FISH HEALTH MANAGEMENT

PDFs available online in

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HEALTH MANAGEMENT OF SEA BASS: English
(Dicentrarchus labrax)

Developed by AQUARK Greece, AMC Ltd Ireland and Stirling Institute of Aquaculture, UK

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AQUALEX Fish Health Toolset

The **AQUALEX Fish Health Toolset** was developed in order to combine teaching and learning in a specific subject area (fish health) with basic language learning in those languages most important in the European aquaculture industry. Its fish health materials should not be regarded as a comprehensive fish disease manual for the selected species, for there are many such reliable and comprehensive publications.

The following topics and species were selected by industry users as well as VET providers:

- Fish Health/Disease Management for Trout, Sea Bass, Turbot and Carp
- Fish Farm Quality Assurance Manual
- Basic Techniques for Fish Haematology

A unique feature of the **AQUALEX Fish Health Toolset** consists in its supporting language units, designed to help users not only to find the information/content they need, but also to enable them to communicate in the workplace in their targeted language.
For those users who need fast access to reliable multi-lingual information on matters concerning fish health, the Toolset contains a **multi-lingual fish diseases glossary** in English, French, German, Spanish, Italian, Greek, Norwegian, Polish, Hungarian, Turkish and Galician.

For those users who need to learn or to improve their language skills, the Toolset provides online language lessons in the above-mentioned languages.

The **AQUALEX Fish Health Language Support** is available at three levels.

Level 1 (Common European Framework of Reference for Languages - CEFR) levels A1, A2)

The priority for many **first-time language learners** is to understand and convey simple but vital pieces of information (i.e., keywords) in a new language. The AQUALEX language lessons for Beginners (**English, French, Spanish, Greek, Norwegian, Polish, Hungarian, Turkish, Portuguese, Swedish** and **Galician**) are designed to enable complete beginners to use their native language knowledge of familiar items in the workplace/laboratory, in step-by-step visual presentations with audio input (www.aqualex.org and www.pescalex.org Level I) This method gives them a chance to fast-track their language learning at their chosen time and at their own speed.

Level 2 (CEFR levels B1, B2)

Having picked up the first essentials in a user-friendly way, **students or workers** aiming to improve their language skills can progress at their own speed through the Toolset Fish Health course materials in **English, French, Spanish, Greek, Norwegian, Polish, Hungarian, Turkish** and **Galician**, online (www.aqualex.org or www.pescalex.org Level II). They can acquire vocationally relevant information on the above aspects of fish health, either in the native or the targeted language.

Level 3 (CEFR levels C1, C2)

For the seasoned practitioner, Ph.D student or academic, the Toolset contains two **multi-lingual fish diseases and aquaculture glossaries** in **English, French, German, Spanish, Italian, Greek, Norwegian, Polish, Hungarian, Turkish and Galician**. These online resources present high-level information and detailed definitions in the accepted academic format.

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SEA BASS VIRAL DISEASES

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Viral Encephalopathy and retinopathy (VER) Viral Nervous Necrosis (VNN)

Epidemiology

Viral encephalopathy and retinopathy (VER) may be caused by several viruses belonging to the family Nodaviridae. The pathogen viral nervous necrosis virus (VNNV), is a nodavirus distributed world-wide with four strains identified (see table below), and several other strains under investigation. The virus characterization carried out from a few isolates confirmed that they belong to genotype RGNNV, which is routinely isolated from cultured sea bass.

Barfin flounder nervious necrosis virus	BFNNV
Redspotted grouper nervous necrosis virus	RGNNV
Striped jack nervous necrosis virus	SJNNV
Tiger puffer nervous necrosis virus	TPNNV

- Affects more than 30 species mainly of marine origin (Munday et al.) Approximately 20 species belonging to about 10 families, most being recorded in the Pacific area, e.g., barramundi, striped jack, Japanese flounder. Among farmed European species, the disease has been detected in sea bass, gilthead sea bream larvae, turbot and halibut.
- Larval mortality can reach 90-100% in a few days
- Mortality is very low in juvenile sea bass (2g to 200g) in some outbreaks
- Mortality increases slowly (e.g. 0.5% per day) but after several weeks it may reach 50%
- Present in the Mediterranean area since 1991, having been detected in French hatcheries in larval and juvenile stages. During 1995 severe epizootics affecting juveniles and adult fish were detected in many regions (Le Breton et al., 1997; Bovo et al., 1999).
- The high resistence and long persistence of nodaviruses in the marine environment present favourable preliminary conditons for endemic situations to be established, particularly in respect of wild susceptible fish populations.

- **Predisposing factors**
  - age
  - temperature - the disease is always significant in sea bass larvae, at 18°C. Among juveniles, one-year-old fish are more susceptible than 2-year- old fish and the outbreaks occur when the water temperature reaches 22-25°C (Le Breton, 1999).
  - poor water quality
  - enclosed conditions
  - transport fish manipulation
  - all stress factors

Naturally infected fish showing signs and mortality	
1	Red spotted grouper (Epinephelus akaara)
2	Brown spotted grouper (E. tauvina)
3	Malabar grouper (E. malabaricus)
4	Orange spotted grouper (E. coioides)
5	Kelp grouper (E. moara)
6	Dragon grouper (E. lanceolatus)
7	Yellow grouper (E. awoara),
8	Black rock cod (E. fuscoguttatus)
9	Sevenband grouper (E. septemfasciatus)
10	Humpback grouper (Cromileptes altivelis),
11	Striped jack (Pseudocaranx dentex)
12	Greater amberjack (Seriola dumerili)
13	Snubnose pompano (Trachinotus blochii)
14	Yellow-wax pompano (Trachinotus falcatus)
15	Red drum (Sciaenops ocellatus)
16	Japanese parrotfish (Oplegnathus fasciatus)
17	Cobia (Rachycentron canadum)
18	Golden grey mullet (Liza auratus)
19	Firespot snapper (Lutjanus erythropterus)
20	Barfin flounder (Verasper moseri)
21	Japanese flounder (Paralichthys olivaceus)
22	Tiger puffer (Takifugu rubripes)
23	Asian sea bass (Lates calcarifer)
24	Japanese seabass (Lateolabrax japonicus)
25	Chinese catfish (Parasilurus asotus) (FW)
26	Guppy (Poecilia reticulata)
27	Oblong rockfish (Sebastes oblungus)
28	European eel (Anguilla anguilla)
29	Barramundi (Lates calcarifer)
30	Striped trumpeter (Latris lineata)
31	Australian catfish (Tandanus tandanus) (FW)
32	Sleepy cod (Oxyleotrix lineolatus) (FW)
33	Winter flounder (Pseudopleuroctes americanus)
34	White sea bass (Atractoscion nobilis)
35	Atlantic cod (Gadus morhua)
36	Haddock (Melanogrammus aeglefinus)
37	European sea bass (Dicentrarchus labrax)
38	Shi drum (Umbrina cirrosa)
39	Sharpsnouth seabream (Diplodus puntazzo)
40	Brown meagre (Sciaena umbra)
41	Dusky grouper (Epinephelus marginatus)
42	White grouper (Epinephelus aeneus)
43	Blacktip grouper (Epinephelus alexandrinus)
44	Cod (Gadus morhua)
45	Halibut (Hippoglossus hippoglossus)
46	Common sole (Solea solea/Solea vulgaris)
47	Russian sturgeon (Acipenser gueldestaedi) (FW)
48	Turbot (Scophthalmus maximus)

Naturally infected fish	
1	Axillary seabream (Pagellus acarne)
2	Black goby (Gobius jozo)
3	Brown meager (Argyrosomus regius)
4	Gilthead sea bream (Sparus aurata)
5	Poor cod (Trisopterus minutus)
6	Red mullet (Mullus barbatus)
7	Scorpionfish (Scorpaena sp.)
8	Striped red mullet (Mullus surmuletus)
9	Thinlip mullet (Liza ramada)
10	Dusky grouper (E. marginatus)
11	White grouper (E. aeneus)
12	Blacktip grouper (E. alexandrinus)
13	Experimental infected fish
14	Tilapia (Oreochromis mossambicus)
15	Wolffish (Anarchis minor)

Transmission

Vertical and horizontal transmission is possible.

