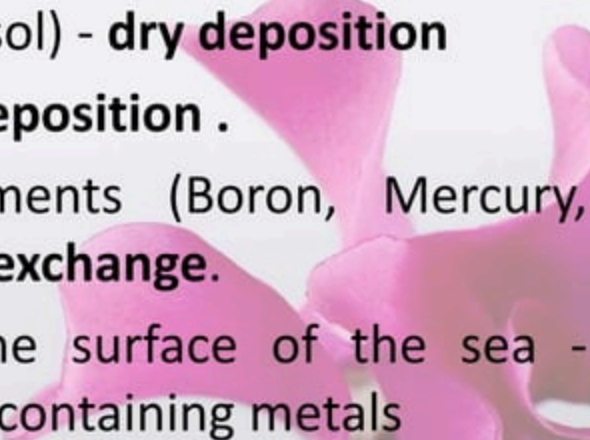


Sources of heavy metal

ATMOSPHERE;

- Gas or particle (aerosol) - **dry deposition**
 - Precipitation - **wet deposition** .
 - Gaseous state elements (Boron, Mercury, Selenium) - **gaseous exchange**.
 - Bubbles breaking the surface of the sea - release salt particles containing metals
- 
- A pink orchid flower is positioned on the right side of the slide, partially overlapping the text. It has several large, delicate petals in various shades of pink, with some darker veins visible. The flower is oriented diagonally, with its stem pointing towards the bottom right corner.

RIVERS;

- Erosion of rocks
- Forest fires ,Volcanic activity.

ANTHROPOGENIC EMISSIONS;

- Coal fired power stations, Contaminated waste dumping, Industrial discharges ,Sewage, car exhausts.
- Bind with sediments - deposited on the seabed enter the marine environment
 - Dredging ,Trawling & Severe weather.

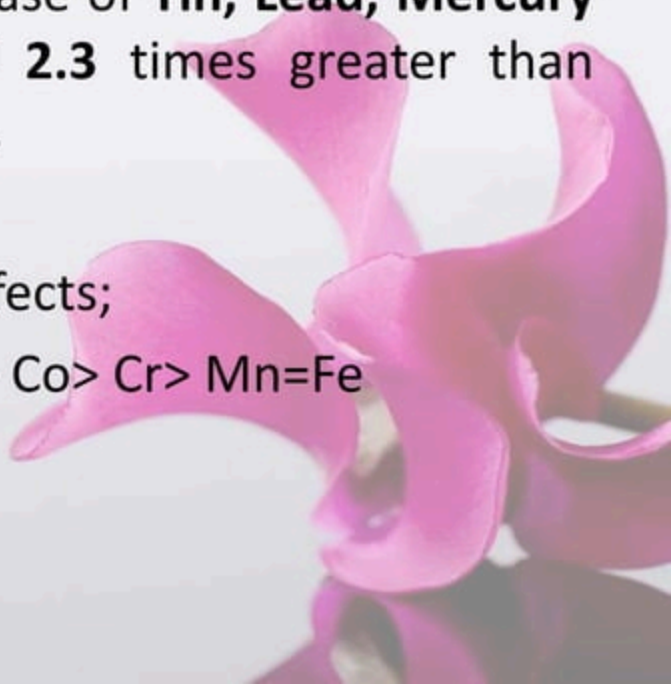


Cont...

- Human induced release of **Tin, Lead, Mercury** are **110.0, 13.0 and 2.3** times greater than geological processes.

Decreasing order of effects;

