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1996

The trouble with antibiotics and pesticides is...

Aquaculture Department, Southeast Asian Fisheries Development Center

Southeast Asian Fisheries Development Center, Aquaculture Department (1996) The trouble with antibiotics and pesticides is... Aqua Farm News, 14(4-5), pp. 14-15.

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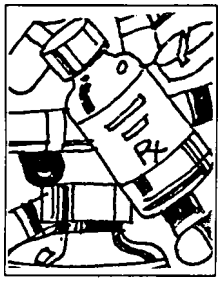
The trouble with antibiotics and pesticides is ...



"...that their **indiscriminate** use can cause mortalities of cultured stock, morphological deformities, and development of antibiotic-resistant bacterial strains," say fish health experts at AQD.

In the Philippines alone, more than **100** chemical products are used by fish farmers for prophylaxis and treatment. "These include disinfectants, soil and water conditioners, pesticides, antimicrobials, plankton growth promoters, organic matter decomposers, and feed supplements," notes Dr. Erlinda Lacierda, a fish disease expert at AQD who conducted a nationwide survey on chemical use in aquaculture.

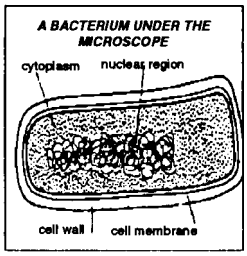
Although chemicals pose potential hazards to humans like other chemical residues in the food industry, aquaculture experts who gathered for the [1]*Meeting on the Use of Chemicals in Aquaculture in Asia* last summer at AQD have agreed that the risks are not excessive. Many chemicals are essentially harmless when applied properly but indiscriminate use can give huge problems.

The meeting also highlighted the effects of chemical use on other cultured stocks in the farm, the immediate environment through discharges and effluents, surrounding areas (especially where other farms operate), farm staff (like toxicity, allergy), consumers (through residues in harvested shrimp and fish) and drug resistance of microorganisms.

Representatives of the public sector (governments, R&D centers including AQD) and the private sector (farmers and suppliers-traders of chemicals) who attended the meeting have also identified, and agreed to, solutions they can adopt to mitigate the adverse effects of chemical use. The public sector will create a research and information network and test alternatives to chemicals with potentially harmful effects on health, the environment and workers. Industry representatives agreed to self-regulation and cooperation with the private sector in seeking more environment-friendly culture methods.

These are solutions for the aquaculture industry not only in the Philippines but also for countries represented in the meeting such as Bangladesh, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Pakistan, Singapore, Taiwan, Thailand, and Viet Nam.

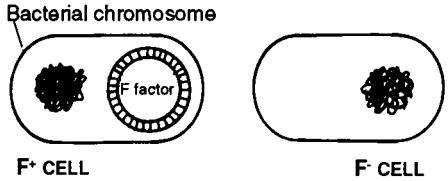
[1] The meeting on chemical use was organized by AQD and the FAO Fisheries Resource Division in cooperation with the Network of Aquaculture Centres in Asia and the Pacific, the Japan International Research Center for Agricultural Sciences, and the Taiwan Fisheries Research Institute. SEAFDEC, FAO and CIDA funded the meeting.



A closer look at the bacterial world ...

The development of antibiotic-resistant bacterial strains is just one of the results of indiscriminate use of antibiotics. Farmers have asked: how will this happen? by what process?

This will happen when bacteria reproduce by conjugation. Microbiologists define bacterial conjugation or mating as the process of genetic transfer that involves cell-to-cell contact. Let's take a look at bacterial conjugation.

