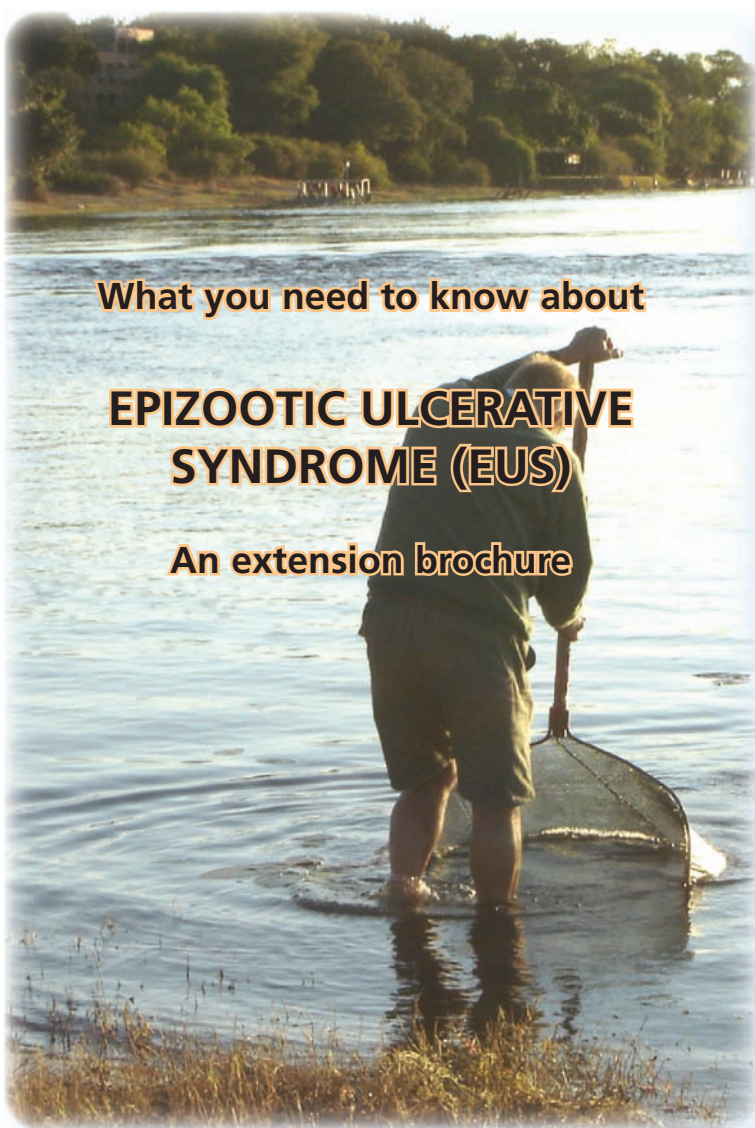


**What you need to know about**

**EPIZOOTIC ULCERATIVE  
SYNDROME (EUS)**

**An extension brochure**



To cite this document:

FAO. 2009. What you need to know about epizootic ulcerative syndrome (EUS) – An extension brochure. Rome, FAO. 33pp.



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What you need to know about

**EPIZOOTIC  
ULCERATIVE  
SYNDROME (EUS)**

An extension brochure

**FOOD AND AGRICULTURE ORGANIZATION OF  
THE UNITED NATIONS  
Rome, 2009**



*This extension brochure – What you need to know about epizootic ulcerative syndrome (EUS) – provides simple facts or frequently asked questions about EUS. This brochure is intended to a wide range of audience from fish farmers and fishermen to extension officers as well as policy-makers as a public information campaign to make available factual information about the disease so that awareness may be raised for better understanding of its potential impact.*

*This brochure, an outcome of FAO's Technical Cooperation Project TCP/RAF/3111 Emergency Assistance to Combat Epizootic Ulcerative Syndrome in the Chobe/Zambezi River System, was prepared under the technical supervision of Dr Melba B. Reantaso and Dr Rohana P. Subasinghe of the Aquaculture Management and Conservation Service, Fisheries and Aquaculture Management Division, FAO Fisheries and Aquaculture Department.*

