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Chemical Cocktail

The Health Impacts of Eating Farm-Raised Shrimp

A report by Public Citizen

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The Health Impacts of Eating Farm-Raised Shrimp

A special report by Public Citizen's
Food Program

This is Part 2 of a series that documents
the dangers of shrimp aquaculture.

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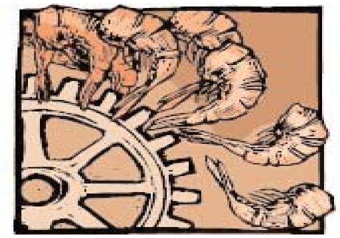
Public Citizen, founded in 1971, is a non-profit research, lobbying and litigation organization based in Washington, D.C. Public Citizen advocates for consumer protection and for government and corporate accountability, and is supported by over 150,000 members throughout the United States.

Introduction



Aquaculture is the farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants. Like all farming, it involves some form of intervention in the rearing process to enhance production, such as regular stocking, feeding, and protection from predators. Aquaculture can be done in inland freshwater environments and in or adjacent to the sea.

One particular type of aquaculture has shown itself to be grossly unsustainable and destructive. ***Shrimp aquaculture*** or ***shrimp farming*** is a capital- and resource-intensive, highly destructive type of aquaculture that is being done in the wrong way and for the wrong reasons. Shrimp farming has devastating impacts on the environment and rural communities in Asia and Latin America. As a result of uncontrolled and destructive expansion of shrimp farming over the past two decades in Asia and Latin America, shrimp in the United States, Europe and Japan has become easily available and inexpensive for seafood lovers.

Many consumers in the U.S., Japan, and Europe want to understand the impact their consumption has on the world. The story of farmed shrimp is also one that health-conscious consumers should want to hear because if they knew more about what might be lurking in the flesh of farmed shrimp, they might think twice about eating too much of it, or about eating any at all. Consumers should know the health risks and environmental and social costs associated with the food they eat.

Consumer health risks associated with eating imported farmed shrimp have been given little attention in the U.S. While shrimp tops the list of popular seafood choices, consumers are usually unaware of the health impacts. By the time shrimp arrive in grocery stores or are served in a restaurant, it has been injected with antibiotics, doused in pesticides, and fed chemical-laden food. Imagine what this chemical cocktail does to your health.

COMMON CULPRITS

The antibiotics being used and how they affect your health

A primary concern for people who eat farmed shrimp, particularly those who consume substantial quantities over a long period of time, is the usage of a range of antibiotics to prevent and treat bacterial conditions common in shrimp farms. (See Chart 1, p. 15) Chemical agents are used in aquaculture ponds as water and soil treatment compounds in order to control viral, bacterial, fungal and other pathogens; to induce plankton growth (fertilizers and minerals); and to inoculate the farmed shrimp larvae. These chemicals include the following: therapeutants (antibiotics), various algaecides and pesticides, disinfectants, detergents and other water and soil treatment chemicals. All of these are used in vast quantities by the aquaculture industry globally.[1]

For decades, various diseases have devastated the shrimp industry throughout the producing nations by wiping out entire crops. One of the most damaging is the White Spot Syndrome Virus (WSSV), which has been the most widespread, causing high mortality rates in many shrimp species and other crustaceans.[2] Symptoms of WSSV include white spots on the body of the shrimp as well as a steady decomposition of the body, which can occur in as little as 10 days, making the crop unmarketable and causing economic set-backs. Unregulated processing, use, and disposal of infected imported shrimp; or, the use of contaminated larvae in farming have caused the rapid spread of WSSV from its endemic regions to wild and cultured stocks of shrimp throughout the world.[3] The WSSV can even survive freezing and consequently survives in previously-frozen farmed shrimp sold in the market. The results of an investigation of shrimp sold in supermarkets in Boston published in January 2002 provided preliminary evidence that an appreciable proportion (4.7%) of the marketed shrimp were carrying

Black tiger shrimp infected with WSSV.

WSSV.[4] The scientists concluded that the virus can spread to the local natural environment, which constitutes a substantial risk. As of yet, there has not been any evidence that there is a human variant of WSSV. The potential impact on public health requires further investigation.