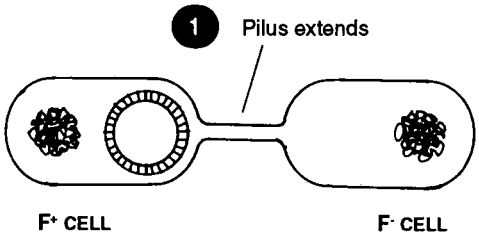


We may think of the F^+ cell (on the left) as the first bacterium that has developed antibiotic resistance on its own by surviving, say, a farm that has indiscriminately used antibiotic products. F^+ encodes antibiotic resistance onto its genes, and pass this on to a non-resistant F^- bacterium

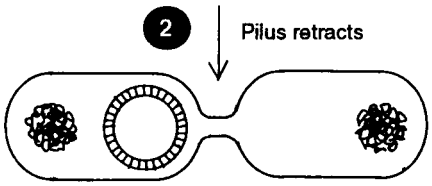
(on the right) during conjugation.

Microbiologists note that the pairing of F^+ and F^- is specific. Donor cells (like F^+) must have conjugative plasmids (the circular *F factor* above) which possess the genetic information to code for sex pili (see below) and for some proteins needed for DNA transfer. Although recipient cells (like F^-) lack sex pili, they have receptors on their surface, as pair formation for conjugation generally occurs only between strains of bacteria that are closely related.

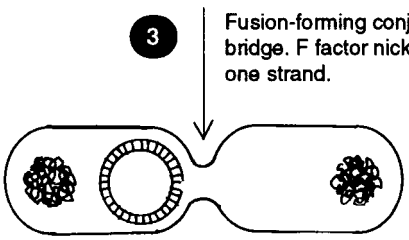
Conjugation is quite rapid. [Bacteria, in general, can reproduce in 30 minutes.] During conjugation, F^+ first extends a "bridge" (sex pilus):

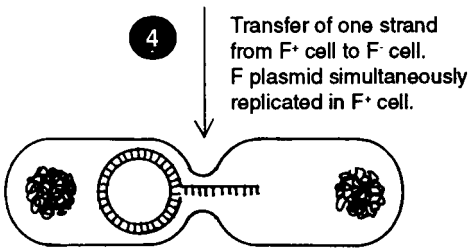


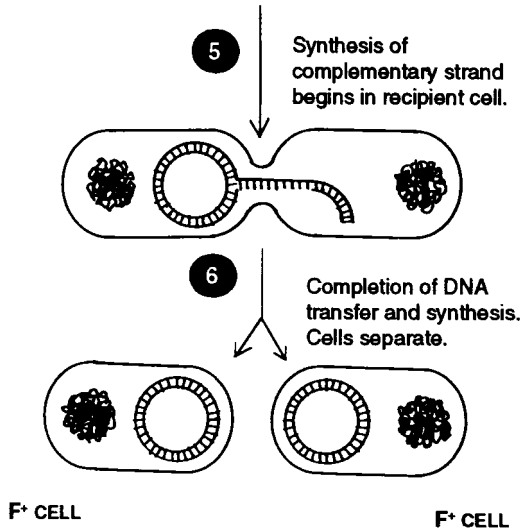
Then this "bridge" or pilus retracts:



After which, microbiologists think, the cell membranes of F^+ and F^- fuse in some way, triggering DNA transfer.





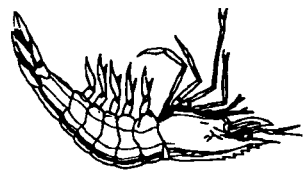


When DNA transfer and synthesis is complete, F^+ and the previously F^- separate. F^- is now an antibiotic-resistant F^+.

Microbiologists note that this process is highly efficient because under appropriate conditions, virtually every recipient cell which pairs can acquire a plasmid. If the plasmid genes can be expressed in the recipient, the recipient itself then soon becomes a donor and can then transfer the plasmid to other recipients. In this fashion, conjugative plasmids can spread rapidly between populations, behaving like infectious agents. It may therefore take only one F^+ bacterium to create a whole colony of antibiotic resistant bacteria.

Microbiologists warn that the infectious nature of bacterial conjugation is of major ecological significance. Bacterial genes that confer selective advantage (or an "ace" up a bacterial "sleeve") can easily allow a whole population to survive and reproduce.

Microbiologists also note that widespread occurrence of infectious drug resistance in clinical medicine has already led to some serious problems in the chemotherapy of infectious diseases.

REFERENCE

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