- Disease occurring in very young larvae favours the theory of transmission to eggs by spawners
- The virus has also been detected in the ovary and fertilized eggs of striped jack
- Horizontal transmission has been experimentally demonstrated in striped jack and Barramundi. It seems likely that in farmed Mediterranean sea bass the disease can be transmitted from diseased fish to healthy ones.
- Spawners may constitute an important virus reservoir, as may some wild fish, e.g. mullet.
- Horizontal transmission, often suspected in the field, has been confirmed by experimental infection
- The high persistence of the viral agent in the marine environment and the existence of a relative high number of susceptible wild species may enhance the risk for the establishment of endemic conditions
- Vertical transmission from sub-clinically infected broodfish is highly suspected for some species and believed to be an important route of infection in farmed fish
- Outbreak evolution
  - First outbreaks were linked with introduction of infected sea bass stock in one farm. The disease spread to three other farms 10 miles apart from each other, within weeks.

- Lack of communication between the farms led to the theory that wild fish were the major responsible for the transmission of VER infection from one farm to another.
- Conversely, sporadic mortalities affecting different grouper species, were observed in Italy and Greece. Symptomatic Blacktip grouper (*E. alexandrinus*) were found close to infected farms in Greece, whereas in Italy dying dusky (*E. marginatus*) and white groupers (*E. aeneus*) were observed in sites with no operational farms.

Clinical Picture

Behaviour

- Affected fish show erratic swimming in circles, on their sides or belly up
- Some maintain a vertical position with the head or caudal peduncle above the water surface,
- Loss of equilibrium and fish appear hyperactive in the water.
- Loss of appetite and lethargy have been noted in cultured halibut

External Appearance

Erosions affecting epithelium tissue of the cephalic area have been observed due to traumatic injuries.

Internal signs

Swim bladder hyperinflation has often been recorded in European sea bass (*Dicentrarchus labrax*), barramundi (*Lates calcarifer*) and striped jack (*Pseudocaranx dentex*) (Breuil et al.; Munday et al., 2002)

Diagnosis

- Presumptive diagnosis is based on clinical signs
- Histopathological analysis with very characteristic lesions in histological sections usually sufficient to confirm the diagnosis
- Extensive vacuolation of the central nervous system and retina and sometimes intra- cytoplasmic inclusions are sparse.
- Immunohistochemistry or IFAT using specific antibodies may assist with the diagnosis.
- Recovery of the viral antigen or its genome have been frequently detected by different techniques from the gonads
- According to OIE (2006)
- 6) the methods recommended for diagnostic purposes in clinical diseased fish are:
    - virus isolation on SSN-1 or E 11 cells,
    - Immunofluorescence (IFAT)
    - Immunohistochemistry (IHC)
    - Reverse transcriptase-polymerase chain reaction (RT-PCR)
- Virus isolation on SSN-1 or E11 cells, followed by identification with RT-PCR or IFAT, is the only suggested method for positive identification of the pathogen.
- To determine carrier status more sensitive techniques are necessary which may include ELISA or PCR but this detects the presence of the pathogen only and not the disease.

Prevention

- No vaccines so far available.
- Prevention of outbreaks in hatcheries
    - Detection and the elimination of covert broodstock carriers
    - Sterilization of the inflow water
- Prevention of outbreaks in growing juveniles,
    - prevention is dependent on the existence of disease-free zones
    - If such zones exist, farms should be stocked with juveniles coming from disease-free hatcheries

Treatment

- When the disease occurs, its effects can be limited through the reduction of stress factors and the use of the usual sanitary precautions.
- No treatment of viral encephalopathy and retinopathy is possible.

Nervous Necrosis due to Rickettsia-like organisms (RLO)

Epidemiology

- Though Rickettsia-like organisms were reported in salmonids (U.K., Norway and Chile), the first report of a systemic infection in farmed seabass was in 2004 in Greece.
- All ages can be infected by this intracellular bacterium with outbreaks of RLO in seabass reported when water temperatures are 12 to 16^0C.

Temperature

- Outbreaks can occur when water temperatures are 12-$16C^0$. For sea bass species disease outbreaks can result in 30-80% mortalities.

Mortality

- Chronic infection in some fish species producing low level mortalities over the duration of the production cycle.

Clinical Picture

Behaviour

- Affected fish appear lethargic
- Abnormal (erratic) swimming behaviour and loss of orientation
- Infected fish stop feeding.

External Appearance

- Affected fish are discoloured with pale gills, having skin lesions which may be superficial to more in-depth raised ulcerated lesions.

Internal signs

- Ascites, with petechial haemorrahges in the gastrointestinal tract, swimbladder and visceral fat
- Liver, kidney and spleen are often swollen and pale.
- Sometimes the liver is haemorrhagic with/without numerous nodules.

Diagnosis

- A combination of classical signs of ill health:
- loss of appetite and lethargy
- nervous clinical signs: erratic swimming and loss of orientation
- positive histopathology can identify nervous necrosis caused by the presence of the intracellular RLO bacteria.
- The bacteria may be difficult to recover from primary isolation and so positive Giemsa stained tissue or immunohistochemistry can be used to detect the presence of the bacteria within the affected tissues.
- histopathology results often show necrosis of the integument, subcutaneous cranial skeletal system with mixed leucocyte dermatitis and perichondritis
- granulocytes are the predominant cell type.

Prevention

- Difficult to prevent the spread of the infection in seawater
- Pre-screening of broodstock and disinfection of fertilised eggs are good precautions against the introduction of the pathogen onto the fish farming site.
- Commercial vaccines are available for salmonid rickettsia infections but their use in other fish species is unknown and no specific vaccine is available for seabass.

Treatment

- Antibiotic treatments are very difficult due to the intracellular nature of the pathogen where disease outbreaks can be controlled more by modification of temperature.

Lymphocystis disease (LCD)-Iridovirus in sea bream

Epidemiology

- Caused by an Iridovirus (large icosahedral 130-380 nm in diameter.)
- First described by (Lowe et al., 1874)
- Affects large number of fresh, brackish and marine cultured and wild teleost (Anders and Darai, 1985: Tidona and Darai, 1999)
- Chronic disease associated with low mortality
- Lymphocystis is self-limiting and the clinical signs usually disappear spontaneously (Nigrelli and Ruggieri, 1965)
- The disease occurs mainly at temperatures ranging between 22-27°C (Bovo et al., 1998)
- In seabream (*Sparus aurata*), the disease is observed mainly in hatcheries with high stocking density. In larger fish mortality is usually less significant.
- Horizontal transmission seems to be the most common route of infection.

