by Douglas Allchin

It started out quite simply, with the strangeness of cats "dancing" in the street--and sometimes collapsing and dying. Who would have known, in a modest Japanese fishing village in the 1950s, that when friends or family members occasionally shouted uncontrollably, slurred their speech, or dropped their chopsticks at dinner, that one was witnessing the subtle early symptoms of a debilitating nervous condition caused by ingesting mercury? Yet when such scattered, apparently unconnected, and mildly mysterious events began to haunt the town of Minamata, Japan, they were the first signs of one of the most dramatic and emotionally moving cases of industrial pollution in history.

The outcome was tragic: a whole town was both literally and figuratively poisoned. Yet for those of us, now, who can view it more distantly, this episode also offers a conceptually clear and affectively powerful example of the concentration of elements in food chains, the sometimes unexpected interconnectedness of humans and their environment, and the complex interactions of biology and culture. In short, it is a paradigm for teaching ecology and science-society issues.

The case of Minamata, Japan, and the mercury poisoning (originally called Minamata disease) that took place there, appeared briefly in news headlines in the 1970s and then receded from public attention--at least in the U.S. The episode was fully and richly documented, however, by former Life photographer, Eugene Smith, and his wife, Aileen, who lived in Minamata for several years. Much of what follows draws on their book (unfortunately, now out of print, but available in many libraries; see Smith and Smith 1972, 1975; Ishimure 1990).

The Episode

Minamata is located on the Western coast of Kyushu, Japan's southernmost island (see map). Its disturbing story begins, perhaps, in the 1930s, as the town was continuing to shed its heritage as a poor fishing and farming village. In 1932 the Chisso Corporation, an integral part of the local economy since 1907, began to manufacture acetaldehyde, used to produce plastics. As we know now, mercury from the production process began to spill into the bay. Though no one knew until decades later, the heavy metal became incorporated into methyl mercury chloride: an organic form that could enter the food chain. At the time, Minamata residents relied almost exclusively on fish and shellfish from the bay as a source of protein. For us, today, the threat of pollution is immediately evident. But one must not fail to appreciate the historical context in which neither scientific experience nor a pervasive environmental awareness could offer such an explicit warning.

After World War II (around 1952), the production of acetaldehyde boomed. So, too, did the local economy--and most residents welcomed their improved lifestyles. About the same time, fish began to float in Minamata Bay. Chisso, as it had since 1925, continued to pay indemnity to local fishermen for possible damage to their fishing waters. Also at that time, cats began to exhibit bizarre behavior that sometimes resulted in their falling into the sea and dying, in what residents referred to as "cat suicides."

In the early 1950s, similar behavior began to appear--sporadically and without much notice--in humans. People would stumble while walking, not be able to write or button their buttons, have trouble hearing or swallowing, or tremble uncontrollably. In 1956 an apparent epidemic broke out and one can imagine the confusion--and fear--that was prevalent because no one knew the cause. Was it a viral inflammation
of the brain? Was it syphilis? Was it hereditary ataxia, or alcoholism? Was it infectious? The popular names of "cat's-dancing disease" and the "strange disease" convey some of both the mystery and its alienating quality.

The physiological effects, including successive loss of motor control, were devastating, and resulted in sometimes partly paralyzed and contorted bodies. Here, the photos of Eugene Smith speak more fully and sensitively than any words one can imagine. One resident, Tsuginori Hamamoto, described the plight of his father, a fisherman. Virtually overnight, Sohachi lost his ability to keep his balance, or to stay afloat in the water once he had fallen off the boat. He could not put on his sandals, walk properly, or understand what others were saying to him. Once hardy and strongly self-willed, his condition quickly degenerated, and he was hospitalized on the fourth day. There, even tied to his bed with bandages, he "craze-danced," said words that were not words; he salivated; he convulsed. Later, he tore at his own skin with his fingernails until his body bled. "Mother would look at Dad," Tsuginori recalled, "and just stand there--tears dropping from her eyes--looking dazed. Then we realized that the same symptoms were developing in Mother." The father died within seven weeks, the mother nine years later.

By the end of 1956, epidemiological and medical researchers identified the disease as heavy-metal poisoning caused by eating the fish and shellfish of Minamata Bay. Direct evidence that mercury from the Chisso plant was responsible, however, did not emerge until 1959. Dr. Hajimé Hosokawa, in private tests on cats at the Chisso Company Hospital, showed that the plant's acetaldehyde waste water caused the disease symptoms (though the results were not made public). Chisso installed a "cyclator" designed to control the emissions, offered 'mimai' (consolation payments) to the patients, and the matter seemed resolved. Nearly 100 patients had been identified, of whom over twenty had died.