- Hg > Cd = Cu > Zn > Pb > Co > Cr > Mn = Fe



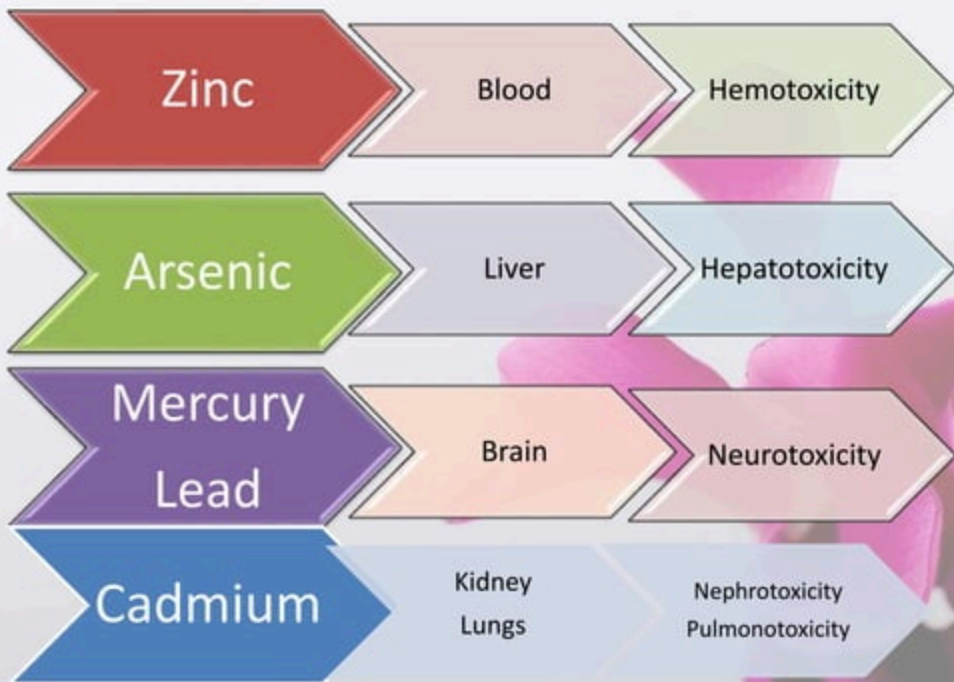
Toxicants in Fish

- (1) Dermally - by swimming in contaminated waters.
- (2) Breathing, by direct uptake of pesticides through the gills during respiration.
- (3) Orally, by drinking pesticide-contaminated water or feeding on -contaminated prey.

“Secondary Poisoning”

Poisoning by consuming another animal that has been poisoned by a pesticide.