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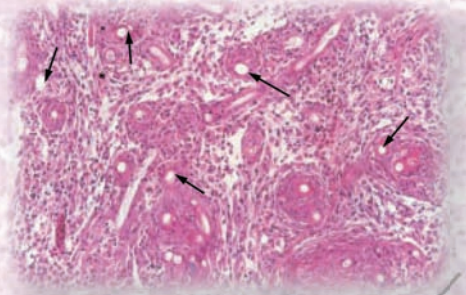
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*Barbus paludinosus* – Straightfin barb

Typical severe mycotic granulomas (black arrows) from muscle section of EUS fish (snakehead from the Philippines) (haematoxylin and eosin [H&E]).



Epizootic ulcerative syndrome or EUS is an infection caused by an oomycete fungi known as *Aphanomyces invadans* or *A. piscicida*.

*Aphanomyces* is a member of a group of organisms formerly commonly known as water moulds; they are currently recognized as belonging to the group of heterokonts or stramenopiles (OIE, 2006).

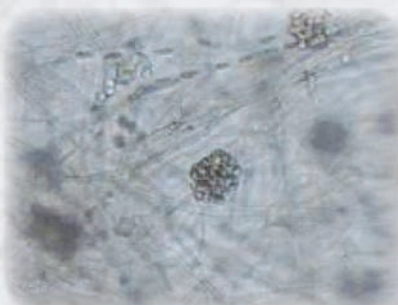
EUS is an epizootic condition affecting wild and farmed freshwater and estuarine finfish since it was first reported in 1971.

EUS is also known by other names such as red spot disease (RSD), mycotic granulomatosis (MG), ulcerative mycosis (UM) and in 2005 it was suggested to rename EUS as epizootic granulomatous aphanomycosis (EGA) (Baldock *et al.*, 2005).

# is EUS?



*Mugil* sp. – Mullet



*Aphanomyces*  
sporangium



*Aphanomyces* sporangium



# What does EUS

## Clinical signs of EUS-infected



*Plecoglossus altivelis* – Ayu



*Clarias gariepinus* – Sharptooth catfish

EUS causes ugly lesions in affected fish.

Lesions can range from small pinpoint red spots, haemorrhagic spots, localized swelling, localized raised areas on the body surface, protruding scales, scale loss, skin erosion, reddened areas of the skin under the scales, exposure of underlying musculature, and ulceration.

Ulcers can be found over a broad area with the center of the lesions being necrotic.

Lesions are observed most often in the lateral surface but can also occur on any part of the body.

