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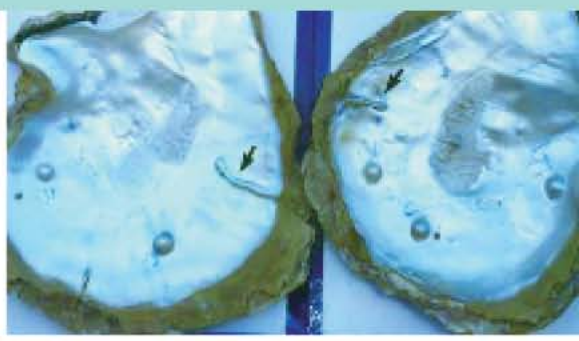
Pearl oyster health management

A manual



Cover photos:
Left: Pearl oyster farm in China (FAO/M.G. Bondad-Reantaso).
Right, top to bottom: Pinctada maxima with mudworms (FAO/M.G. Bondad-Reantaso); South Korean women cleaning and sorting mother-of-pearls before grafting (courtesy of F.C.J. Berthe/EFSA); South Sea pearls (FAO/M.G. Bondad-Reantaso).

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Preparation of this document

This document was prepared in an effort to determine what health management options can best support development and sustainability of the pearl oyster industry as well as collate past experiences in dealing with pearl oyster disease outbreaks and other health problems. This is the second occasion that FAO is publishing important information about pearl oyster. The first and pioneering publication was the Pearl Oyster Farming and Culture, an output prepared for the Pearl Oyster Farming Training Course (Training Manual 8) conducted by the Central Marine Fisheries Research Institute at Tuticorin, India and organized by FAO's Regional Seafarming Development and Demonstration Project (RAS/90/002).

This paper was prepared under the technical supervision of Dr Melba G. Bondad Reantaso, Fishery Resources Officer, Aquaculture Management and Conservation Service, Fisheries and Aquaculture Management Division, FAO Fisheries and Aquaculture Department.

Part 1 consists of two articles: "Why the interest in pearl oyster health?" by Dr Sharon E. McGladdery of the Canadian Food Inspection Agency (CFIA) and "Overview of the cultured marine pearl industry" by Prof. Paul Southgate of James Cook University. Part 2 on Pearl oyster health management was jointly written by Dr Sharon E. McGladdery of CFIA, Dr Melba G. Bondad-Reantaso of FAO and Dr Franck C.J. Berthe of the European Food Safety Authority. Part 3, consisting of experiences in dealing with pearl oyster mortalities and other health management options, was contributed, in alphabetical order by Dr Franck C.J. Berthe (France/Italy), Dr Jeremy Carson (Australia), Dr Melba G. Bondad-Reantaso (Philippines/Italy), Dr Ben Diggles (New Zealand/Australia), Dr Francis Mike Hine (New Zealand/France), Dr J. Brian Jones (Australia), Ms Daisy Ladra (Philippines), Dr Sharon E. McGladdery (Canada), Dr Jean Prou (France), Dr Katsuhido Wada (Japan) and Dr Wang Chongming (China).

Abstract

The pearl oyster industry is a growing multibillion dollar sector of mollusc aquaculture. Pearl farming occurs throughout Australasia, the Middle East and South America. Few species of molluscs possess the ability to produce pearls of gem quality. The South Sea pearl oyster is one of them. Pearl production in the wild is an unpredictable and uncontrolled event which human intervention, through pearl culture, has progressively overcome by improving culture practices. Farming mother-of-pearls shares commonalties with edible mollusc aquaculture. However, the endproduct, pearl production, is unique to this sector. In aquatic production, health issues are of utmost importance; pearl production is based entirely upon health. The pearl itself is a product of the oyster's immune defences as a response to soft-tissue irritation. Exploited stocks receive frequent handling stresses which often predispose farmed animals to infection and diseases. Therefore, the importance of health management for pearl oysters is paramount. Today, most disease problems are caused by opportunistic pathogens taking advantage of oysters weakened by the stress of handling, including pearl surgery and sub-optimal growing conditions. Except for the mass mortalities experienced in Japan, the pearl oyster industry have not yet faced the types of epizootics which has impacted mollusc culture elsewhere in the world. Development of the industry will, inevitably, lead to increased risk of disease introduction, spread or emergence. Against such an unwanted future, health management is the critical defence line.