Target Organ Toxicity of Heavy Metals



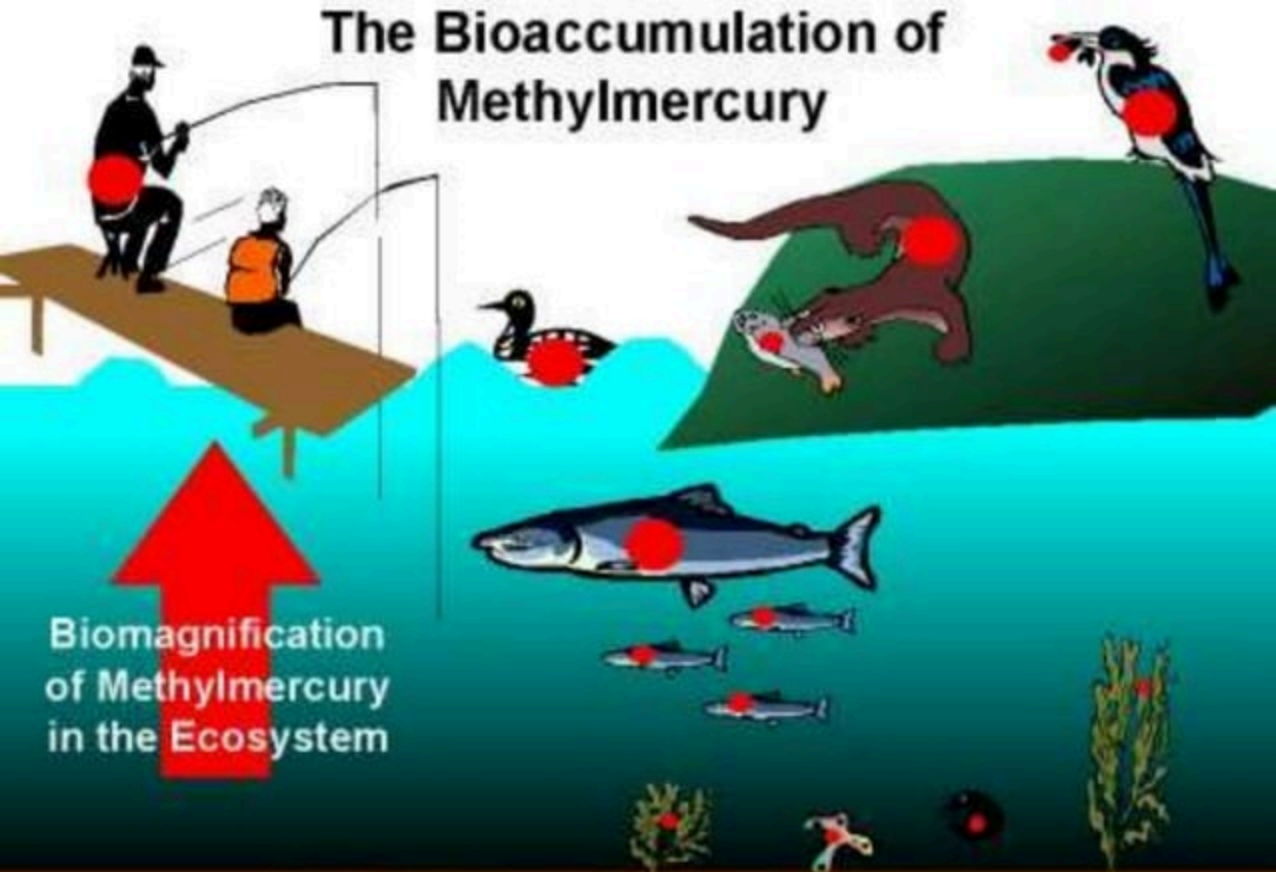
Hg in Fish



Toxic form; Methylated mercury.

- ☼ Most fish species have mercury levels of approximately 0.15 ppm in muscle tissue.
- ☼ Hg levels over 0.5 to 1.0 ppm -unsafe for human consumption.
- ☼ Long-lived top predators & marine mammals - mercury in Striped dolphins is 485 ppm wet weight.
- ☼ Oceanic sp has less amount compared with Coastal Sp.
- ☼ Inputs of Mercury **6000-7500 tons a year.**

The Bioaccumulation of Methylmercury



● Methylmercury Bioaccumulation in Organisms

Toxic effects of Mercury

- Cause neurological damage, immune system suppression and can cause fetal abnormalities in mammals [Clarkson (1987)].
- Associated with disease -induced mortality i.e. mercury may damage the immune system.
- Lesions in the liver and other tissues; decrease nutritional state.



Minamata Disease

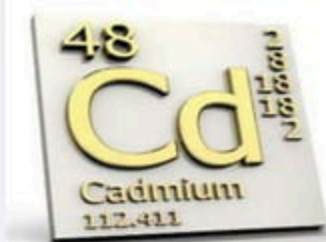


- In 1952 a factory in Minamata Japan was using mercury as a catalyst.
- Mercury washed into bay In 1953 fishermen and farmers showed symptoms – neurological damage, fetal deformity even casualties etc. Hg content in fish: **10-55 ppm** of dry weight.

Faroe Islands (whale meat)

- Children born to mothers with high body levels of Hg scored lower on brain function tests than mothers with low body levels.

Cadmium (Cd)



Used in:

Electroplating and as a pigment for plastics.

Main sources of current production:

By product of zinc mining, Nickel-Cadmium battery production.

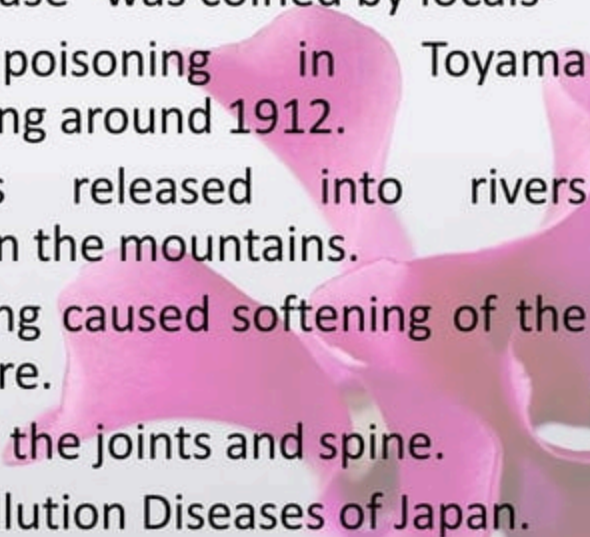
Input 8000 tons/year to ocean - 50% anthropogenic.

Effects;

- ❖ Present in skin & scales of fish.
- ❖ Kidney dysfunction in cetacean - liver concentrations of Cd exceed 20 ppm wet weight.
- ❖ Inhibit fish gill Na^+/K^+ -ATPase activities in European sea bass .

Itai-itai Disease

("It hurts-it hurts Disease"),

- The term "*Itai-itai* disease" was coined by locals:
 - Mass Cadmium poisoning in Toyama Prefecture, Japan, starting around 1912.
 - The cadmium was released into rivers by mining companies in the mountains.
 - The cadmium poisoning caused softening of the bones and kidney failure.
 - Severe pains caused in the joints and spine.
 - one of the Four Big Pollution Diseases of Japan.
- 
- A large, soft-focus pink flower, possibly a lily, is positioned on the right side of the slide, partially overlapping the text.