# do to the fish?

fish showing the range of lesions



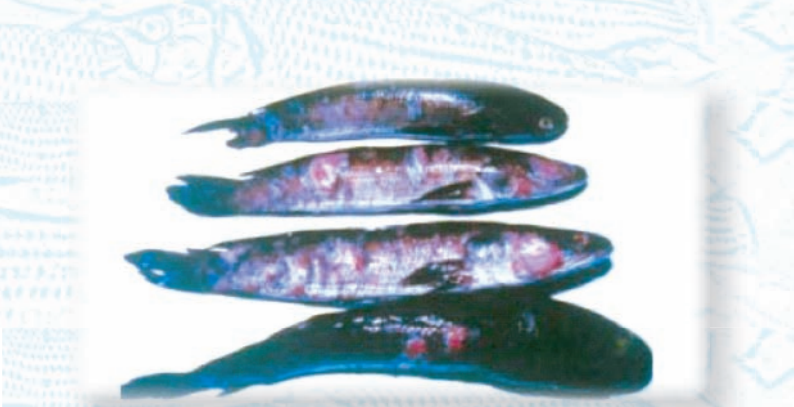
*Barbus poecheii* – Dashtail barb



*Brycinus lateralis* – Striped robber

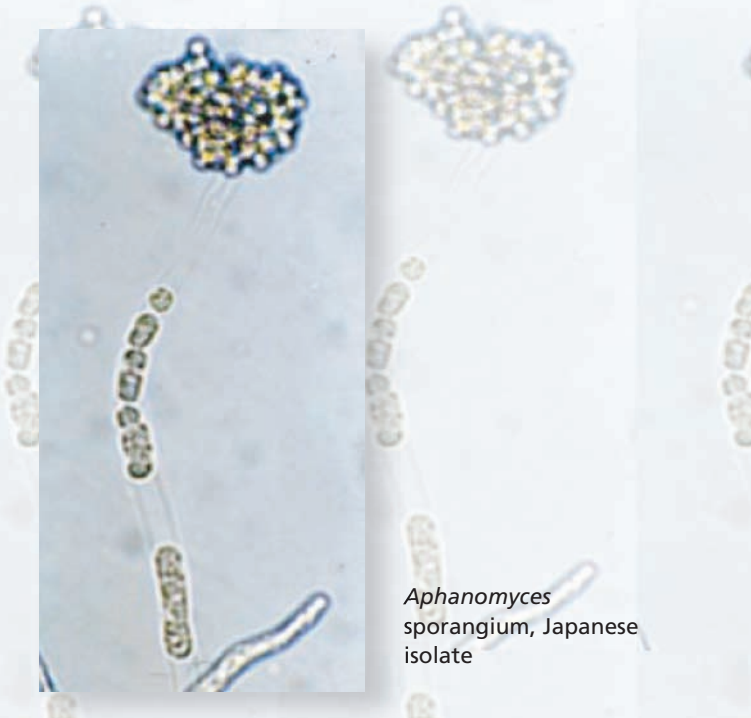


*Sargochromis codringtonii* – Green bream



*Channa striata* – Snakehead

# When does



*Aphanomyces*  
sporangium, Japanese  
isolate

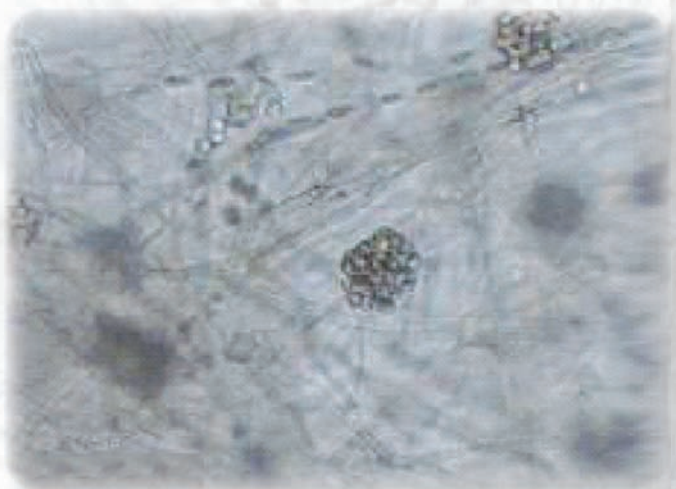
Infection in fish occurs when motile spores of the fungi *Aphanomyces invadans* in the water or other carriers/vectors are attracted to the skin of the fish.

The spores penetrate the skin and germinate, forming fungal filaments or hyphae.

The hyphae invade widely into the surrounding skin and deeply into the underlying muscle tissues, resulting in extensive ulceration and destruction of tissues.

The sporangia are narrow, with diameters similar to that of the hyphae.

# EUS occur?



*Aphanomyces* sporangia, Botswana isolates

A single row of primary zoospores formed within a zoosporangium are then released through the sporangium to encyst at the apical tip to form achlyoid clusters.

The main free-swimming stage of *Aphanomyces* spp. is the secondary zoospore which is discharged from the encysted primary zoospores.



# How is EUS



EUS susceptible fish  
*Serranochromis robustus* – Nembwe

Ulcerative skin lesions are common in freshwater and estuarine fishes.