In efforts to protect their shrimp from the effects of WSSV and other pathogens, shrimp farmers worldwide turn to the chemical and pharmaceutical industries, although it is nearly impossible to control WSSV other than by destroying the entire infected crop.[5] There are relatively few constraints on chemical usage in aquaculture in the countries where shrimp is farmed and many antibiotics are widely available from chemical and pharmaceutical suppliers. The U.S. is comparatively strict in this respect, limiting the use of antibiotics in aquaculture to three drugs: *oxytetracycline*, *sulfamerazine*, and a drug combination containing *sulfadimethozine* and *ormetoprim.*

A host of antibiotics are broadly used in aquaculture to stimulate growth and to reduce the incidence and effects of diseases caused by crowded, factory-farm conditions, not unlike the conditions found in chicken factories where antibiotics are also prevalent. The more antibiotics used, however, the more rapidly bacterial resistance develops, and this problem is reaching crisis proportions today. When such resistance develops, bacterial growth is no longer stopped by the antibiotic, and thus the antibiotic is no longer capable of treating or curing the disease. Increasingly more bacteria are becoming resistant not only to one, but many antibiotics, making it more difficult to combat bacteria that cause illnesses in humans.

Various chemicals used in aquaculture.

The FDA agrees that antibiotic resistance has become an increasing problem. "Disease-causing microbes that have become resistant to drug therapy are an increasing public health problem. Tuberculosis, gonorrhea, malaria, and childhood ear infections are just a few of the diseases that have become hard to treat with antibiotic drugs."[6] Not only is antibiotic resistance an increasing problem, but the resistant bacteria could potentially transfer resistance genes to other bacteria in what is termed, "horizontal gene transfer."

These bacteria can also be transferred between and among animals and people.[7] For example, in the United States, genes resistant to the antibiotic tetracycline have been found in bacteria in soil and groundwater downstream from two Illinois swine facilities that use antibiotics as growth promoters. The finding shows the potential for spreading resistant organisms back into the food chain of animals and people.[8]

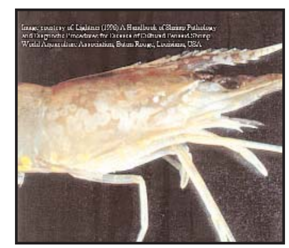
Antibiotics are categorized according to how they act on the cells of the bacteria they target. Among the most powerful class of antibiotics that has been widely used in shrimp aquaculture are those that block protein synthesis in the cells of pathogens, such as nitrofurans, phenicols, and tetracyclines. Another broadly used class of antibiotics, the quinolones, interferes with DNA replication and repair in the cells of bacteria. The tetracyclines, especially oxytetracycline, and the quinolones, including oxolinic acid and flumequine, are among the most commonly used antibiotics in shrimp farming. When disease infestations become severe, however, shrimp farmers turn to the powerful phenicols and nitrofurans.

The FDA banned the powerful and potentially toxic chloramphenicol (one of the phenicols) in 1989 because of the risks of the development of antibiotic-resistance in human pathogens[9] and a link with a rare and often fatal disease, aplastic anemia. Chloramphenicol is highly toxic to humans, but the antibiotic is used to treat humans only in life-threatening situations when no other drug is effective.[10] Europe, Japan and many other countries have also banned the antibiotic in feed, but it is still permitted for specific veterinary treatments. Nitrofurans are also dangerous because of their potential carcinogenic properties[11] and so are like-

wise banned for use in food-producing animals in the EU and the US.[12] Being banned in consuming countries, however, does not mean these powerful and potentially dangerous antibiotics aren't used in aquaculture in producing countries. Although governments of some countries where shrimp farming is booming restrict its direct application in aquaculture, it is still often applied illegally, or indirectly applied by mixing it with imported fishmeal-based shrimp feeds, which leave chemical residues in the shrimp that are exported to the U.S. for human consumption.[13]

The farmed shrimp antibiotic issue blasted into the news in Europe and subsequently in Japan, Canada, and the U.S. when, in late 2001 and into 2002, EU food authorities detected unacceptable levels of chloramphenicol and nitrofurans in imported shrimp from China, Vietnam, Indonesia, Thailand and India.[14] Several shrimp producers and exporters argued that the allegations were not true, that the products delivered were not produced using these drugs, or that the trace amounts were at such low levels that it was more likely picked up through environmental contamination, rather than the illicit use of drugs. Some also argued that very low levels pose no risk to consumers, contrary to the zero tolerance standards.