More patients emerged, however. Children were also born with the "disease." The geographical distribution of cases widened. In 1963, Public Health Service researchers traced the disease to mercury from Chisso. Controversy soon erupted over who was responsible for compensating the victims and supporting their families. It was not until 1970 that a district court ruled that Chisso make payments totalling $3.2 million to the original group of patients; others soon received payment by negotiating directly with Chisso.

Chisso still operates in Minamata and now produces chemicals, fertilizer and floppy discs. The city has diminished in size, now almost 70% of its peak population in the 1960s. Mercury permeates sediment of bay, where fishing has long been prohibited. One of the two dumping sites is being filled in and a memorial garden is planned. The incident is rarely discussed, but residents know that things have changed; a certain confidence or buoyancy is missing. In a sense, the way of life in Minamata itself has been poisoned.

The Science

Biologically the case of Minamata exemplifies (as many will recognize) the concentration of elements (described in most texts). Students may be guided in developing this concept on their own. One need only remind them of their knowledge of the loss of energy (and biomass) for each step in a food chain. From there, they may speculate what will happen to chemicals, such as DDT or heavy metals, that are not excreted or broken down, but stored in the tissue. Successively higher concentrations of the chemical (they should conclude) appear in each trophic level--a result dramatically illustrated in the Minamata food chain (see chart). The Minamata example may also be an occasion to introduce students to Rachel Carson, who identified the same phenomenon with pesticides in her influential Silent Spring in 1962.
The Minamata case is such a vivid example because the town and the bay where the mercury was dumped may be seen as a relatively closed system. The ecological consequences, which are often diffuse and indirect, may be seen as a closed loop: the effects of the effluent led gradually but nevertheless inevitably back to humans. That is, in this exceptional case, one can trace the mercury from its source in Chisso's production process, through the waste water to the organisms inhabiting the bay, and then to the cats or humans consuming the fish and shellfish. As a microcosm, Minamata illustrates the sometimes fuzzy concept that humans and their environment are inextricably interconnected.

One may also address the physiological effects of mercury. Mercury concentrates itself specifically in neural tissue. Early effects thus include loss of peripheral sensation and restriction of the visual field. Patients in advanced stages of the condition show considerable atrophy of brain. The granular cells of the cerebellum are especially targeted, accounting for the ataxic gait, tremors, and sometimes violent convulsions of the patients.

In some classes, students may be well-prepared to understand why the disease affected growing children more severely than adults. In fact, five children, ages 5-11, who had collected shellfish from the shore while playing, were the first documented cases. Students may also be ready to predict how the mercury would concentrate in a developing fetus, leading to congenital cases, even where the mother showed no signs of the poisoning. In one dramatic incident, an umbilical cord (traditionally boxed and preserved in Japan) provided material evidence of the suspected mercury concentration, years after the fact.

The Social and Cultural Consequences

The case of Minamata is surely engaging because the relationship between the causal agent and the effect is so unambiguous (at least today). Yet a full account also includes the more "human" dimension--those elements which contributed to the figurative poisoning of the city, and that make the case both more striking and more valuable for reflection.

For example, because the disease was related to the unexplainable behavior of wildly-acting cats, the disease became stigmatized, often in the victim's own eyes. In the Japanese view of medicine, the condition of the body reflects how the individual has maintained his or her balance with the external world--and sickness can be viewed as something "deserved." The victims were thus often implicitly "blamed" for their own condition. Also, wary of contagion, residents ostracized disease patients. Neighbor turned against neighbor. One tatami mat-maker, Yahei Ikeda, for instance, disparaged those who had the disease--until one day he, too, ironically, showed the symptoms. Neighbors with whom he

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**Mercury Concentrations in Tissue Samples (ppm)**

<table>
<thead>
<tr>
<th>Fish &amp; Shellfish</th>
<th>Cats</th>
<th>Humans</th>
</tr>
</thead>
<tbody>
<tr>
<td>oyster</td>
<td>5.6 control</td>
<td>0.9-3.66 control</td>
</tr>
<tr>
<td>gray mullet</td>
<td>10.6 kidney</td>
<td>12.2-36.1 kidney</td>
</tr>
<tr>
<td>short-necked clam</td>
<td>20.0 liver</td>
<td>37-145.5 liver</td>
</tr>
<tr>
<td>china fish</td>
<td>24.1 brain</td>
<td>8-18 brain</td>
</tr>
<tr>
<td>crab</td>
<td>35.7 hair</td>
<td>21-70 hair</td>
</tr>
</tbody>
</table>

*Minamata's food chains dramatically illustrate the `concentration of elements'--in this case, of mercury--in successive trophic levels. Assays of tissue from fish and shellfish from the bay, and from cats and humans who died from the poisoning, show high concentrations of mercury. Kidney and liver concentrations indicate how the bodies tried--unsuccessfully--to excrete and detoxify the heavy metal._
had earlier shared his isolationist sentiments regarding the victims now turned those same feelings against him.