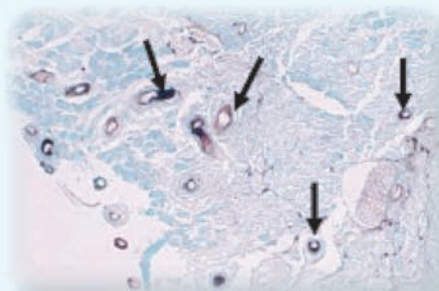
The presence of lesions often indicate contaminated or stressed aquatic environments and may be associated with a variety of infections including parasites, bacteria, viruses and fungi, as well as non-infectious causes such as for example toxic algae.

*Presumptive diagnosis* of EUS can be based on gross appearance (open dermal ulcers) (Bondad-Reantaso *et al.*, 2001) and the observation of aseptate hyphae in squashed preparations of the muscle underlying gross lesions.

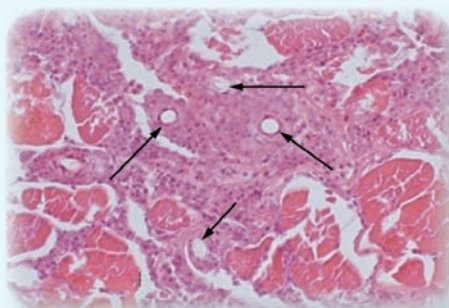
*Confirmatory diagnosis* requires histological demonstration of the typical granulomatous inflammation (OIE, 2006) around invasive hyphae or the isolation of *Aphanomyces invadans* from the underlying muscle (OIE, 2006).



# diagnosed?



Histopathology of EUS-infected dashtail barb (Botswana) showing typical mycotic granulomas surrounding the invasive fungal hyphae (stained black, black arrows) in the skin layer (Grocott's silver stain)



Typical severe mycotic granulomas (black arrows) from muscle section of EUS fish (barb from Namibia) (H&E)



Non-EUS susceptible fish  
*Hepsetus odoe* – African pike

# Which species are



*Clarias gariepinus* – African catfish



*Bidyanus bidyanus* – Silver perch

More than 50 species of both farmed and wild fish, freshwater and estuarine, are susceptible to EUS.

These include, for example:

- barbs (Africa),
- bream (Africa),
- catfishes (Africa),
- cichlids (Africa),
- churchill (Africa),
- eels (Asia),
- gobies (Asia),
- gouramies (Asia),
- Indian carps (catia, mrigal, rohu) (Asia),
- ayu (Japan),
- menhaden (United States of America),
- mullets (Asia),
- perches (Asia, Africa),
- seabass (Asia),
- seabream (Asia),
- snakehead (Asia) and
- tilapias (Africa).

# susceptible or affected?



*Hepsetus odoe* – African pike



*Brycinus lateralis* – Striped robber



*Barbus poechnii* – Dashtail barb



*Clarias gariepinus* – Sharptooth catfish



# How is EUS spread? What get infected



Successful invasion and establishment of EUS in fish requires tissue (epithelial) damage, a susceptible fish species and environmental conditions which favour sporulation of the fungi.

In some countries, outbreaks occur in wild fish first and then spread into fish ponds (Lilley *et al.*, 1998).

There are a number of risk factors (Lilley *et al.*; 1998; Baldock *et al.*, 2005; Blazer *et al.*, 2005, OIE, 2006; FAO, 2009) associated with EUS occurrence; some are predisposing factors, others are environmental conditions and biological factors that contribute to the occurrence of EUS.

Shipping movements, ballast water, fish migrations, ocean currents are potential pathways for pathogen movement.

Cross border movement of fish for aquaculture and the ornamental fish trade are proven pathways.

# factors cause the fish to with EUS?



Some EUS outbreaks are associated with heavy rainfall and flood events, drop in temperature, low alkalinity and salinity, acidified run-off water from acid sulphate soil areas.

Parasites and rhabdoviruses have also been associated with particular outbreaks, and secondary gram-negative bacteria invariably infect EUS lesions.