The History of Chloramphenicol



The use of the potentially toxic antibiotic chloramphenicol in shrimp farming is particularly worrying. It is considered to be a drug of last resort for humans, usually administered to humans only in life-threatening situations when less potent antibiotics are ineffective (e.g., in the treatment of salmonella, anthrax, and typhoid). In addition to the broad problem of bacterial resistance developing from over-exposure to antibiotics generally, chloramphenicol use can cause severe toxic effects in humans. Chloramphenicol has been evaluated several times by the Joint FAO/World Health Organization Expert Committee on Food Additives.[15] That committee concluded that the compound can cause genetic damage and possibly lead to cancer, as well as causing allergies and anemia. Chloramphenicol is also known to cause an extremely serious human disease called "aplastic anemia," in which bone marrow stops producing red and white blood cells. The condition is often irreversible and fatal. The onset may occur weeks or months after treatment with chloramphenicol has been discontinued. The frequency of the disease appears greatest in Asia. Some 1,000 new cases of aplastic anemia occur yearly in the U.S.

The FAO has warned that a very low concentration of chloramphenicol could be enough to trigger the fatal illness. The dose or residue level is irrelevant to the development of aplastic anemia when the antibiotic is found in foods like shrimp; and therefore, there is no maximum residue limit (MRL). This means, according to the FAO, that the ban on its use should be total and not be subject to a detectable level or an MRL.[16 17]

As research spanning from the 1980's to 2003 consistently concluded that any concentration of chloramphenicol is potentially lethal for humans, some governments around the world established zero tolerance policies, which means no detectable residues in food are permissible. Unfortunately, interpretations of zero tolerance vary widely among countries, because countries can only detect chloramphenicol at levels higher than zero. In Japan, detection of zero tolerance thresholds for chloramphenicol is defined as 50 parts per billion (ppb). In Europe and Canada, detection of zero tolerance is defined as 0.1 ppb.[18]

SICK SHRIMP

Shrimp infected with diseases that run rampant in polluted ponds.

Following the detection of chloramphenicol and nitrofurans in tested imported samples of farmed shrimp in 2001, the EU moved swiftly to ban any shrimp that tested positive, implementing a zero tolerance food safety policy to protect European consumers.[19] Consequently, each consignment of shrimp from China, India, Pakistan and Southeast Asian producers sent to the EU was subjected to strict testing to ensure there were no traces of chloramphenicol contaminants. As a result, in 2002, EU inspectors ordered the destruction of three large consignments of shrimp from India after chloramphenical was detected. Canada and Japan quickly moved to similar controls, but the U.S. FDA was slow off the mark.

The first U.S. case of chloramphenicol detected in imported farmed seafood was made public in May 2002 when imported Chinese crawfish from retail stores in Louisiana tested positive by state officials at 2 parts per billion, which was higher than the state's allowable limit.[20] Crawfish, like shrimp, is another farmed crustacean species. Within a few days the state seized almost two million pounds of crawfish and passed new regulations that required all Chinese shrimp and crawfish to be tested before it could be sold in the state. Unfortunately, Louisiana's action did not impact the FDA's inspection policy.

A month earlier, in April, Florida had expanded their chloramphenicol testing program for shrimp. Then, in June 2002, Florida discovered positive samples of imported shrimp from China and Vietnam. The highest residue finding was from the sample from China, reaching 2.7 parts per billion.[21] This was followed by a temporary ban on imported shellfish in Alabama after more products with high levels of chloramphenicol residues from China were discovered.[22] In January of 2002, the EU and Canada had already set their zero tolerance testing standards at 0.1 parts per billion upon which it based its ban, while the official detection standard set by the FDA, which claimed it too used a zero tolerance standard for chloramphenicol, had been 5 parts per billion until more sophisticated testing procedures were finally developed to detect down to 0.1 part per billion.[23 24]

Once the U.S. was able to test at 0.1 parts per billion, the FDA could finally match the more sophisticated sampling of Canada and the European Union. Using these methods, FDA laboratories confirmed (as the states of Louisiana, Florida and Alabama had already done) the presence of chloramphenicol in many imported shrimp shipments.[25] Unfortunately, the FDA only tests 1 to 2 percent of all shrimp that is imported to the United States.