Lead (Pb)



Used in: Battery casings, pipes, sheets etc.

43 million tons produced a year.

Combined with colloidal particle found in water.

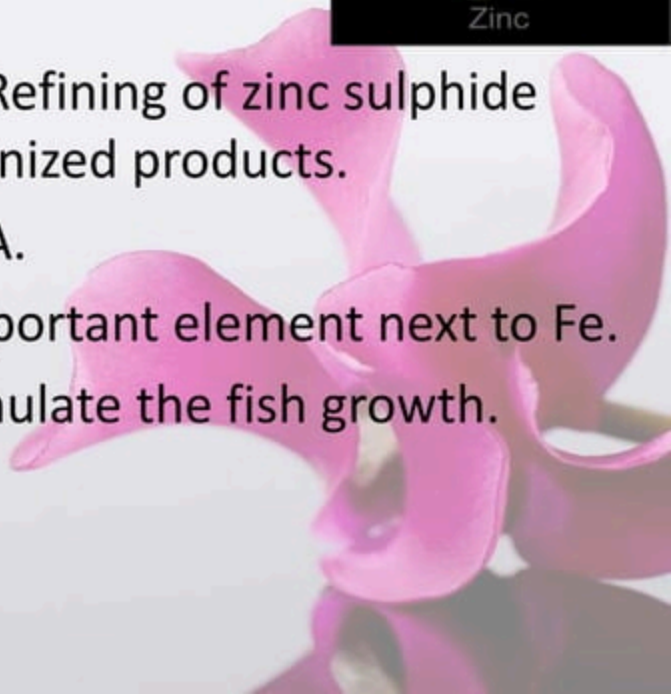
Effects

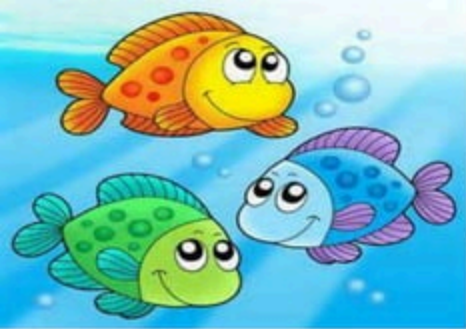
- » High levels of lead have been found in marine life near areas of high car density - e.g. 10 ppm in fish caught 300 miles off California coast.
- » Neurotoxin, Teratogen (formation of abnormal structures), affects fertility.

Zinc



- ◆ Ubiquitous - Smelting, Refining of zinc sulphide ores, Corrosion of galvanized products.
- ◆ Synthesis of DNA & RNA.
- ◆ Second quantitative important element next to Fe.
- ◆ 0.03 to 0.06 mg/l – stimulate the fish growth.