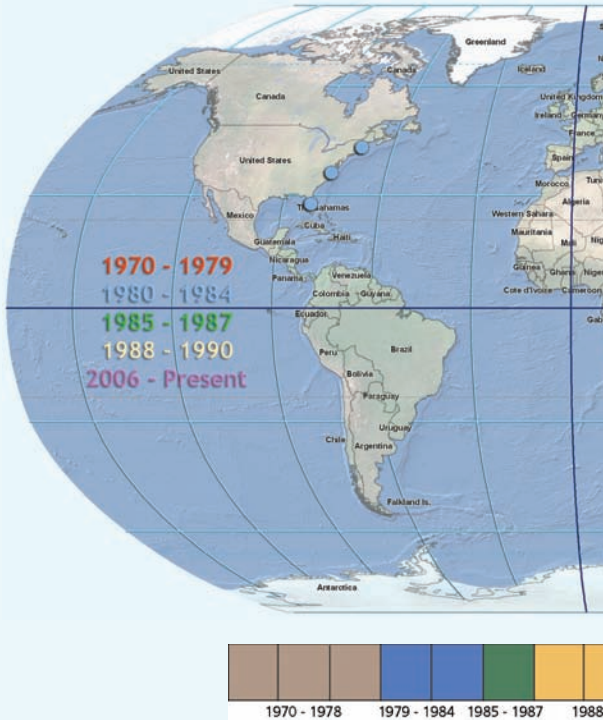


Ornamental fish (koi carp)



# Why and where is

## Map showing the current global distribution



Chronology of global occurrence of EUS; dates with question mark indicate outbreaks of ulcerative fish disease and/or unconfirmed EUS outbreaks; dates without question mark indicate year of EUS confirmation (Lilley *et al.*, 1998; Baldock *et al.*, 2005; FAO, 2009). **Japan** (1971); **Australia** (Queensland – 1972, New South Wales – 1989, Northern Territory – 1990 and Western Australia – 1994); **Papua New Guinea** (1975 – 1976?; 1982–1983?; 1986); **Indonesia** (1980?; 1993–1994); **Singapore**

EUS is one of the most serious aquatic diseases affecting finfish.

It causes high losses to fish farmers and fishermen through mortalities, market rejection and public health concerns due to the presence of ugly lesions and reduced productivity of all susceptible fish species.

There are at least 24 countries affected by the disease (FAO, 2009).

More than 50 species of finfish are susceptible to EUS.

Other indirect long-term effects include the threat to the environment and aquatic biodiversity through, for example, declining fish biomass and cause irreversible ecological damage.

# EUS a problem today?

of epizootic ulcerative syndrome (1971 to 2008)



(1977?); Malaysia (1979?; 1980); Thailand (1981); Myanmar, Lao People's Dem. Rep. and Cambodia (1983 or 1984); Viet Nam (1983?); China (1982?; 1987-1988?; 1989?); China, Hong Kong SAR (1988?); Philippines (1985); Sri Lanka (1987); Bangladesh (1988); India (1988); Bhutan and Nepal (1989); Pakistan (1996); United States of America (North Carolina, Florida and Connecticut - 1984); Botswana (2006?; 2007); Namibia (2006?; 2007); Zambia (2007?; 2008).

EUS has the potential to financially decimate those who rely on fishing for income. In addition, and perhaps more importantly, EUS outbreaks threaten food security for subsistence fishers and fishfarmers and subsequently people's physical health, as fish are an important source of animal protein for people in the affected countries.

The spread of EUS across Asia from Japan and Australia where it was first identified in the early 1970s to Pakistan in 1996 and to southern Africa in 2006 is a major epizootiological phenomenon.

EUS is an OIE-listed disease, and notification to the World Animal Health Organisation (or OIE) is required in the event of an outbreak.

# Is it safe to



The agent causing EUS does not pose any human health implications.

Except for the fish exhibiting deep ulcerations and tissue decay, which could harbour secondary pathogens which may have human health implications, the fish infected with EUS do not pose human health hazards for consumers.

However, it is recommended not to eat EUS fish unless it is properly and thoroughly cooked.



eat EUS fish?