While this might be disturbing news to many shrimp lovers, even more disturbing is the fact that the FDA sampling is extremely rare. The FDA can only manage to sample just over one percent of all seafood coming to the U.S. from overseas.[26] More troubling is that the FDA experiences long delays between finding deficiencies and actually taking action. In January 2001, the U.S. Government Accountability Office conducted a review of the FDA's foreign-firm inspection records for seafood safety. One troubling finding was that it "took an average of 348 days for the FDA to alert port-of-entry personnel about serious safety problems identified at six foreign firms."[27]

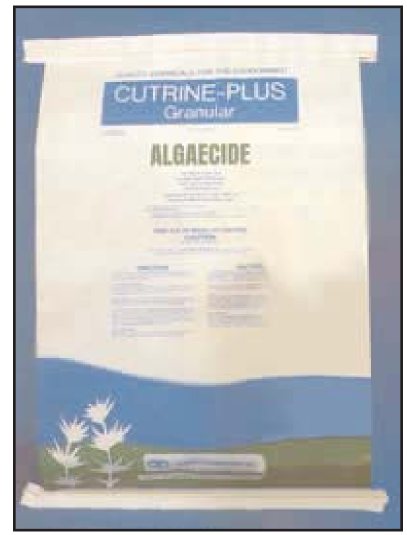
Potent Polluters

The use of pesticides and how it can affect your health

The use of antibiotics in shrimp farming is not the only troubling health issue that consumers need to be aware of in deciding whether or not shrimp is safe to eat, especially in large quantities over time. Another area of concern is the wide array of chlorinated, fluorinated, and organophosphate pesticides used in shrimp aquaculture. (See Chart 2, p. 16) Unfortunately, precise data on the types and quantities of pesticide used in aquaculture are limited to a few studies of environmental impacts and consequences for human health. In the 1990's, detection methods for pesticide residues improved, but are not yet comprehensive. As a

result, consumer health still is not protected from potentially dangerous chemicals used to farm raised shrimp.[28]

There is a substantial body of information confirming the myriad and wide-ranging extent of human health impacts from exposure to pesticides in the environment and in the human food chain.[29 30] These compounds work on almost every organ and process in the human body, beginning at the genetic level, manifesting in an array of health problems and defects, including the following: fetal and birth defects; miscarriages; weakening of the immune system; male infertility; brain damage; higher cancer rates in children and various forms of cancer affecting various organs, for example, the brain and lungs, prostate cancer in men, breast cancer and cancers affecting female reproductive organs; Parkinson's disease, non-Hodgkin's lymphoma; and attention deficit and hyperactivity disorders in children.[31]



Algaecide used in aquaculture.

Use of these pesticides and other chemicals, such as formalin, copper sulphate, malachite green, detergents, and other water quality control chemicals, can result in the presence of complex mixtures of chemicals in the sediments and discharges from intensive shrimp ponds and the potential for exposure of shrimp consumers to chemical residues and to pathogens with resistance to antibiotics.[32]
Indeed, one complex question about which virtually nothing is known due to lack of research is how all of these chemicals might interact with one another to create new, potentially highly toxic compounds. Research must be done to find out how these compounds can persist in the environment, make their way into the food chain of human communities living near large shrimp farming complex-

es, or accumulate in shrimp tissue sold on the market, and accumulate in the human body over time.

There is an urgent need for reliable data on the current use of chemicals in shrimp aquaculture, particularly those used for disease and pest control, and for stringent controls on their application or elimination entirely. Ultimately, it must be recognized that the use of large quantities of hazardous chemicals in order to maximize short term profits from intensive shrimp culturing is a potential human health time bomb and a completely unsustainable practice.