The objectives of this technical paper are to: (i) review pearl oyster mortalities and disease problems in order to help design programmes aimed at reducing the risks from diseases; and (ii) provide technical guidance to pearl oyster farmers and the industry on management of pearl oyster health so that sector development will be sustainable not only in providing huge employment to communities where pearl farms are located but also contributing to maintain environmental integrity. Pearl oyster farming can serve as environmental sentinels recognizing the fact that pearl oysters thrive only in pristine environment.

This publication contains three parts. Part 1 consists of pearl oyster health – the current interest in it and an overview of the cultured marine pearl industry. Part 2 on pearl oyster health management consists of seven sections, namely: (a) introduction; (b) general information on husbandry and handling, hatchery production, introductions and transfers; (c) disease diagnostic protocols dealing with field collections of samples, gross external examination, gross internal examination and laboratory protocols; (d) health zonation; (e) disease outbreak protocols; (f) national strategies on aquatic animal health; and (g) references. Certain countries in the pearl oyster producing regions have acquired a great deal of experience in health management of cultured species. Experiences from Australia, the Cook Islands, Japan, the French Polynesia, the Philippines, China, the Persian Gulf and the Red Sea are included in Part 3 which also contains a general review of pearl oyster mortalities and disease problems.

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Contents

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Abbreviations and acronyms

ASBUMI	Indonesian Pearl Culturer's Association
ASE	accelerated solvent extraction
BFAR	Bureau of Fisheries and Aquatic Resources (Philippines)
BHIA	brain heart infusion agar
BOD	biological oxygen demand
BRD	Brown Ring Disease
CMFRI	Central Marine Fisheries Research Institute
DO	dissolved oxygen
EDTA	ethylenediaminetetraacetic acid
EM	electron microscopy
FAO	Food and Agriculture Organization of the United Nations
FDA	Food and Drug Administration
GC-FID	gas chromatography/flame ionization detection
ICES	International Council for the Exploration of the Seas
ICP-MS	inductively coupled plasma mass
LD50	lethal dose 50
MA	marine agar
MMR	Ministry of Marine Resources (Cook Islands)
MOP	mother-of-pearl
NT	Northern Territory
OIE	World Organisation for Animal Health
PCR	polymerase chain reaction
PPTA	phosphotungstic acid
QLD	Queensland, Australia
RFTM	Ray's Fluid Thioglycollate Medium
SOD	sediment oxygen demand
SOPAC	the Pacific Islands Applied Geoscience Commission
TCBS	thiosulphate citrate bile salt
TEM	transmission electron microscopy
TSA	tryptone soya agar
WA	Western Australia

Glossary

Abcess	an aggregation of haemocytes (blood cells) which contains necrotic (decaying) host cells
Akoya pearl	saltwater pearls cultivated from *Pinctada fucata*; the mainstay of the Japanese and Chinese cultured pearl industries
Bivalve mollusc	a mollusc, such as an oyster or a clam, that has a shell consisting of two hinged valves. Bivalves are members of the phylum Mollusca, class Bivalvia.
Blister pearls	a natural pearl, usually irregular in shape, which occurs when a parasite (or an irritant) enters a mollusc through its outer shell causing the mollusc to secrete nacre over the irritant, cementing it to the shell
Ceroid	non-staining metabolic by-product found in many bivalves. Abnormally high concentrations indicate possible environmental or pathogen-induced physiological stress
Conchiolin	nitrogenous albuminoid substance, dark brown in color, that forms the organic base of molluscan shells
Concretions	non-staining inclusions in the tubule and kidney cells of pearl oysters, produced during the digestive cycle. Similar inclusions are also found in the epithelia of other bivalves
Cultured pearl	pearls which are produced by the reaction of an oyster or molluscs to insertion of a foreign object (called a nucleus or a bead) into its tissue; this induces secretions to cover the nucleus. Culture pearls are formed when a pearl oyster secretes nacre over the nucleus
Fouling	accumulation and deposition of living organisms and certain non-living material on hard surfaces, most often in an aquatic environment
Gold-lip oyster	one of two varieties of *Pinctada maxima*; the other is the silver-lipped oyster. The names relate to the colour of the mother-of-pearl lining the shell
Gonad	the reproductive organ that produces either the sperm or the eggs. gonads in males are called testes; gonads in females are called ovaries
Grafting	also known as “seeding”, “nucleus implantation” or “nucleation” is a surgical procedure where a nucleus and a small piece of mantle tissue (from another oyster) are inserted into the gonad for cultured pearl formation