# Can EUS-infected



Control of EUS in natural waters (e.g. rivers) is impossible.

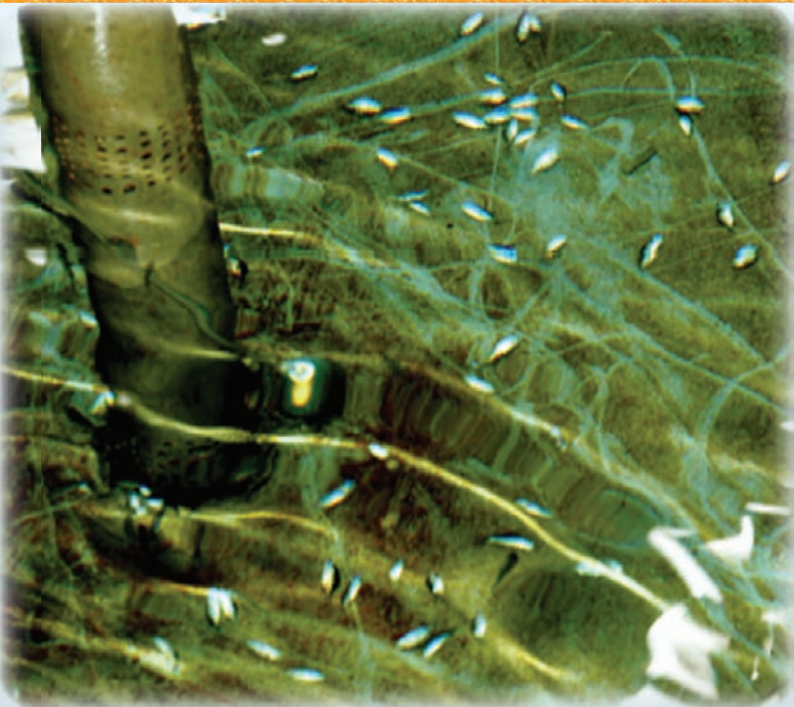
Fishfarmers whose farmed fish have been affected with EUS are encouraged to culture non-EUS susceptible species or avoid farming susceptible species during EUS season, i.e. rainfall period and low temperature season.

A strict ban on the movement of fish from infected waterways or river systems, especially those with lesions of EUS, to other waterways or river systems is recommended; diseased fish should not be moved from one fish farm to another.

Properly dried, salted and iced fish have not been reported as potential carriers of EUS, therefore trade of these products can be allowed to continue.



# fish be treated?



*Clarias gariepinus* – African catfish

# Can infection by



A number of simple biosecurity measures can minimize or prevent the spread of EUS. These include:

- All possible carriers or vectors such as freshly dead fish, birds or terrestrial animals as well as contaminated fishing gears/net and fish transport containers should be prevented from getting into water bodies or fish ponds.
- In outbreaks occurring in small, closed water bodies, liming of water and improvement of water quality, together with removal of infected fish, are often effective in reducing mortality.
- Increasing salinity in holding waters may also prevent outbreaks of EUS in aquaculture ponds.
- During dry and cold seasons, close observation of wild fish should be made to determine the presence of EUS-diseased fish in neighbouring tanks or canals, in which case, exchange of water should be avoided.

# EUS be prevented?



- EUS infected fish should not be thrown back to the open waters and should be disposed of properly by burying them into the ground or through incineration.
- Additional practical aquaculture biosecurity measures include:
  - good farm hygiene (e.g. handwashing between tanks, separation of nets/tanks/stocks, regular and correct disinfection procedures, etc.)
  - good husbandry practices
  - good water quality management
  - proper handling of fish
  - regular monitoring of fish health
  - good record keeping (gross and environmental observations and stocking records including movement records of fish in and out of aquaculture facility, etc.)
- Early reporting or notification to concerned authorities of a disease outbreak or suspicion of any abnormal appearance, behavior or other observations in fish stocks.



