, Rubec and others argue that the industry should be able to absorb the remaining additional costs of certification.

Not Soon Enough for Some

ONLY TIME WILL TELL whether economic obstacles will stymie MAC's mission. A few certified fish will be available to certain U.S. consumers this fall, but it may take a while for the desires of the market to force the aquarium trade to comply with the MAC standards. For some reef experts, the wait is agonizing.

"I don't think the Marine Aquarium Council has been tough enough," says marine biologist James M. Cervino, now a doctoral candidate at the University of South Carolina. After seeing cyanide damage for himself during his six years of service with the Global Coral Reef Alliance, Cervino argues that the trade should be halted temporarily: "If you don't have evidence that your fish were caught in a sustainable way, I can't see [this trade] being allowed to continue."

International law already bans the trade of thousands of species of stony coral under the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), but most of the coral-reef animals in the aquarium trade are not listed. Some local village governments in the Philippines have experimented with export bans on certain live reef species, but Cruz says that the restrictions just drove the fishermen to oth-

About 2,500 of the Philippines's estimated 4,000 cyanide fishers who work in the aquarium trade have been trained to use hand nets instead of poison.

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er illegal activities. He has been campaigning for local governments to grant fishing licenses as an alternative way to regulate collection. "If this trade does not prove to be sustainable, then it will have to close completely," Cruz warns. "In the meantime, we should still use the resources the right way so that the community can profit from it."

After a certification system is up and running, import restrictions in the U.S. could tighten the loop. Last fall the U.S. Coral Reef Task Force, established by an executive order in 1998, helped to draft legislation that would ensure that consumer demand for marine aquarium organisms does not contribute to the degradation of reefs and their inhabitants, as it does today, says task-force member Barbara A. Best. The trade recommendations, which were still being considered by Congress in mid-May, reflect MAC's philosophy that certification is a way to encourage responsible and sustainable trade. The legislation also provides that after an unspecified period of time, the U.S. should ban the import of any coral-reef species unless it is accompanied by official documentation that the animal was not collected through the use of destructive fishing practices.

"Industry-certification schemes can be quite slow in catching on, and legislation that required certification would speed up the process," explains Best, who also advises the U.S. Agency for International Development on marine resource and policy issues. "I have had some retailers tell me that they view the trade recommendations as one way to ensure that everyone carries animals that are being collected sustainably and treated humanely," Best says. "This would also ensure that those retailers that are behaving responsibly and carrying certified products are not undermined by lower prices from other retailers."

"I would adapt, because all of my competitors would have to do the same," says Bennett, who has seriously considered eliminating sales of live marine fish from his Portland aquarium store. "Some of us would invest a lot of money in a hurry and try to farm these things."

Even with legislative restrictions and a strong consumer demand for certified fish working in tandem, coral reefs in certain export countries may still be at risk. Indeed, the first MAC-certified fish may not actually be cyanide-free. A few tainted fish

The number of **fish testing positive** for cyanide exposure in the Philippines **dropped** from 43 to 8 percent between 1996 and 1999—a sign that reform efforts are working.

POISON CONTROL: Fish confiscated from an export warehouse in Manila await testing for cyanide exposure. Clockwise from upper right: unidentified, spot-banded butterflyfish, regal angelfish, redtooth triggerfish, forcepsfish, herald's angelfish, unidentified damselfish, keyhole angelfish, pyramid butterflyfish and redfin wrasse.

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may slip through this initial testing phase of MAC's long-term plan, in which the standards are intentionally basic so that they can be met relatively quickly. "We'll raise the bar as we go along," Holthus says. During the next two years, MAC will design more detailed standards, and the organization will monitor the health of the reefs as the changes take place.

Even if MAC's certification works to curtail cyanide use among aquarium-fish collectors, some researchers worry that there is still no guarantee that fish collection will not degrade the reefs. A case in point is Kona, Hawaii. Although aquarium-fish collectors do not use cyanide in this area, Brian N. Tissot of Washington State University in Vancouver, Wash., and Leon E. Hallacher of the University of Hawaii at Hilo discovered in late 1999 that the collectors' activities were stunting the populations of seven species of coral-reef fishes, three of which are herbivores. Without these grazing fish to keep algae in check, the prolific plants could eventually suffocate the coral animals.

Another challenge is reducing destructive practices among collectors of live food fish, who have spread cyanide use into Malaysia, the Marshall Islands, Papua New Guinea and possibly other areas of Southeast Asia.

Cruz and other IMA officials have reported that these fishermen often make forays into coastal areas where they have little interest in the long-term productivity of the reefs. Aquarium-fish collectors, on the other hand, are mainly people from local communities that have been relying on the same reefs for their livelihoods for generations. In part on Cruz's recommendation, MAC's certification standards require that local fishermen protect their own turf, even if that means patrolling coastal waters and chasing outsiders away—a practice that Cruz has already helped implement in several Filipino villages.

Creating strong incentives for local fishermen to be responsible for managing their own reefs "is probably the best hope in most of these areas for ever conserving the reefs," Holthus says. He has also seen growing interest among certain players in the live food fish trade to set up their own certification scheme. Better still, reefs might be developed into tourist areas for divers or protected parks where no fishing is allowed. But because of economic and political barriers, only a small number of reefs will ever fall into these categories.

The bottom line according to Cruz: If cyanide fishing isn't stopped, a lot of these reefs will be gone in a few decades. The good news, he believes, is that the battle against cyanide use in the Philippines is no longer uphill. SA

Sarah Simpson is a staff editor and writer. Additional reporting by Gary Braasch.

Ways to Stop Cyanide Fishing

Anyone who wants to argue that cyanide fishing does not damage coral reefs should consider one important fact: the practice is forbidden in most of Southeast Asia. In 1975 a presidential decree in the Philippines made it illegal to fish with cyanide, possess it on a boat or sell fish caught with it, and Indonesia followed suit 10 years later. But cyanide still has several legitimate uses in industry—extracting gold from ore, for example—so the poison's importation is not strictly regulated. Clever criminals, along with government corruption and political strife, make enforcement extraordinarily difficult. That's why the International Marinelife Alliance, the Marine Aquarium Council and dozens of other organizations are pursuing a variety of strategies to halt this lethal—and illicit—practice.

1. Confiscate random samples of live fish from export warehouses and test them for cyanide exposure.

2. Train aquarium fishers to use proper collecting techniques: hand nets rather than poison or other chemicals.

3. Label fish that were caught without cyanide so that fish buyers can choose to support practices that preserve the reefs.

GLOVED CHEMIST weighs a dead redfin wrasse at a cyanide detection laboratory that has operated in Manila since 1991.

4. Encourage fishing communities to keep foreign fishers and illegal activities out of their local waters.

5. License aquarium collectors in export countries in order to limit their effects on the reefs.

6. Restrict the import of live coral-reef species that are not accompanied by documentation that they were captured without poison.

MORE TO EXPLORE

Poison and Profit: Cyanide Fishing in the Indo-Pacific. Charles Victor Barber and Vaughan Pratt in *Environment,* Vol. 40, No. 8, pages 5–34; October 1998. Also available at **www.imamarinelife.org/environment.htm**

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Marine Aquarium Council, **www.aquariumcouncil.org/**

International Marinelife Alliance, **www.imamarinelife.org/**

U.S. Coral Reef Task Force, **http://coralreef.gov/**

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