Mabé pearl	a pearl which is formed when a flat-sided nucleus is glued to the inside of a pearl oyster shell. Also known as "half-pearls" and "blister-pearls" they can be made in a variety of shapes determined by nucleus shape
Mantle	the part of a pearl oyster's soft tissue that lines the inside of the shells and secretes nacre
Mantle retraction/ recession	during periods of no growth in molluscs, the mantle retracts away from the edge of the shell. Prolonged mantle retraction leaves the inner shell edge open to erosion and fouling
Mikimoto pearls	a leading brand of pearls founded by the Japanese Kokichi Mikimoto, the Japanese credited for creating the cultured pearls
Mother-of-Pearl	the substance which is secreted by pearl oysters to line the inside of their shells. It is also called "nacre" and is the same substance which forms pearls. Mother-of-pearl is now used extensively as the nucleus in pearl cultivation. The shell of a mussel is cut into squares and then run through a process which rounds the pieces into beads. These beads are then implanted into the oysters which then secrete nacre upon the mother-of-pearl beads to form the cultured pearl
Nacre	also known as mother-of-pearl is the basic substance which is secreted by oysters and molluscs after a foreign substance (e.g. a grain of sand, a piece of rock or even a parasite) has entered the shell and caused irritation. Nacre is composed of layers of calcium carbonate (in a crystalline form) and conchiolin (an organic protein substance which provides bonding)
Natural pearl	pearls which are formed in nature, following the actions of a parasite or foreign body lodging itself in the gonad or mantle tissues of a host oyster
Nucleus	a bead or implant onto which nacre is secreted to form cultured pearls. They may be round (round pearl production) or flat sided (mabé production). Round nuclei are generally made of mollusc shell that has been cut, rounded and polished
Pearl	a hard, round object produced by certain animals (primarily molluscs) such as pearl oysters particularly valued as a gemstone and is cultivated or harvested for jewellery
Pearl formation	when a small irritant or parasite penetrates the shell and irritates the mantle tissue a pearl may be formed when nacre is secreted as a response. As nacre builds up in layers, it surrounds the irritant forming a pearl. Pearls that form within tissues generally do so when mantle epithelial cells are dislodged into the tissue
Pearl oyster	bivalve molluscs of the Family Pteridae (genera *Pinctada* and *Pteria*) all members of the Family share the physiological properties that lead to the production of large pearls of commercial value

Pinctada fucata	Akoya pearl oyster producing cultured Akoya pearls
Pinctada margaritifera	the black-lip pearl oyster producing the "black" South Sea pearls
Pinctada maxima	the gold-lip or silver-lip pearl oyster producing "white" South Sea pearls
Pteria penguin	species of pearl oyster also known as the "winged pearl oyster", rainbow pearl oyster" or "penguin shell" used to primarily to produce mabé
Pteria sterna	species of pearl oyster from Central America also known as "concha nácar" or "rainbow lip pearl oyster" used to produce mabé and cultured round pearls
South Sea Pearls	pearls produced by both *Pinctada maxima* and *P. margaritifera* which are differentiated on the basis of their colour
Spat	young juvenile pearl oyster or other bivalve mollusc