Susceptible Species	
Gilthead seabream (*Sparus aurata*)	Paperna et al. (1982)
	Garcia-Rosado et al., (1999)
	Masoero et al., (1986)
	Menezes et al., (1987)
	Basurco et al., (1990)
	Moate et al., (1992)
	LeDeuff and Renault, (1993)
Red drum (*Sciaenops ocellatus*)	Colorni and Diamant, (1995)
Sharpsnout seabream (*Diplodus puntazzo*)	Alborali et al., (1996)
Cultured sole (*Solea senegalensis*)	Alonso et al. (2005)
Wild blackspot (*Pagellus bogaraveo*)	Alonso et al. (2005)

Clinical Picture

Behaviour

- Usually normal behaviour
- Fish stop eating
- Lethargic
- Cannibalism and biting on cutaneous nodules leads to fin loss and secondary infections

External appearance

- Characteristic skin and fin grey-whitish nodules that look like neoplastic lesions
- Raised clusters of pebble-like appearance.
- Nodules consist of hypertrophied connective cells

Internal Signs

- Lymphocystis cells often appear in the internal tissues, particularly the muscle, peritoneum and on the membranes covering other tissues.

Diagnosis

- Evident cutaneous lesions lead to presumptive diagnosis.
- Histopathology provides definitive diagnosis and the lesions consist of hypertrophied connective cells resembling neoplastic lesions.
- Electron microscopy is required to confirm the presence of typical icosahedral virions.
- Recovery of the pathogen can be performed using the following cell-lines

GHSBL-1 (Comuzzi et al., 1993)
SAF-1 (Perez-Prieto et al., 1999)
GCO and GCK (Zhang et al., 2003)

- Additional tests to confirm lymphocystis infections are
  - ELISA (Lorenzen and Dixon, 1991) and
  - Polymerase chain reaction (PCR) (Schnitzler and Darai, 1993; Tidona et al., 1998; Alonso et al., 2005)

Prevention

- It is necessary to prevent the entry of the causative agent by UV treatment of the hatchery inlet water.

Treatment

- LCD control is very difficult

Epitheliocystis (sea bream)

Epidemiology

- Host range of epitheliocystis includes over 39 freshwater, marine and anadromous fish species from both warm- and cold-water environments (Frances et al., 1997)
- The epithelicystis agent is a member of the Chlamydiales.
- Group of related organisms that produce similar pathology in different hosts (Nowak and Clark, 1999).
- Intracellular microorganisms probably belonging to the genus Chlamydia (Paperna, 1977; Desser et al., 1988).
- Epitheliocystis infections have been found in many wild and farmed fish, but only in a few of them was it associated with mortalities. In most cases it is very difficult to establish the relationship between pathology due to epitheliocystis and mortalities.

Susceptible Species	
Cultured fish	**Wild fish**
Seabream (*Sparus aurata*)	Grey mullet (*Liza ramada*)
Red sea bream (*Pagrus major*)	Amberjack (*Seriola dumerilii*)
Grass carp (*Ctenopharyngon idella*)	*Salvenilus mamaycush* (Turnbull, 1994).
White perch (*Morone americanus*)	
Striped bass (*Morone saxatilis*)	
Yellowtail (*Seriola mazatlana*)	
Amberjack (*Seriola dumerilii*)	
Common grey mullet (*Mugil cephalus*)	
Rainbow trout (*Oncorhynchus mykiss*)	
Lake trout (*Salvenilus mamaycush*)	
Bartail flathead (*Platycephalus* sp.)	

Disease

- Widespread disease resulting in the formation of cysts in the gill epithelium
- Cysts (hypertrophic host cells filled with the pathogen) may appear as transparent white to yellow capsules on the gill filaments
- The enlarged host cells range from 10 to 400µ m in diameter and are frequently surrounded by squamous or cuboidal epithelial cells (Turnbull, 1994).

Mortality

The species in which mortalities have been associated with epitheliocystis are listed above (Turnbull, 1994; Miyaki et al., 1998)

- The mortality in some batches of cultured juvenile fish ranges from 4-100 %.
- Chlamydia-like organisms (CLO) only have been associated with mortalities
- Limited host response
- Low or no mortality associated with infection.
- Heavy infection may result in severe mortality among juvenile fish (especially sea bream fry)

Transmission

- Waterborne transmission
- Horizontal transmission has been proved by means of cohabitation experiments
- Contaminated nets or other equipment can be a cause of spreading the infection in culture facilities (Paperna, 1977)

Temperature

- Wide temperature range, but more prevalent during the spring and summer months.
- Highest incidence and severity of the disease is often associated with elevated stock densities, poor environmental conditions and multiple infections with other pathogens

Clinical picture

Behavioural changes

- No external signs in slightly infected fish
- Heavily infected fish breathe rapidly
- Lethargy

External Appearance

- Normal behaviour in slightly infected fish
- Heavily infected fish may show excess mucus production around the gills,
- flared opercula

Internal signs

- No specific internal pathology

- Massive hyperplasia of the epithelial tissue and large areas of necrosis in heavy infections

Diagnosis

- Small white cysts on the gill lamellae provide a provisional diagnosis.
- Microscopic examination of stained tissue sections shows enlarged epithelial cells containing large inclusions.
- Histological observation with light microscope shows hypertrophied epithelial cells containing a grainy basophilic inclusions
- Electron microscopy is required for definitive diagnosis.
- No serological techniques are available for identification of the CLO or for the diagnosis of infection.
- The epitheliocystis organism has never been cultured *in vitro*.

Prevention

- Inlet water may be sterilized using ultraviolet radiation.
- Disinfection of nets and other equipment and maintainance of high level of biosecurity on site.
- Any affected fish should be immediately quarantined.
- There are no vaccines available

Action

No legal action required.

SEA BASS BACTERIAL DISEASES

- **Vibriosis**
  - ***Vibrio anguillarum***
  - ***V. alginolyticus***
  - ***Vibrio vulnificus***

- ***Tenacibaculum maritimum*** **(formerly** ***Cytophaga marina*** **and** ***Flexibacter maritimus*****)**

- **Fish mycobacteriosis, "fish turberculosis"**

- **Enteric Redmouth diease (ERM)**

- **Epitheliocystis (Chlamydiales)**

- ***Streptococcus iniae***

- **Pasteurellosis (*Photobacterium damsela* subsp. piscicida)**

- ***Aeromonas*** **spp.**

- ***Pseudomonas anguilliseptica***

Vibriosis by *Vibrio anguillarum*

Epidemiology

- Primary systemic infections by a pathogenic *Vibrio* species that are differentiated from non-specific infections where a large number of secondary or opportunistic *Vibrio* spp. can be involved.
- 23 O serotypes among *V. anguillarum* (Sorensen and Larsen, 1986; Pedersen et al., 1999)
- Only serotypes O1, O2 and less serotype O3, have been associated with mortalities in farmed and wild fish (Tajima et al., 1985; Toranzo and Barja, 1990, 1993; Larsen et al., 1994)
- Using genetic studies, homogenicity was detected within the serotype O1 strains regardless of area and host.
- Remaining serotypes are considered to be environmental strains and they are rarely isolated and associated with vibriosis in fish.
- The most common species affected by serotype O3 are eel and ayu.
- Other fish pathogenic vibrios
    - *Vibrio ordalii*
    - *V. damsela*
    - *V. vulnificus*
    - *V. algilolyticus*
    - *V. parahaemolyticus*
    - *V.carchariae*
    - *V. salmonicida*, the agent of the cold water Vibriosis is Hitra disease.