# What can one do disease



- Report immediately a suspected outbreak to concerned authorities (nearest fisheries or veterinary authority) and ask for guidance concerning collection of samples (see page 26)
- Take note of simple observations such as:
  - abnormal fish behaviour (e.g. fish swimming near the surface, sinking to the bottom, loss of balance, flashing, cork-screwing or air gulping (for non air-breathers) or any signs which deviates from normal behaviour
  - date and time of observed outbreaks
  - estimate of mortalities
  - species of fish affected and estimate of mortalities
  - pattern of mortality (small number of fish dying everyday, large number of fish dying at one time, etc.)
  - any unusual events

in the event of a  
outbreak?





# Can I collect for laboratory



- Live samples if available are best for laboratory examination. The fish should be packed in double plastic bags, filled with water to one third of their capacity with the remaining 2/3 volume inflated with air/oxygen. Bags should be tightly sealed (with rubber band or tape).
- If live fish which can be transported to the laboratory is not available, freshly dead or moribund fish with clinical lesions can be used.
- Using a scalpel or a blade, take samples of skin/muscle sections (<math><1\text{ cm}^3</math>), including the edge of the lesion and the surrounding tissue. Parts of internal organs may also be collected by dissecting the whole fish.
- Fix the tissue samples immediately in 10 percent formalin (10 ml of formalin in 90 ml of water preferably distilled water) in a plastic or bottled container. The amount of formalin should be 10 times the volume of the tissue to be fixed. Tissues should be fixed for at least 24 hours before processing.

# EUS samples examination?



- Fixed tissues can be wrapped into formalin-moistened tissue paper and placed into small plastic bags to prevent leakage or smell during transport.
- Make sure that samples are properly labelled with the following information: date of samples, type of tissue samples (e.g. skin, gills, muscle, kidney, other internal organs), collected, locality (place of collection), species of fish (weight and length measurements if possible), name of collector, type of fixative used (10 percent formalin, etc.).
- Samples can be packed into a padded envelope or container and sent by mail if no courier services exist.
- Call the laboratory to inform of the kind of samples collected and when they are expected to arrive or to be delivered.

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# Glossary

<b>Disease</b>	any deviation from or interruption of the normal structure or function of any part, organ, or system (or combination thereof) of the body that is manifested by a characteristic set of symptoms and signs and whose aetiology, pathology and prognosis may be known or unknown
<b>Epidemiology</b>	science concerned with the study of the factors determining and influencing the frequency and distribution of disease or other health related events and their causes in a defined population for the purpose of establishing programme to prevent and control their development and spread
<b>Epizootic</b>	affecting many animals within a given area at the same time; widely diffused and rapidly spreading (syn. Epidemic – used for human disease)
<b>Epizootiology</b>	the study of factors influencing infection by a pathogenic agent
<b>Fungi</b>	heterotrophic organisms possessing a chitinous wall, with majority of fungal species growing as multicellular filaments called hyphae forming a mycelium. Fungi are more closely related to animals than plants, yet the discipline of biology dedicated to the study of fungi, known as mycology, often falls under a branch of botany
<b>Granulomas</b>	any small nodular delimited aggregation of granular haemocytes, or modified macrophages resembling epithelial cells (epithelioid cells)
<b>Granulomatosis</b>	any condition characterized by the formation of multiple granulomas
<b>Heterokonts</b>	or stramenopiles are a major line of eukaryotes presently containing about 10 500 known species; includes the group oomycetes
<b>Infection</b>	invasion and multiplication of an infectious organism within host tissues. May be clinically benign (cf subclinical or carrier) or result in cell or tissue damage. The infection may remain localized, subclinical and temporary if the host defensive mechanisms are effective or it may spread an acute, sub-acute or chronic clinical infection (disease)