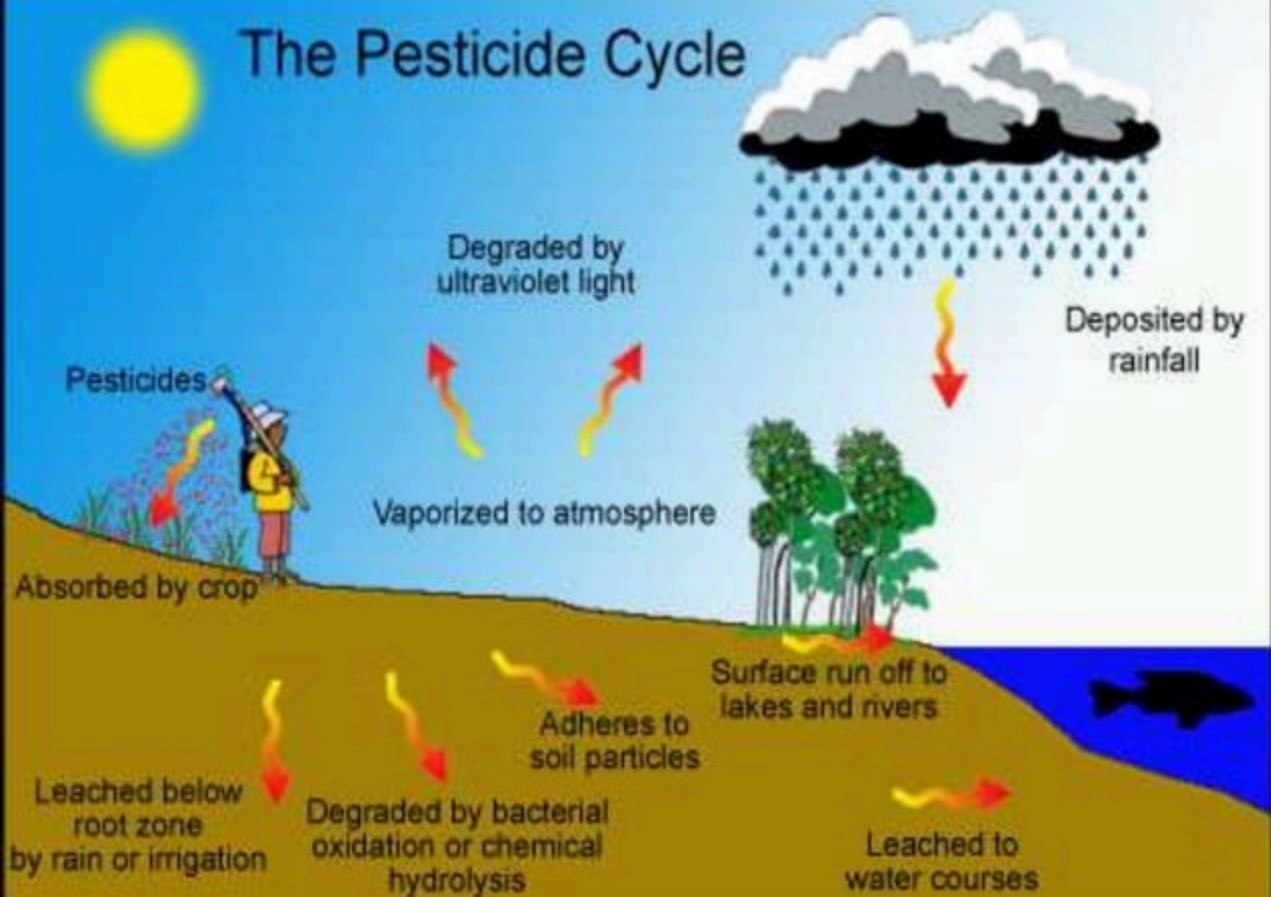


Pesticides



- "Chemical or biological agent (such as a virus, bacterium, antimicrobial, or disinfectant) that deters, incapacitates, kills, or otherwise discourages pests"
- "-cide" -Latin word "**to kill.**"
- According to the Stockholm Convention on Persistent Organic Pollutants, **9 of the 12 most dangerous** and persistent organic chemicals are pesticides.

The Pesticide Cycle



Types of Pesticides

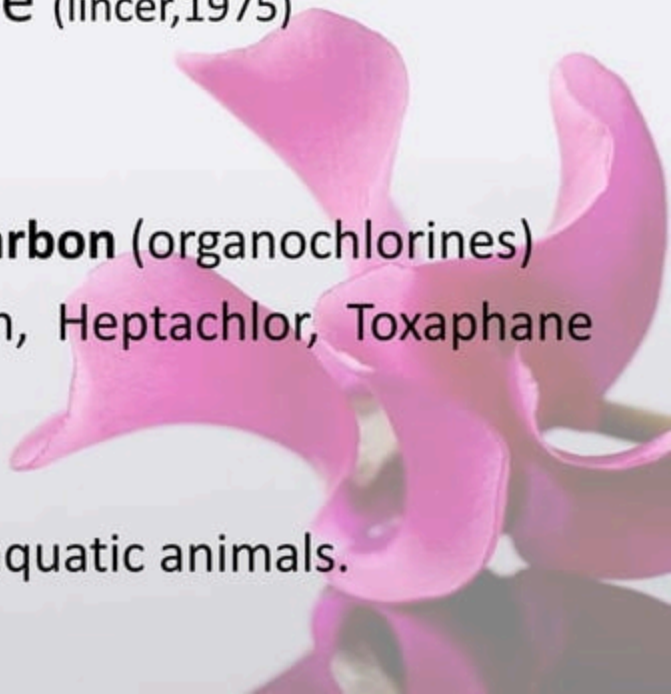
Based on the categories and chemical structure (lincer,1975)

1. Insecticides

a) Chlorinated hydrocarbon (organochlorines)

DDT, Aldrin, Dieldrin, Heptachlor, Toxaphane and Chlorodane.

- Present world wide.
- Bio-accumulated in aquatic animals.



DDT

- ✳ Available for public use from 1945.
- ✳ Insoluble in water, but soluble in fat.
- ✳ Zooplankton – initial step for the entry of DDT into marine environment.
- ✳ Banned in USA since 1972.