Scientific reviews indicate that the staggering amount of chemicals used in shrimp farms are severely problematic, yet little actual research has been conducted.[33] In an extensive review of the chemicals used in Thai shrimp farming, Swedish researchers reached the following conclusion:

> *"Theoretically, chemicals other than antibiotics that are added to the shrimp ponds, or by-products from the applied substances, that have a bioaccumulation potential, could be found as residues in the shrimps. ...However, little attention has been paid to the risk of residues other than antibiotics in farmed shrimps, and no data from such investigations have been found."* [34]

FISH FOOD

The way shrimp are fed and how it can affect your health

A third area of potential human health risk from eating farmed shrimp centers around the foods that are used to fatten them up for market. The feeds are based on fish meals and oils, and therein lays the potential for human health problems. Fish meal and fish oil come from small, oily fish such as anchovies, sardines, and menhaden, which are specifically caught for animal feed production.

In recent years, fish meals and fish oils have been publicly exposed as a source of high-level concentrations of the deadly compounds known as dioxins and dioxin-like compounds such as polychlorinated biphenyls, (PCBs), which are grouped into a category of toxic substances known as persistent organic pollutants (POPs).

Dioxins and PCBs are a unique class of chemicals, known broadly as organochlorines, which along with other types of POPs, are man-made products of the industrial age. PCBs have been used since 1929 in a variety of applications, including as heat transfer fluids in large transformers and as dielectric fluids in capacitors, though their use has now ceased. Dioxin is the well-known toxic chemical which contaminated Agent Orange — a defoliant used to clear forests in the Vietnam War and is suspected to remain in the Vietnamese environment, including in areas where shrimp is farmed[35] — and caused the evacuation of the town of Times Beach, Missouri, in 1983, and of the Love Canal site in Niagara Falls, New York, in 1978.

> ***"...these POPs contaminants are especially dangerous for children, nursing mothers, pregnant women, and women considering pregnancy..."***

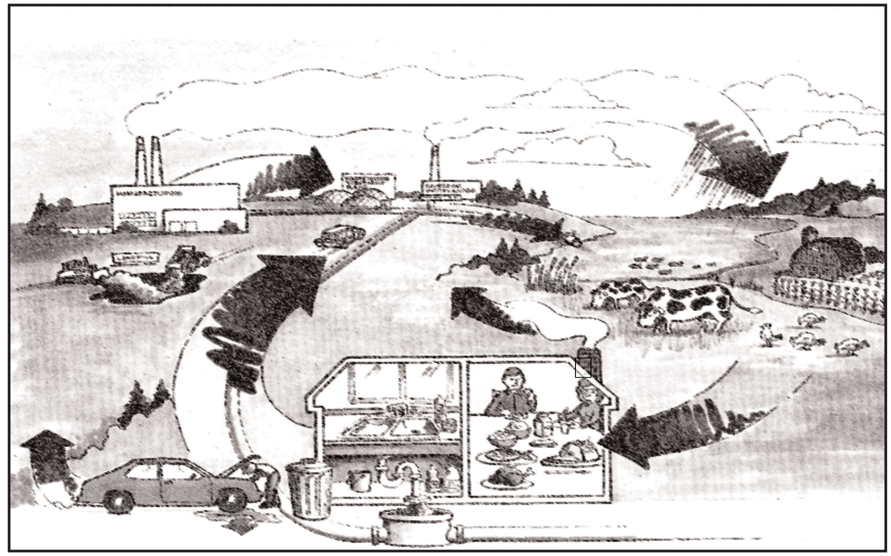
Dioxins and PCBs are the cause of severe environmental and health problems such as cancer, hormone disruption, reduced ability to reproduce, skin toxicity and immune system disorders.[36] They are prevalent in the environment now, and are particularly abundant in the oceans where they are bio-accumulated and concentrated up through the marine food web, and are especially concentrated in the flesh of farmed aquatic species, where they not only absorb these chemicals from the environment, but also in their feed, which have high levels of contaminants.[37]

Scientific evidence from Canada and Great Britain has revealed that potentially dangerous levels of POPs are contained in the feed given to farmed salmon in Canada and Scotland. The studies conducted in Canada for the David Suzuki Foundation and in Britain in conjunction with the U.S. Environmental Protection Agency highlighted the fact that these POPs contaminants are especially dangerous for children, nursing mothers, pregnant women, and women considering pregnancy, and can affect the human nervous and the immune systems, as well as potentially cause cancer.[38]