Fishermen and their families were the earliest and most severely afflicted, having consumed the most contaminated fish. But it was also the fishermen, perhaps, who most embodied the traditional Japanese appreciation of nature, so evident in classical haiku poetry and watercolor painting. For the fishermen, the sea, viewed romantically perhaps, was life-giving. It was hard for the villagers to comprehend that the sea could also take life away. One fisherman expressed his love of the sea:

\[
\text{When I thought I was dying} \\
\text{and my hands were numb} \\
\text{and wouldn't work--} \\
\text{and my father was dying too--when} \\
\text{the villagers turned against us--} \\
\text{it was to the sea} \\
\text{I would go to cry.}
\]

\[
\ldots \\
\text{No one can understand} \\
\text{why I love the sea so much.} \\
\text{The sea} \\
\text{has never abandoned me.} \\
\text{The sea} \\
\text{is the blood of my veins.}
\]

Indeed, it was the poison in the food from the sea that also flowed in his blood, generating the numbness in his hands and prompting his fears of dying. Here, not only his food was polluted, but also the fundamental view of nature in his culture.

The most disturbing social overtones in Minamata may have involved the employees of Chisso. In the 1950s and 60s, Chisso employed about 60% of the town's workforce. Having essentially inherited the role of patriarchal lord from feudal Japan, Chisso was both provider and protector. The employees depended on Chisso for their livelihood and, in turn, honored this with their loyalty. So deep was this loyalty that Dr. Hosokawa, who had uncovered his company's role in causing Minamata disease, felt he could not divulge the results of his research publicly (though he did so later on his deathbed). Even today, Chisso enjoys a favorable image among many residents. When fishermen began to demonstrate against Chisso for damages, therefore, there were counter-demonstrations by company employees. To have admitted Chisso's "guilt" would have been to acknowledge that the corporation had abandoned its filial responsibility and that the relationship, now violated, could no longer be trusted. In the same way perhaps, residents of Rochester, New York felt betrayed when in 1988 "Mother Kodak" spilled 30,000 gallons of methylene chloride solvent in the local area (consider also a similar case involving Martin Marietta in Denver, 1987). Though members of Chisso's Workers' Union could sympathize with those in Minamata's Fishermen's Union, in this case there was no question where loyalty would lie. The whole town of Minamata was thus splintered. The mercury not only poisoned individuals' bodies, but also the community's social relations.

Causation and Responsibility

In a narrow, epidemiological sense, Chisso's effluent was the source or the "cause" of the problems in Minamata. But the case here is also valuable in that it allows one to see the broader economic and cultural contexts that linked Chisso and its effluent with the community around it. Causes occur at many
levels or in many contexts simultaneously: physiological, ecological, economic and political. The lessons that emerge here about the conditions that promote pollution (even if unwanted) are correspondingly clearer. They can help students move beyond the simple black-and-white view that pollution is blatantly "evil" and can be easily avoided.

There is no question, now, that Chisso withheld critical information in 1959 and continued to dump waste. They were held legally liable for their negligence in 1972. Yet this does not solve the deeper problems of responsibility. One must look at how the pollution first started, and later continued. Blaming victims is unwarranted. Yet there is a sense in which the entire episode resulted from communal values and social decisions. The town as a whole welcomed Chisso's arrival and later growth, and the town as a whole prospered. And the town as a whole also suffered the unfortunate consequences. In this sense, the case of Minamata follows the classical form of tragedy (taught since Aristotle, and still today in high school English classes): there was a tragic choice, followed by unforeseen tragic consequences. The difference is that, here, events occurred on a social rather than individual level. Who, ultimately, is responsible, especially when consequences may be unforeseen or unintended?

One lesson may be that all the members of the society must accept the undesirable, even unanticipated consequences of their collective judgements. Even if we do not "choose" individually to endorse nuclear energy or manufacturing with toxic by-products, for instance, we cannot personally abdicate social responsibility for the consequences of their waste. The problem is epitomized in current efforts to situate new landfills and hazardous waste sites. "Anywhere but in my neighborhood (or state)," is the common reply. The closure of events in Minamata, however, challenges whether attitudes, exemplified by the "not-in-my-back-yard" syndrome, can be effectively, or even ethically, maintained.