Effects;

- ✳ It blocks normal nervous system of fish eating birds.(Bald eagles, Ospreys, Pelicans etc...)
- ✳ Interferes with calcium deposition during the formation of egg shell in marine birds.
- ✳ Stored in a blubber of Arctic penguin.

Contd...

b) Organophosphate; Persistence in Fish- Years

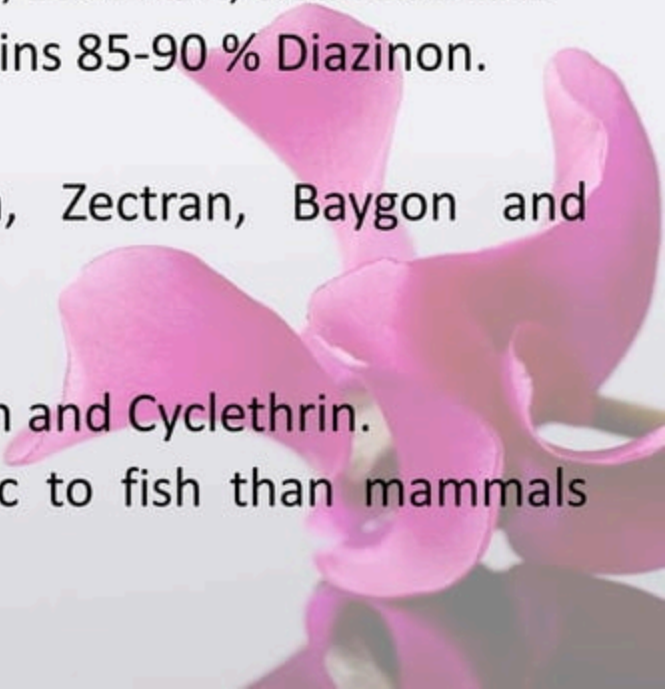
Malathion, parathion, Diazinon, and Guthion.

Agriculture spray contains 85-90 % Diazinon.

C) Carbonates; Sevin, Zectran, Baygon and Temik.

D) Pyrethrins; Allethrin and Cyclethrin.

1000 times more toxic to fish than mammals and birds.

A close-up photograph of a pink flower, likely a petunia, with several large, ruffled petals in shades of pink and magenta. The flower is positioned on the right side of the slide, partially overlapping the text.

2. Fungicides

- a) **Dithiocarbamates;** Ferbam, Ziram, and Meneb.
- b) **Nitrogen containing compounds;** Phenyl Mercuric acetate, Triazines, Quinones and some heavy metals.
- c) **Hexachlorobenzene.**

3. Herbicides;

- a) **Phenoxy acids;** 2,4-D and 2,4,5 –T.
- b) **Endothal**
- c) **Diquat**



2,4-Dichloro phenoxy acetic acid (2, 4-D)

- Most successfully and widely used herbicides.
- Microorganisms present in the sediment are responsible for the degradation of 2,4-D.

Effects;

- » Affects the reproductive function of various aquatic insects like Dung beetles and Chironomids.
- » Oocyte maturation in Bivalve *Xenopus laevis* blocked.
- » At low concentration it alter the morphogenesis.

4. Bactericides;

Destroy & prevent the spread of bacteria.

(eg) Chlorine containing chemicals

5. Repellents;

These repel rather than destroy a pest.

(eg) Camphor, Clove oil

6. Rodenticides;

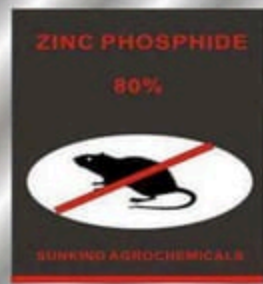
Used for controlling Rodents.

(eg) Zinc Phosphide, Warfarin

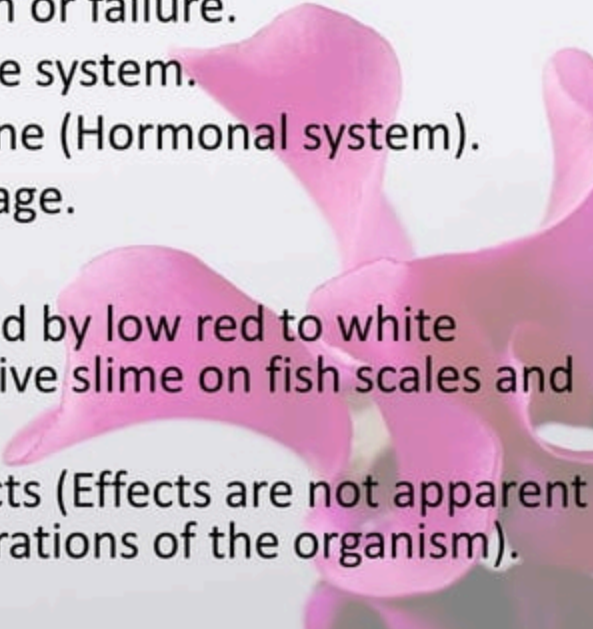
7. Baits;

Ready- prepared products which need to be mixed with a food to control pest.