- Vibriosis is widely distributed throughout the world causing typical haemorrhagic septicaemia in a great variety of warm and cold water fish species of economic importance, including salmon, rainbow trout, turbot, sea bass, sea bream, striped bass, cod, eel and ayu.

Susceptible species	
42 fish species are affected by *Vibrio anguillarum* (Colwell and Grimes, 1984).	
Wild fish	**Cultured fish**
Eel (*Anguilla anguilla*)	sea bream (*Sparus aurata*) (Anderson, 1990)
Sea mullet (*Mugil cephalus*) (Burke, 1981)	sea bass (*Dicentrarchus labrax*) (Anderson, 1990)
golden grey mullet (*Mugil auratus*) (Blanch and Jofre 1992)	sharpsnout sea bream (*Diplodus puntazzo*) (Anderson, 1990)
Saithe (*Pollachius virens*), (Håstein and Smith, 1977; Myhr et al., 1991)	Striped bass (*Morone saxatilis*)
wild turbot (*Scophthalmus maximus*) (Toranzo et al., 1985)	Coho salmon (*Oncorhynchus kisutch*)
big scale sand smelt (*Atherina boyeri*) (Yiagnisis et al., 2005)	Cod (*Gadus morhua*)
ayu (*Plecoglossus altivelis*) (Muroga et al., 1984)	Channel catfish (*Ictalurus punctatus*)
Sand smelt (*Atherina boyeri*)	Japanese eel (*Anguilla japonica*)
Gadus virens	Turbot (*Scophthalmus maximus*)
	Yellowtail (*Seriola quinqueradiata*)
	Winter flounder (*Pseudopleuronectes americanus*)
	Pink salmon *(Oncorhynchus gorbuscha*)
	Rainbow trout (*Oncorhynchus mykiss*)
	Atlantic salmon (*Salmo salar*)

- World-wide distribution
- Temperatures during outbreaks vary extensively and depend on the fish and/or vibrio species or strain
- Studies have shown that *Vibrio anguilarum* is able to survive in sea water for more than 50 months.
- Sediment, seawater and invertebrate organisms can act as reservoirs of the pathogen. However, strains isolated from diseased fish appeared ecologically different from the environmental ones (Fouz et al., 1990).
- The bacterium can enter through skin, fins, gills and anus (Kanno et al., 1989). It survives for a long period in the sediment of the sea bottom, in the water and in invertebrate organisms. In seawater microcosms it showed the capacity to survive for more than 50 months (Hoff, 1989)

- A salinity of 5‰ proved lethal to *V. anguillarum* harvested in the late-exponential growth
- Vibriosis in Northern hemisphere usually appears from spring to autumn, particularly when the temperature is rising or falling.

Transmission

  - through the water by infected carrier fish (possibly wild fish) or
  - by contaminated farm equipment.
  - Many *Vibrio* species, including pathogenic strains, can survive a long time in sediments and in the water column as well as within invertebrates so eradication can be difficult.
- High stocking densities on the farm combined with high organic pollution can add to fish susceptibility and can result in long-term chronic outbreaks.

Clinical picture

Behavioural changes

- In acute cases the onset of mortality from a true *Vibrio* infection is very rapid
- Total mortality in acute could be up to 80%.
- In chronic cases of *Vibrio* infections can ocurr resulting in low but constant mortality over a long time. Chronic cases are associated with "stressful" factors or inadequate husbandry/management, (high stocking denstities).
- Fish stop feeding and may become lethargic in chronic cases
- In acute cases rapid mortalities occur with no symptoms

External Appearance

- Per-acute conditions (mainly in juveniles) may have no changes in appearance
- Anorexia and skin darkening
- Red bloody lesions around the anus and/or at the basis of fins
- Sometimes skin-muscle swellings may appear and become ulcerated
- Gills are pale due to severe anaemia

Internal Signs

- Internal lesions involve all the viscera
- Congestion, haemorrhage and oedema
- Fibrinous peritoneal adhesions can be found in chronic forms.

Prevention

- Avoid high farming densities, organic pollution and all stress factors although some very pathogenic strains can cause the disease without related stress factors
- Good husbandry and management practices with optimal feeding and stocking densitity and optimal water quality
- Limit contamination, fallowing of sites , usual sanitary precautions
- Application of commercial vaccines against some pathogenic strains
- Injectable or bath preparations are available, the former are considered more effective, but require additional staff and/or machines
- Limited evidence that application of vitamins and immunostimulants may reduce the severity of an infection but it will not prevent an outbreak
- Control of Vibriosis should be based on systematic vaccination programme

Treatment

- In feed antibiotic treatment for 10 days
- However, a medicated feed may not be sufficient to kill the bacteria and persistence in the
- marine environment may lead to re-infection.
- Any diseased fish should be quickly removed and disposed of to limit the spread of the disease within the fish population.
- Several antibacterial drugs are available which may be effective provided that the bacterial strains involved are not resistant

Vibrio vulnificus

Epidemiology

- *Vibrio vulnificus* is a bacterial disease which results in vibriosis in farmed fish produced in the Mediterranean region.
- This is a marine bacterial species, often recovered in hatcheries and can affect fish in tropical and warm brackish waters.
- It is also a potential pathogen for humans and other aquatic organisms (Amaro and Biosca, 1996; Bisharat et al., 1999; Dalsgaard et al., 1996).
- There are three recognised biotypes:
    - Biotype 1 is often associated with infections in fish and shellfish and can result in food poisoning in humans,
    - Biotype 2 has been isolated from infections in eels and invertebrates but it has also caused illness and wound infection in humans who handle infected animals and
    - Biotype 3 causes severe wound infection and bacteraemia in humans; this has been reported in Israel only.
    - Biotype 1 is the most geographically widespread.
    - Majority of the strains belonged to biotype 1, biotype 2 was detected in seawater.
- *V. vulnificus* infections cause vibriosis resulting in a bacterial hemorrhagic septicaemia in infected animals.
- The disease can spread through water. A capsule seems to be essential for waterborne infectivity (Amaro et al., 1995)
- Survival in brackish water or attached to eel surfaces for at least 14 days
- Spread of the disease is depending on temperature and salinity
- Water Temperatures from 8 to 31^{o}C
- Salinities between 1 and 34‰.
- It can also infect eels through the gastrointestinal tract by contaminated food
- Main portals of entry into the eel body are the gills (Marco-Noales et al., 2001)
- The eel pathogen *V. vulnificus* biotype 2 serovar E, is the only one involved in both epizootics of eel vibriosis and sporadic cases of human infections.
- High densities of *V. vulnificus* were found in the intestinal contents of fish that consumed molluscs and crustaceans in Alabama and Gulf of Mexico (De Paola et al., 1994)
- Seawater can serve as a reservoir and might facilitate spread of *V. vulnificus* biotype 2 to eels but there are no documented examples of disease transmission between wild and farmed fishes.