One of the scientists responsible for the research, Dr. Michael Easton, explained that the level of POPs in farmed fish is related to the fact the high-protein feed used in aquaculture is made from fish meals and oils that contain highly concentrated amounts of these toxic contaminants. The Suzuki report confirmed findings of a November 2000 study by the European Commission's Scientific Committee on Animal Nutrition which had found that among many animal feed ingredients studied, fish meal and fish oil were the most heavily contaminated with dioxins.[39]

Dioxins and PCBs can contaminate both wild and farmed fish and shrimp, but fish and shrimp that are farmed appear to be subject to higher concentrations as the combined result of the fishmeal they're fed and their location in coastal areas where such compounds can be more highly concentrated as a result of runoff from industrial developments upstream from farming areas. It is the concentrations of these compounds in the fishmeal that seem to be of greatest significance, however. A survey report-

Life Cycle of Dioxins



Source:"The Persistent Toxic Cycle" (c)1997, Western Lake Superior Sanitary District, Duluth, MN

ed in the journal *Science* compared the level of organochlorine contaminants, including PCBs and dioxins, in farmed versus wild salmon collected from around the world.[40 41] Most organochlorine substances analyzed in the study show a significantly higher level of contamination in farmed than in wild salmon, which has negative implications for farmed shrimp as well.

Fish feed contamination has been found to be the cause of the high levels of dioxins in farmed fish.[42 43] The FDA test fish randomly four times a year, but does not distinguish between farm and wild fish. The researchers routinely find dioxins in the fish, but within the agencies allowable level.[44] The FDA's limits for consuming PCB's are 500 times higher than the U.S. Environmental Protection Agency (EPA). The EPA is concerned solely with health issues surrounding food, while the FDA also looks at nutritional values and economic impacts. [45] Even if fish offers consumers a nutritious choice with high protein content and a good source of Omega-3 fatty acids, the contaminants in fish may detract from the health benefits. Consumers must choose between nutrients, such as Omega-3 fatty acids, and contaminants, such as heavy metals, industrial chemicals and pesticides.

Conclusion

Considered as a whole, the presence of antibiotics such as chloramphenicol, toxic chemical compounds that include POPs, and pesticides used to farm raise aquatic species, demand that consumers require further investigation by scientists and health authorities into the health risks of farmed raised shrimp. The science that currently exists does not allow consumers to feel confident that their health is safe when eating these foods. When scientific investigations show that the use of these chemicals in aquaculture is unsafe for humans, such use must be globally banned and that ban enforced.

Shrimp farm in Brazil.

In order to take a precautionary approach and protect consumers' health with the knowledge available, the U.S. Food and Drug Administration must institute a strict and comprehensive inspection system for chemicals that are already banned in the United States. When shipments of shrimp with chloramphenicol residues are found to be imported to the U.S., those shipments must be destroyed and the violating country must be reprimanded for violating U.S. law and compromising consumers' health. Until consumers know for certain that their health is protected, farm-raised shrimp should be avoided.

CHART 1: Antibiotics used in Shrimp Aquaculture

Chemical	Use in Shrimp Aquaculture	Health Hazards	Legal Status
Amoxycillin	Antibacterial administered in feed or, more rarely, by direct injection	Dangerous for those allergic to penicillin. Promotes the development of resistant strains.	Not approved for use in the U.S.
Chloramphenicol	Broad spectrum antibiotic	Aplastic anemia - lethal blood disease.	Banned in EU, Canada, U.S., Japan
Cotrimoxazole	General antibacterial	Toxic epidermal necrolysis in sensitive individuals	Not approved for use in the U.S.
Erythromycin	Used against bacterial kidney disease and streptacoccosis in SE Asia shrimp hatcheries	Development of resistant strains	Use allowed in U.S
Ethoxyquin	Commonly used in feed preservation	Harmful by ingestion. Irritant.	Not approved for use in the U.S.
Furazolidone	Broad spectrum antibacterial and antiprotozoal activity	Possible human carcinogen. Has been used as drug for AIDS patients	Use for food animals prohibited in EU. Use allowed in U.S.
Nitrofurin	Broad spectrum and potent antibacterial and antiprotozoal agent	Suspected human carcinogen	Restricted residue level allowed in U.S., EU
Oxolinic acid	Used against gram-negative bacteria	Development of resistant strains. Residues resistant to degradation	Not approved for use in the U.S.
Oxytetracycline	Probably the most widely used antibacterial agent in shrimp aquaculture, especially in SE Asia	Development of strains resistant to oxytetracycline and other related antibiotics	Use allowed in U.S.
Rifampicin	Antibacterial, effective against mycobacterial infections	Rapid development of resistant strains	Not approved for use in the U.S.
Sulfadiazine	Commonly used in combination with diamino-pyrimidine to yield broad spectrum antibacterial action.	Development of resistant strains	Use allowed in U.S.