(eg) Bait for Cockroaches

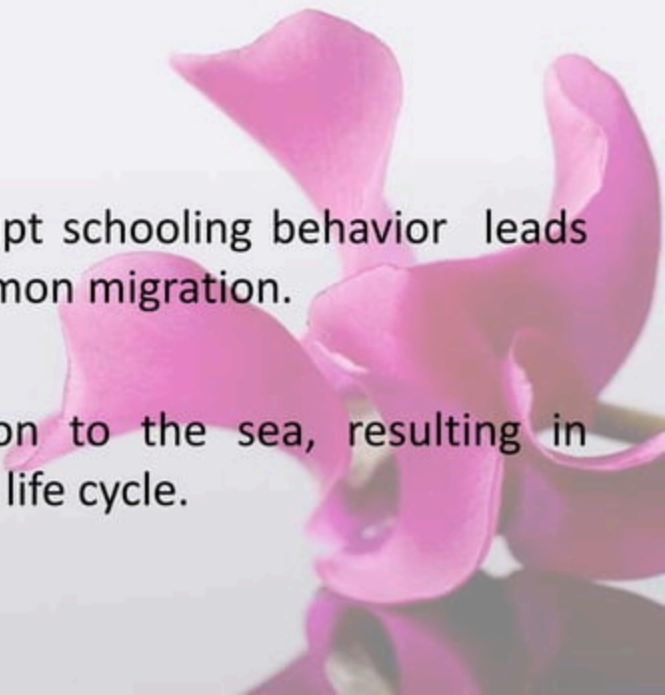


Effects of Pesticides


- # Death of organism.
 - # Cancers, Tumors and Lesions on fish and animals.
 - # Reproductive inhibition or failure.
 - # Suppression of immune system.
 - # Disruptions of endocrine (Hormonal system).
 - # Cellular and DNA damage.
 - # Teratogenic effects.
 - # Poor fish health marked by low red to white blood cell ratio, excessive slime on fish scales and gills etc..
 - # Intergenerational effects (Effects are not apparent until subsequent generations of the organism).
 - # Egg shell thinning.
- 

Behavioral Effects of Pesticides

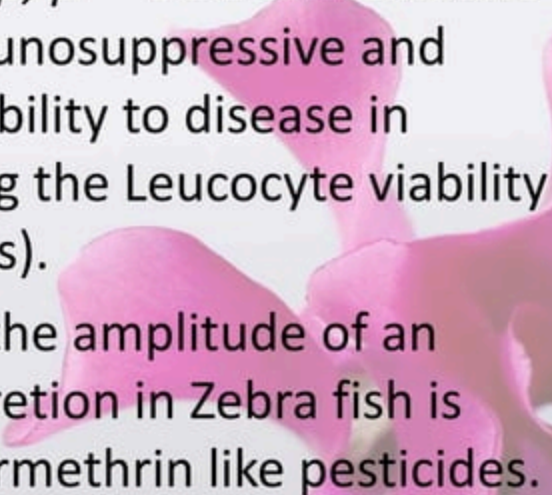
- Ⓢ Increase stress in juvenile fish - more susceptible to predation.
- Ⓢ Alter swimming ability.
- Ⓢ Many pesticides interrupt schooling behavior leads to predation, during salmon migration.
- Ⓢ Inhibit normal migration to the sea, resulting in severe disruption of the life cycle.