Susceptible species	
Wild fish	Cultured fish
Pomacentrus trichourus (Gulf of Eilat) (Diamant et al., 2004)	*Anguilla anguilla*
Variola louti (Gulf of Eilat)	Sea bass (Tunisia and Greece)
Wild fish eels, (Hoi et al., 1998)	Sea bream (Tunisia and Greece)
Eelpouts (Hoi et al., 1998)	
Flounders (Hoi et al., 1998)	

- Zoonotic impact
    - Eels can transmit *V. vulnificus* to humans as has been shown in at least four clinical cases (Veenstra et al., 1993; Dalsgaard et al., 1996)
    - Septicaemia occurs mainly in people who have eaten raw seafood.
    - *V. vulnificus* causes wound infections by entering pre-existing skin lesions during exposure to seawater

Clinical Picture

Behavioural changes

- Infected fish appear lethargic
- Infected fish stop eating

External Appearance

- Haemorrhagic ulcers often develop on the mouth or skin surface.
- There may also be lesions within the muscle.
- In some cases this can become a haemorrhagic ulcer with a white rim and a black pigmented halo is produced surrounding the ulcer.
- Gills can become pale due to anaemia.

Internal clinical signs

- The fish have a haemorrhagic septicaemia
- Spleen and kidney are pale and become necrotic.

Diagnosis

- Bacterial isolation from internal organs onto
    - General purpose agar supplemented with 2% NaCl.
    - Selective agar like
        - Cellobiose-polymyxin B-colistin (CPC) agar (Massad and Oliver, 1987)
        - *Vibrio vulnificus* medium (VVM) with eel serum (Sanjuan and Amaro, 2004) for virulent strains of biotype 2 E serovar.
- Isolates can be identified using primary techniques and biochemical profiles, however, to differentiate the strains genetic ribotyping has been performed.
- Agglutination with specific antisera to *V. vulnificus* serotype E (biotype 2) can also be performed.
- Histopathological changes in gills and internal organs (Bullock, 1977).

V. alginolyticus

- There are reports on the isolation of *Vibrio alginolyticus* from cultured and wild fish species.
- Many isolates are probably opportunistic, unable to invade the tissues of healthy, non-stressed fish and unable to cause a contagious disease.
- Ubiquitous in seawater
- Isolated from different marine organisms (Carli et al., 1993) including finfish, shellfish, and marine sediments .
- Reported to cause wounds in humans when exposed to seawater containing high numbers of the bacteria.
- Predisposing factor for the disease includes elevated stress from handling,
- Frequently involved in outbreaks causing fish mortality and great economic losses in Mediterranean aquaculture.
- High-mortality outbreaks
- Abdominal swelling in larvae of several fish species
- *Vibrio alginolyticus* should be considered a pathogen for sea bream after handling, when the mucus layer is removed and the skin is damaged (Colorni and Diamant, 1992; Balebona et al., 1998)
- Infection of silver seabream *Sparus sarba* through integumental breaches (Li et al., 2003).

Susceptible species	
Farmed fish	**Wild fish**
Juvenile Turbot (*Scophthalmus maximus*) (Austin et al., 1993)	*Heniochus diphreutes* (Israel) (Diamant et al. 2004)
Gilthead seabream (*Sparus aurata*) (Colorni et al., 1981; Balebona et al., 1998)	Wild *tilapia* (Slack, 1997) in US
Spotted sand bass (*Paralabrax maculatofasciatus* Steindachner: 1868), (Martinez Diaz et al., 2002)	Grouper (*Epinephelus malabaricus*) (Lee, 1995)
Sea bass (*Dicentrarchus labrax*) (Bakhrouf et al., 1995)	

Clinical Picture

Behavioural Changes

- See *V. anguillarum*

External Appearance

- Infected fish appear darker
- Haemorrhages which may lead to ulceration similar to *V. anguillarum* or *V. vulnificus*.

Internal Clinical Signs

- Similar wide spear septicaemia as described for *V. anguillarum*.

Diagnosis

- Bacteiral isolation from internal organs (spleen or kidney) can be taken onto general purpose agar with 2% NaCl. 1-2 days' incubation at 22^0C.
- Bacterial identification using primary and biochemical tests
- Diseased fish should also be sampled for histology

Prevention & Treatment

- See Vibriosis section

Legal

- There is no legal action required.

Flexibacteriosis by *Tenacibaculum maritimum*-(formerly *Cytophaga marina* and *Flexibacter maritimus*)

Epidemiology

- *Tenacibaculum maritimum* (Sukui et al. 2001) is a bacterium commonly found in seawater (Salati et al., 2005).
- Opportunistic bacterial pathogen of marine fish
- Widespread in Europe, USA and Japan
- Serologically, at least three groups of marine fish were identified (Serology or with randomly amplified polymorphic DNA-PCR) (Avendano et al. 2003)
- Associated with skin lesions
- Yellow pigmented organisms
- Both adults and juveniles can be affected
- More severe in younger fish (Wakabayashi, 1994)
- Predisposing factors
    - Increased water temperature
    - various stressors
    - skin surface condition (Toranzo et al. 2005)
- Water Transmission
- Entry through the gills or abraded skin.

Tenacibaculum maritimum	
Group 1	sole (*Solea senegalensis* and *S. solea*)
	gilthead seabream (*Sparus aurata*)
Group 2	gilthead seabream (*Sparus aurata*)
	European Sea bass (*Dicentrarchus labrax*)
	yellowtail (*Seriola quinqueradiata*),
	Atlantic salmon (*Salmo salar*)
	turbot *(Scophthalmus maximus*)
Group 3	turbot (*Scophthalmus maximus*)
	one isolate from *Pagrus major*
	one from *Solea solea.*

Susceptible species
Dover sole 'Black patch necrosis' (Campbell and Buswell, 1982)
Flounder
Turbot
Atlantic salmon
coho salmon
sea bass

Clinical picture

Behavioural changes

- Lethargy
- Loss of appetite
- Increased production of mucus
- Mortality can be as high as 100 % of the infected fish group
- In most cases the mortality is low but the morbidity is high
- Stressed young fry and fingerlings are most susceptible.

External appearance

- Initially pale areas of skin
- lesions may have a yellow edges (severe infections)
- necrotic skin ulcers and erosions, particularly in sea bass and in salmonids
- Haemorrhagies in the mouth
- affected gills
- frayed fins
- tail rot (Toranzo et al. 2005)

Internal Clinical Signs

- Observation of accumulations of long filamentous rods in wet mounts mainly in the affected fish gills.
- yellow pigmented colonies on nutrient low agar (Anacker and Ordals culture medium)
- Gram-stained preparations obtained from gills or skin lesions
- Isolation in selective culture media, especially Anacker and Ordal, Marine Agar, *Flexibacter maritimus* medium (FMM) (Pazos et al. 1996)
- Polymerase chain reaction (PCR) (Toyama et al. 1996; Avendano et al. 2004) may also be used to confirm the presence of the bacterium.

Prevention

- Outbreaks appear to be stress related so optimal husbandry conditions and nutrition required in order to avoid outbreaks.