**Political Action**

Finally, Minamata can teach us about politics, particularly as they might apply to environmentalism. The patients of Minamata disease suffered not only from a physical handicap alone. Due to their economic status and the social dimensions of the disease, the victims were also politically handicapped. They--and the fishermen whose livelihoods (if not whose lives) had been destroyed--did not initially command the power or the resources to obtain proper compensation from Chisso. The story of their struggle, therefore, is equally informative.

In the late 1950s, the disease patients organized a "Mutual Help Society." Through continued petitioning, recruiting of grass-roots support across Japan, months of sit-ins at Chisso headquarters, and an unsightly tent settlement on their front sidewalk in Tokyo, they focused unfavorable public attention on Chisso. Eventually Chisso management agreed to negotiate directly with the patients, rather than appeal to the government's authority (which supported Chisso). Other patients brought suit, wherein Dr. Hosokawa's testimony was made public and became instrumental in demonstrating Chisso's particular negligence. The court ruled in favor of the patients and the demands of the negotiations group were met soon thereafter. The political campaign succeeded, but only through an investment of considerable effort and time. Here, bearing witness, patience and persistence proved effective.

Political lessons may seem inappropriate in a biology classroom. However, students today are increasingly exposed to acts of violence intended to "resolve" conflicts. An example where bearing witness, patience and persistence have proven their effectiveness can provide a significant alternative model for action. Even in environmentalism, we are easily reminded of the ethical issues involved in spiking trees and other forms of "monkey-wrenching" or ecological sabotage.
Epilogue

Disasters such as the massive release of methyl isocyanate gas from Union Carbide plant's in Bhopal, India, certainly focus our attention on the adverse human effects and environmental risks of some industry. Yet such "incidents," like those at Three Mile Island, Chernobyl or the Valdez oil spill can also be dismissed as "accidents" or exceptional single occurrences--not as symptomatic of the status of human ecology. One can easily forget the often larger threats posed by low-level but more sustained release of chemicals--the "slow-motion Bhopals." And one can easily overlook the more difficult, yet far more fundamental issues involving attitudes, lifestyles, and economic and social forces--issues that are so keenly profiled by the history of Minamata.

In hindsight, it is easy to prescribe what ought to have been done in Minamata--and to assign blame accordingly. But such an interpretation fails to appreciate what a sensitive historical perspective can teach us. Who could have guessed, for instance, when autos first started rolling off the assembly line and onto the streets, that decades later we would be concerned about carbon monoxide, smog, leaded gas, drunk drivers, and global warming? Minamata is a paradigm for informing an environmental ethos that treading lightly is advisable where consequences are unknown. Even so, no one can foretell the longer-term and sometimes undesirable consequences of an action, and we must cope with them as they emerge.

Chisso finally stopped production of acetaledyde in 1968--when an alternative technology for producing plastics was developed. Still, through the 1970s and 80s, new patients continued to surface. In some cases, the symptoms are partial--numbness or tingling in the extremities, for instance, or frequent headaches or the inability to concentrate--and it is hard to determine the exact extent of the mercury's effects. Aware of the potential scope of the problem, the government is generally reluctant to verify patients. Even so, 1,760 victims have been verified; almost 3,000 more await verification--of whom 412 have already died. Over 8,000 have been denied status. No one can be sure of the extent of the damage, but one neuropsychiatrist at a local university estimates that 10,000 victims exist currently and that at least 3,000 have died. Over $611 million has been paid to victims in compensation. But it is hard to measure the real cost.

As described to me by one Japanese native, the story of Minamata looms over the country as an example of the dark side of Japan's post-World War II industrialization. Given the cases of Love Canal and Times Beach in the U.S., however, he might easily not have referred to Japan alone.

Much like the dropping of nuclear bombs on Hiroshima and Nagasaki on the nearby island of Honshu, the poisoning of Minamata has left an enduring legacy. The long-term biological effects in each case have placed a medical and social burden on society, measured both in terms of yen and our collective conscience. They also serve as poignant reminders of the consequences when man disregards the environmental effects of his actions.

The basin where Chisso dumped its poisonous mercury waste has now been filled in and a memorial garden has been planted. The city of Minamata now takes pride in itself, having learned a hard lesson, and looks forward to a better, more environmentally informed future.
References


Questions for Discussion:

- Uncertainty is a recurrent problem in environmental issues (alar; radon; EMF fields; CFCs and the ozone layer; global warming). In Minamata, the problem was certainly compounded by having no history of industrial pollution to provide models of interpretation, no clear understanding of heavy metals in the food chain and no previous knowledge of the effects of acetaldehyde wastewater. At what point
- How does one assess responsibility in a case such as this? If Chisso installed a pollution control device in good faith, should they be held accountable for damages that follow?