CHART 2: Organophosphates and other pesticides, herbicides and fungicides used in Shrimp Aquaculture

Chemical	Use in Shrimp Aquaculture	Health Hazards	Legal Status
Carbaryl (organophosphate)	Controls burrowing shrimp in Central and S. America.	Acetylcholine esterase inhibition	Not approved for use in the U.S.
Chlorpyrifos (organophosphate)	Controls monogenetic trematode infections in shrimp hatcheries	Acetylcholine esterase inhibition	Not approved for use in the U.S.
Endosulfan	Used as a pesticide in Thailand.	Possible reproductive and immunotoxicant in humans. Affects central nervous system, causing dizziness, hyperactivity and nausea.	Banned in numerous countries, and variously classified as "toxic" and "hazardous"
Malachite green oxalate (Organonitrogen compound)	Antifungal and antiprotozoal bath treatment, primarily in shrimp hatcheries	Respiratory poison Persistent residues in tissues of seafood	Prohibited for use in US, EU and in Thailand
Malathion (organophosphate)	Control of trematode infections in shrimp hatcheries	Acetylcholine esterase inhibition	Not approved for use in the U.S.
Methylene blue	Used as antifungal and antiprotozoal treatment.	Can produce hemolytic anemia in laboratory animals	Not approved for use in the U.S.
Simazine	Herbicide	Toxic to ingest. Effects on liver and thyroid in humans. Potential reproductive toxin.	Not approved for use in the U.S.
Trichlorfon (organophosphate)	Used in SE Asia	Acetylcholine esterase inhibition. Hydrolyses to form more toxic and persistent dichlorvos	Not approved for use in the U.S.
Triphenyl tin acetate (Organotin compound)	Previously used as antifoulant to remove molluscs from shrimp ponds in SE Asia	Immunotocicity in mammals. Possible neurotoxicity. Residues accumulate in fish cultured in treated ponds and persist for many months	Banned in U.S., EU, Philippines and Indonesia
Triphenyl tin chloride (Organotin compound)	Previously used as antifoulant to remove molluscs from shrimp ponds in SE Asia	Immunotocicity in mammals. Possible neurotoxicity.	Banned in U.S., EU, Philippines and Indonesia

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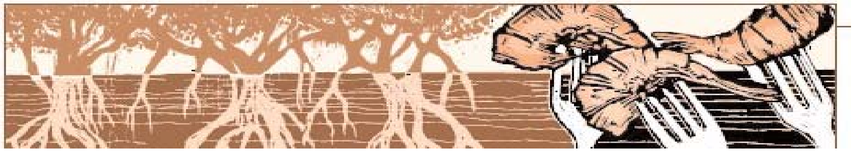

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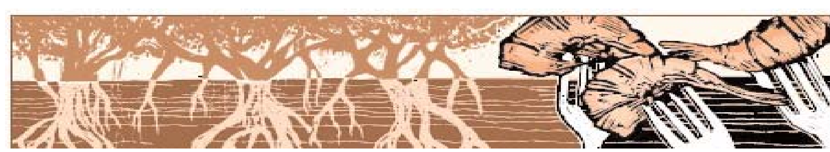

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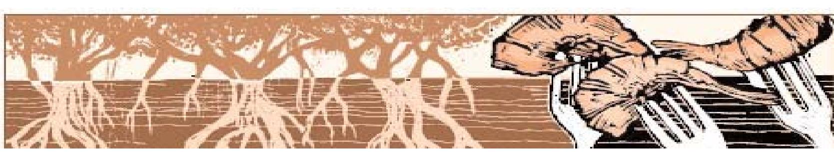

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