Treatment

- Antibiotics can be applied in medicated feed given during a confirmed infection
- Field vaccine trials

Action

- No legal action is required.

Fish mycobacteriosis, "fish turberculosis" by acid fast bacterium *Mycobacterium marinum*

Epidemiology

- Potential zoonosis
- Mycobacteria are potentially infective to humans and can penetrate the skin surface through existing cuts or abrasions causing locally serious granulomatous infections (aquarist finger)
- All year
- Generally a chronic disease that results in a slow, but regular mortality
- The most probable route of transmission is oral
- Other points of entry are cuts or open abrasions on the epidermis.

Susceptible species
Salmonids
sea bass
gilthead sea bream
striped bass
mackerel
cod
red drum
tilapia

Clinical picture

Behavioural Changes

- Listlessness
- Lack of appetite.

External Appearance

- Skin discolouration,
- Exophthalmia (pop eye)
- Scale loss
- Skin ulceration.

Internal signs

- Variable sized white-greyish lesions associated with the spleen, kidney or liver
- Distended abdomen with lesions or nodules.
- Enlarged tissues
- Skeletal deformities in some species (chronic condition)
- Light microscopy
    - formation of granulomatous lesions
    - various stages of necrosis,
    - fibrous response.

Diagnosis

Micoscopy

- non-motile, acid-fast bacteria stained red using the Ziehl-Neelsen

Micobiology

- Isolation and culture requires a specialized medium and prolonged incubation times at 25°C.
- Several PCR reactions have been developed for confirmation of pathogenic species involved.

Histology

- Observation of granulomas acid-fast stained tissues (presence of bacteria)

Prevention

- Effective water changes
- Good biosecurity will help limit the occurrence and spread of infection within closed environments.
- In aquaria apply chloramine T, followed by a water change.
- There are no vaccines available
- Culling of the fish with complete disinfection and restocking is often advised.

Treatment

- There are no really effective treatments for mycobacterial infections in fish.

Action

- There is no legal action required.

Enteric Redmouth diease (ERM) by *Yersinia ruckeri*

Epidemiology

- Gram negative, mobile, short rod (family Enterobacteriaceae)
- Mainly disease in freshwater fish
- In the sea mortality is generally low
- In freshwater environments the mortality can reach between 10-60%
- There are currently 5 serotypes

Transmission

- *Y. ruckeri* is an obligate pathogen. It may survive for several months in water of sediments
- Primary reservoir is the carrier (covert) fish that can shed many bacteria into the water with the faeces
- Other carrier fish include gold fish and other coldwater ornamentals
- Contaminated water (survives several months)
- Other animals (found in bird faeces and some mammals)
- Personnel
- Usually in fry below 5g

Temperature

- Outbreaks can occur throughout the year
- Mainly in spring and autumn.
- Outbreaks are rare in winter with water temperatures below 5°C although infected fish with no clear clinical signs can be found

Mortality

- Repeated outbreaks might decrease clinical sign frequency and in fry less than 5g
- Mortality can ocurr without overt clinical signs

Management

- Clinical outbreaks of disease particularly related to those farms where there are poor husbandry conditions or where the fish have been stressed, possibly though grading. So avoid high stressful conditions and improve husbandry conditions to avoid onset of the disease.
- Regular intestinal shedding of the pathogen may also cause recurrent infection
- Contaminated farm equipment and water can harbour the bacterium so disinfection is advised
- Improved biosecurity can limit the occurrence or spread of the disease

Susceptible species	
FRESH WATER	MARINE
Rainbow trout	Salmonids and related fish
Atlantic salmon	turbot
F.W invertebrates (Crayfish)	sea bass
	Atlantic salmon (Northern Europe)

Clinical picture

Behavioural Changes

- Loss of appetite
- Swollen abdomen (stomach and gut filled with gas and fluid)
- Darkening
- Lethargy
- Slow swimming particularly at the edge of the enclosure.

External Appearance

- Bacterial haemorrhagic septicaemia
- Dark appearance
- Swollen abdomen
- Haemorrhage mainly on the paired fins
- “Classical” red mouth with reddening of mouth, gums, palate and tongue
- Uni or bi-lateral Exopthalmia

- Petechial haemorrhages in the eye and Opercula

Internal Clinical Signs

- Enlarged spleen with rough edge
- Haemorrhage of the thymus gland and general septicaemia.

Diagnosis

- Bacteriology – Bacteial isolation on general purpose agar (e.g. TSA).
- Histology

Prevention

- Quarantine purchased fish
- Avoidance and eradication are generally difficult due to widespread distribution of the pathogen movement of infected fish and the difficulty of detecting carriers
- Improve husbandry and hygiene
- Reduce stress (avoid handling and grading of suspect infected fish as well as high stocking densities
- Improve biosecurity - apply disinfection programmes
- Avoidance can be done by vaccination using commercially available vaccines. Vaccination programme usually refers to immersion vaccination followed by injection or oal booster vaccination.

Treatment

- Antibiotics can be prescribed during an infection when ERM has been confirmed.
- Care should be taken as to the possibility of re-occurrence of outbreak 2 weeks to 2 months later

Action

- No legal action is required.

Epitheliocystis (Chlamydiales)

Epidemiology

- Wide temperature range, but more prevalent during the spring and summer months.
- It is thought that this disease is waterborne.
- Infection may result in severe mortality among juvenile fish, especially in sea bream fry

Susceptible species
Atlantic salmon
rainbow trout
sea bream
sea bass

Clinical picture

Behavioural Changes

- Lightly infected fish often show no behavioural changes
- Chronic or terminally infected fish have rapid respiration and are letharigic.

External Appearance

- A heavily infected fish may show excess mucus production around the gills
- Operculae may be flared.

Internal Clinical Signs

No specific internal clinical signs of this disease.

Diagnosis

- Microscopy - Small white cysts on the gill lamellae provide a provisional diagnosis.
- Histology - Enlarged epithelial cells containing large inclusions in stained gill sections

Prevention

- Quarantine of infected fish populations.
- Inlet water may be sterilized using ultraviolet radiation to prevent infection,
- Enhanced biosecurity during an infection.
- Good disinfection procedures are recommended

Treatment

- No treatment available

Action

- No legal action required.