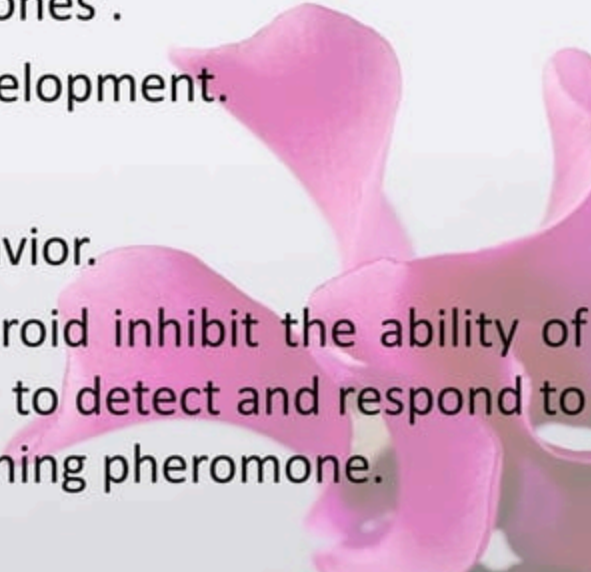
Smoltification in Salmon

- Characterized by a change to a silvered-colored body and hypo osmoregulatory capacity.
 - Increase in thyroid hormones may trigger seaward emigration.
 - Smolts undergo olfactory imprinting.
 - Atrazine (pesticide used in Corn and Sugarcane farming) modifies olfactory sensitivity.
- 
- A soft-focus image of a pink flower, possibly a gerbera, is positioned on the right side of the slide, partially overlapping the text.

Compromised Immune Systems

- Organochlorines like p , p' – DDE and Lindane compounds are immunosuppressive and increase the susceptibility to disease in mammals by affecting the Leucocyte viability (Apoptosis & Necrosis).
 - Cytokine (Modulate the amplitude of an immune system) secretion in Zebra fish is highly affected by Permethrin like pesticides.
- 
- A soft-focus image of a pink flower, likely a gerbera, is positioned on the right side of the slide, partially overlapping the text.

Reproductive System

- ✧ Pesticides at low concentrations may act as blockers of sex hormones .
 - ✧ Abnormal sexual development.
 - ✧ Abnormal sex ratios.
 - ✧ Unusual mating behavior.
 - ✧ The synthetic Pyrethroid inhibit the ability of male Atlantic salmon to detect and respond to the reproductive priming pheromone.
 - ✧ Delayed spawning.
- 
- A soft-focus image of a pink flower, likely a gerbera, is positioned on the right side of the slide, partially overlapping the text area.

Indirect Effects of Pesticides

- ψ Fish habitat and feeding **e.g. Climbing perch.**
- ψ Reduce reproductive success of fish and aquatic animals, Because weedy area act as nursery.
- ψ Affects fish breeding.
e.g. *Hydrilla* for Common carp
- ψ Reduction in DO level.



References;

- National Pesticide Information Center

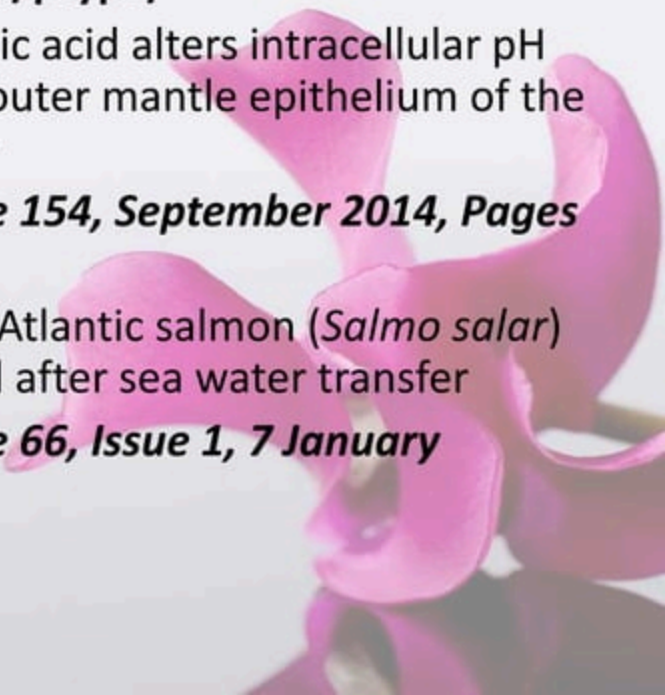
<http://npic.orst.edu/ingred/ptype/>

- 2,4-Dichlorophenoxyacetic acid alters intracellular pH and ion transport in the outer mantle epithelium of the bivalve *Anodonta cygnea*

Aquatic Toxicology, Volume 154, September 2014, Pages 12-18

- The effect of atrazine on Atlantic salmon (*Salmo salar*) smolts in fresh water and after sea water transfer

Aquatic Toxicology, Volume 66, Issue 1, 7 January 2004, Pages 93-104



- Effects of the organochlorines *p,p'*-DDE and lindane on gilthead sea bream leucocytes immune parameters and gene expression

Fish & Shellfish Immunology, Volume 25, Issue 5, November 2008, Pages 682-688