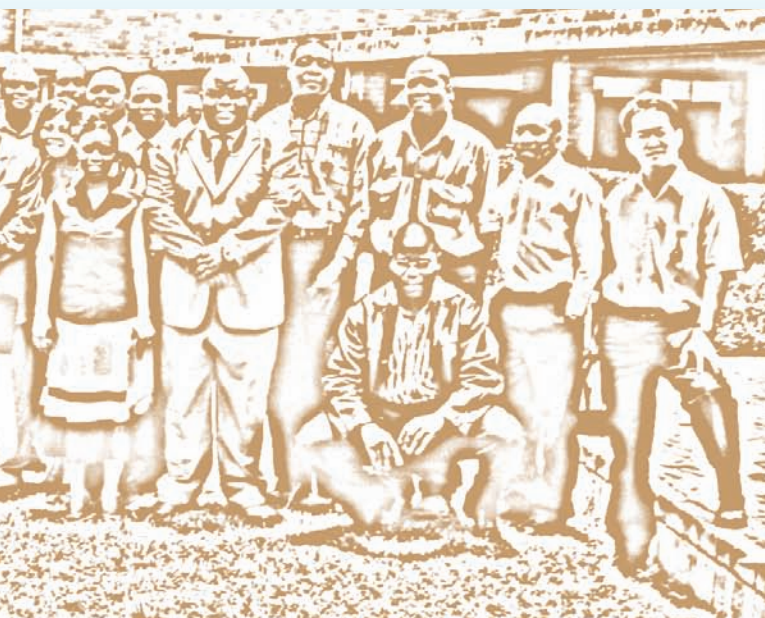
<b>Lesion</b>	any pathological or traumatic change in tissue form or function
<b>Mycology</b>	the study of fungi (Mycota)
<b>Mycosis</b>	any disease resulting from infection by a fungus
<b>Oomycetes</b>	a group of filamentous, unicellular heterokonts or stramenopiles physically resembling fungi; they are microscopic, absorptive organisms that reproduce both sexually and asexually and are composed of mycelia
<b>Outbreak</b>	the sudden onset of disease in epizootic proportions
<b>Pathogen</b>	an infectious agent capable of causing disease
<b>Predispose</b>	to make susceptible to a disease which may be activated by certain conditions, as by stress
<b>Sporangium</b>	(mycology) hyphal swelling which contains motile or non-motile zoospores; release is via a pore or breakdown of the sporangial wall (syn. zoosporangium)
<b>Spore</b>	infective stage of an organism that is usually protected from the environment by one or more protective membranes (syn. zoospores)
<b>Sporogenesis</b>	formation of or reproduction by spores; sporulation
<b>Stress</b>	the sum of biological reactions to any adverse stimuli (physical, internal or external) that disturb the organism's optimum operating status
<b>Susceptible</b>	an organism which has no immunity or resistance to infection by a another organism
<b>Syndrome</b>	an assembly of clinical signs which when manifest together are indicative of a distinct disease or abnormality (syn. pathognomic/pathognomonic)
<b>Ulcer</b>	excavation of the surface of an organ or tissue, involving sloughing of necrotic inflammatory tissue



# Acknowledgements



The following individuals are gratefully acknowledged for providing comments and contribution to this publication: Drs S. Kanchanakhan and C.V. Mohan (Thailand), Drs B. Hang'ombe and M. Songe (Zambia); Ms B. Nyandat (Kenya); Dr R. Perera (Australia); Dr B. Van der Waal and Mr E. Kingelhoeffer (Namibia); Dr F. Corsin (Viet Nam); Dr P. Ziddah (Ghana); Mr W. Waisma Mwanja and Mr A. Peter (Uganda); Mr G. Moyo (Zimbabwe); Dr G. Njunga and Mr G. Kanyerere (Malawi); Mr S. Nengu (Botswana); Ms E. Justiz and Mr F. Ditomene (Angola) and Mr R. Rafael (Mozambique).



From the FAO Fisheries and Aquaculture Department, Mr Jia Jiansan (Aquaculture Management and Conservation Service); Ms Françoise Schatto and Ms Tina Farmer (Fisheries and Aquaculture Information and Statistics Service); and from the FAO Emergency Operation Service, Ms Angela Hinrichs, Ms Jacqueline Were and Ms Nina Brandstrup are also gratefully acknowledged for support and assistance.