Streptococcosis by *Streptocossus iniae*

Epidemiology

- *Streptococcus iniae* has become one of the most serious aquatic pathogens in the last decade causing high losses in farmed marine and freshwater finfish in warmer regions.
- Streptococcal infections are a continuing emerging problem in aquaculture where *S. iniae* and *S. agalactiae* appear to be more prevalent in outbreaks of streptococcosis in fish.
- Infections are global and outbreaks can be economically devastating.
- *Streptococcus iniae* is perhaps the most dangerous member of this genus.
- At least three other related species (*S. parauberis, S. agalactiae* Serotype 2 (tilapia), *Lactococcus garvieae* (trout)) are known to cause diseases in mariculture (Toranzo et al., 2005).
- *Streptococcus iniae* is considered a true pathogen as it is able to invade the tissue of healthy, non-stressed individuals.
- *S. parauberis* isolated on several occasions from cultured turbot in Spain seems to be endemic to that region (Toranzo et al., 1994, 1995; Doménech et al., 1996).
- Streptococcal septicemia (streptococcosis) was first reported in cultured rainbow trout (*Oncorhynchus mykiss*) in Japan (Hoshina et al., 1958).
- An epizootic was described by Plumb et al. (1974) in estuarine fish along the Florida and Alabama Gulf Coast of Mexico in the US.
- The disease has occurred both sporadically and epizootically among cultured and wild fish, in marine and freshwater environments, in many parts of the world.
- In the Mediterranean basin, mortalities from *S. iniae* were reported in Italy (in freshwater cultures) and Israel (in both freshwater and marine environments).
- Streptococcal infections tend to develop into lethal septicemia.
- Suspected transmission of *S. iniae* from wild fish to inland farmed fish in Israel (Mediterranean Sea) (Zlotkin et al., 1998b).
- Suspected transmission of *S. iniae* from sea cages to wild fish in Israel (Red Sea) (Colorni et al., 2002; Kvitt and Colorni, 2004).
- Interaction of *Streptococcus* spp. in cage-cultured yellowtail *Seriola quinqueradiata* and wild fish (sardines, anchovies, round herring, chub mackerel, black scraper) demonstrated in Japan (Minami, 1979; Kusuda and Kawai, 1982).
- The same strain of *S. agalactiae* was isolated from cultured sea bream *S. aurata* and wild mullet *Liza kluzingeri* in Kuwait, Arabian Gulf (Evans et al., 2002).
- *S. iniae* also has zoonotic potential, with human infections identified in the USA, Canada, and throughout Asia. In humans, infection is clearly opportunistic with all cases to date associated with direct infection of puncture wounds during preparation of contaminated fish, and generally in elderly or immunocompromised individuals.

Susceptible species	
Wild fish	**Cultured fish**
Siganus rivulatus (Mediterranean Sea)	*Sparus aurata* (Mediterranean Sea, Red Sea)
Pomadasys stridens (Red Sea)	*Dicentrarchus labrax* (Mediterranean Sea, Red Sea)
Synodus variegatus (Red Sea)	*Sciaenops ocellatus* (Mediterranean Sea, Red Sea)
Variola louti (Red Sea)	*Epinephelus aeneus* (Red Sea)
Ocyurus chrysurus (Barbados, Caribbean Sea)	*Lates calcarifer* (Australia)
Haemulidae (grunt) (Barbados, Caribbean Sea)	*Paralichthys olivaceus* (Japan)
Scaridae (chub) (Barbados, Caribbean Sea)	*Seriola quinqueradiata* (Japan)
Torquigener flavimaculosus (Red Sea)	*Siganus canaliculatus* (Bahrain)
Chaelodipterus lachneri (Red Sea)	Tilapia (*Oreochromis niloticus*)
Pterois miles (Red Sea)	
Chlorurus genazonatus (Red Sea)	

Clinical Picture

Behavioural Changes

- Infected fish become sluggish and letharigic
- Loss of appetite

- Swimming in irregular fashion producing twirling, spiral or erratic movements.

External Appearance

These vary depending on fish species affected but usually include:

- darkening of the body colour
- exopthalmia (uni- or bi-lateral pop eye)
- corneal opacity
- haemorrhages on the fins, operculae and eyes.
- haemorrhages can develop into superficial lesions with a raised irregular surface.
- lesions are frequently observed in the vent and anal area.

Internal Signs

- Spleen and liver are more often affected but the heart and kidney may also be damaged.
- Liver is generally pale with high numbers of white areas (focal necrosis)
- Spleen is enlarged in size with rounded edges and a sherry-coloured appearance.
- If heart is affected this can produce pericarditis.
- If it crosses the blood-brain barrier then the bacterium can cause neurological injury resulting in meningo-encephalitis.

Diagnosis

- Histology
    - Presence of Gram positive cocci in the brain is often a presumprtive diagnosis of streptococcosis.
- Bacteriology
    - Spleen samples in order to isolate the pathogen in TSA or BHI agar
    - In marine cases the media can be prepared with 25% aged seawater, either alone or supplemented with 5% blood.
    - Hemolysis of the solid agar is variable and may be strain or bacterial species dependant.
    - Small, punctuate, opaque colonies are Gram positive cocci often in chains.
- Serotyping can be done with PCR using specific primers for *Streptococcus iniae* or *S. agalactiae* and *Lactococcus garvieae* (Zlotkin et al., 1998a; Bachrach et al. 2001; Kvitt et al., 2002).

Prevention

- There are commercial vaccines for *Streptococcus iniae* but efficacy is open to question. Vaccine failure appears to result in part from serotypic variation and, whilst two serotypes have been named, variation would appear to be more complex.
- Good husbandry and optimal nutrition/water quality can help to prevent the onset of an outbreak.
- Reduction in crowding and handling can alleviate stress.

Treatment

- Control of *S. iniae* by vaccination has had limited success.
- Thus, antibiotic usage is the current practice for reducing mortality and consequent economic loss.
- Antibiotics can be given if the infection is in the early stage or fish are still feeding.

Actions

- No legal action is required.

Pasteurellosis or Pseudotubecullosis (*Photobacterium damsela* subsp. piscicida)

Pathogen

- *Photobacterium damsela* subsp. piscicida (formerly known as *Pasteurella piscicida*)
- Gram-negative short rod (often bi-polar staining when viewed by light microscopy)
- All isolates exhibit quite similar profiles, in terms of morphology, biochemical properties and antigen profiles.
- Only at the molecular level, distinct clones can be distinguished into the European, the Japanese and the Israeli strains (Kvitt et al., 2002).
- Regardless of the geographic origin and source of isolation, this pathogen exhibits homogeneous biochemical and serological characteristics (Magariños et al 1992a, b; Bakopoulos et al. 1997).
- However, DNA fingerprinting methods, such as ribotyping, AFLP and RAPD and plasmid content were able to differentiate the European from the Japanese isolates (Kvitt et al., 2002).
- Young fish tend to be more susceptible to the pathogen (Toranzo et al. 2005)
- It affects a wide range of fish species in many geographical areas including Europe.
- Formation of granular lesions in the spleen and kidney of the infected fish.
- These are more obvious in the chronic, advanced form (Kusuda and Yamaoka, 1972)
- Once the pathogen contaminates an area it is likely to survive there for long periods.
- Ability of the pathogen to enter a viable but not culturable state and thus its survival in this form, in the water column and the sediment for long periods while retaining its pathogenicity and the existence of carriers at low water temperatures.

Mortality

- Sub-clinical forms – at low temperatures - low mortality to as high as 90%, in some batches (Hawke et al. 2003).
- Usually, the loss is around 10%.
- In wild populations, extreme cases of estimated 50% mortality have been reported (first isolation in wild population, in Chesapeake Bay, USA) (Snieszko et al. 1964).

Transmission

- Vertical, through the ovaric and seminal fluids from the apparently healthy broodstocks (Romalde et al., 1999)
- Horizontal, via the water (Fouz et al. 2000)
- Able to infect its host through the gills, the gastrointestinal tract and possibly the skin.
- The pathogen can enter a viable but not culturable (VBNC) state and thus survive in the water column for long periods (Magariños et al., 1994).

Clinical Picture

Behavioural Changes

- The fish become lethargic
- Loss of appetite

External Appearance

- The infected fish become darker in colour

Internal Clinical Signs

- Internally granulomas-type lesions can be observed as white nodules in the spleen and the kidney
- Histopathology - tubercle-like lesions with masses of bacteria and epithelial cells and fibroblasts.
- In the chronic form, whitish patches are formed in the infected organs, although their formation depends on the fish species

Susceptible species	
Wild fish	**Cultured fish**
White perch (*Morone americanus*)	Yellowtail (*Seriola quinqueradiata*)
Striped bass (*Morone saxatilis*)	Ayu (*Plecoglossus altivelis*)
Mullet *(Liza rumada*)	sea bass (*Dicentrarchus labrax*) (Kvitt et al., 2002; Toranzo et al., 2005).
Rudd (*Scardinius erythrophthalmus hesperidicus* H.)	Black seabream (*Mylio macrocephalus*)
Sea mullet (*Mugil cephalus*)	Red seabream (*Pagrus major*)
Thicklip grey mullet (*Chelon labrosus*)	Young black seabream (*Acanthopagrus schlegeli*)
white perch (*Morone americanus*)	Oval filefish (*Navodan modestus*)
Oval filefishes (*Navodan modestus*)	Red grouper (*Epinephelus akaara*)
	Snake-head fish (*Channa maculata*)
	striped bass (*M. saxatilis*) (Snieszko et al. 1964)
	Gilthead seabream (*Sparus aurata*)
	Mullet (*Mugil* sp.)
	Yatable blenny (*Pictiblennius yarabe*i)
	Striped jack *(Pseudocaranx dentex*)
	Hybrid striped bass (*Morone saxatilis x M. chrysops*)
	Japanese flounder (*Paralichthys olivaceus*)
	Sole (*Solea senegalensis*)
	Common dentex (*Dentex dentex*)
	Cobia (*Rachycentron canadum*)
	Sharpsnout seabream (*Diplodus puntazzo*)

Diagnosis

- Presence of numerous, white bacterial colonies throughout the internal viscera, especially the kidneys and spleen lead to presumptive diagnosis
- Isolation from internal organs of diseased fish on tryptic soy agar (TSA), brain heart infusion agar (BHIA) and blood agar, all supplemented with 1-2% NaCl, after 2-4 days' incubation at 22°C.
- Presumptive identification is carried out according to morphological features (short gram-negative, non-motile rods with bipolar staining) and using biochemical assays.
- In terms of antigenic profiles, *P. damselae* ssp. piscicida isolates are a very homogenous group. Thus, many immunological techniques, such as
    - ELISA
    - fluorescent antibody techniques (IFAT) and
    - immunohistochemistry (IHC) have been developed to identify all isolates.
    - Commercial kits using polyclonal anti-Ph. *damselae* ssp. piscida antibodies are also used.
- Molecular biology tools, such as polymerase chain reaction (PCR) (Osorio et al., 1999, 2000; Osorio and Toranzo 2002) can also be applied.

Prevention

- Commercial vaccines are available.

Treatment

- Antibiotic treatment leads often to recurring outbreaks.

SEA BASS FUNGAL INFECTIONS

Ichthyophonus hoferi

Ichthyophonus hoferi

Pathogen

- A Protistan of uncertain affinity frequently described as a fungus

Susceptible fish species

- Most marine fish species
- If infected raw marine fish is used as a feed for freshwater fish including salmonids, then these can also be infected.

Temperature

- No specific temperature

Mortality

- In marine flatfish *I. hoferi* infection is frequently fatal in three months.
- In roundfish such as herring infected animals may survive for considerable periods
- Massive fish kills of natural stocks have been reported to have occurred in Canadian waters at regular intervals

Transmission

- It seems possible that zooplankton may be involved in transmission.
- Infection has been demonstrated by the oral route so that if an infected tissue is consumed, transmission can occur.

Clinical Picture
Bahavioural changes

Internal Signs

- Grossly infected fish show the presence of yellow pustules, particularly in the musculature
- Fillets from infected fish have a characteristic acrid smell

Diagnosis

- From gross signs and characteristic smell
- Confirmed microscopically by fresh squash preparations and histology
- Large 50-100µm cyst-like structures some of which may show limited hypha-like branches extending from the thick walled cysts

Prevention

- Do not feed raw marine fish to farmed fish stocks.
- Since infection may be transmitted by the oral route
- Remove all fish and fallow before any attempt at restocking

Treatment

- No treatment available

Action

- No legal action required.

SEA BASS OTHER PATHOLOGIES

- **Cataracts**
- **Blindness-melanism syndrome**
- **Planktonic bloooms**
- **Contact with jellyfish**

Cataracts

Cataracts are defined as a partial or complete opacity of the crystalline lens. They are attributed to several factors, including:

- Deficiency of amino acids (e.g. zinc) or vitamins (e.g. riboflavin).
- Pathogenic agents such as helminthes, viral and bacterial infections
- Toxins
- Osmoregulatory difficulties (e.g. smolts transferring from fresh water to sea water)
- Mechanical damage to the eyes.

Susceptible species

- All fish are susceptible

Temperature

- No specific temperature range identified

Mortality

- Mortality is generally low but fish losses may continue over long periods.

Transmission

- Not applicable for non-infectious causes

Clinical picture

Behavioural changes

- Loss of appetite
- General weakness in the fish.

External Appearance

- The lens of the eye becomes opaque
- This may cause total or partial blindness
- Subsequent lesions due to unilateral or bilateral opacity of the lens
- Accompanying exophthalmia.
- In some cases this may lead to ulceration, swelling and gross enlargement of the entire corneal diameter.

Internal Signs

- Not relevant

Diagnosis

- Obervation of the eye of the affected fish uni- and bilateral cataract.
- Examination of stained histological sections provides additional information relating to this condition

Prevention

- There are many causes of cataracts. Many are reversible and therefore can be alleviated.
- If the cataract is nutritional or toxin-related then it is important to identify the cause.

Treatment

- There are many causes of cataracts. Many are reversible and therefore can be alleviated.
- If this is nutritional or toxin related then it is important to identify the cause.
- If the cataracts are untreatable this will lead to permanent blindness in the long term and the fish may need to be removed to avoid secondary infections and transfer of infection to other fish.

Action

- No legal action required.

Blindness-melanism syndrome

Influencing Factors

- High light intensity (demersal fish are normally farmed in the upper layers of the water column where the condition is associated with high water temperatures).
- Transparency of the water, shallowness of cages and high water temperatures all contribute.
- The susceptibility of the retina to these factors is increased by vitamin (E and C) deficiency

Susceptible species

- Most fish species which are farmed under these unfavourable conditions may be susceptible
- It has been observed in sea bass, turbot and in the native Caribbean fish species such as *Ocyurus chrysurus, Lutjanus analis* and *Sciaenops*.

Temperature

- Each species of fish has a particular range where they are susceptible
- In Sea bass it is evident in 25-30ºC.

Mortality

- Mortality is usually low
- It is influenced by the extent of the blindness
- It can reach 50% over several months
- The mortality is low but the moribund fish numbers are high.

Clinical picture

Behavioural changes

- The blind fish fail to find their prey (or feed pellets) and become thin

External Appearance

- Blindness and darkening of the skin (melanisation).
- Thin fish with loss of peritoneal fat
- Subsequent mechanical damage and secondary infections.
- Direct macroscopic observation of the eye does not reveal any lesion (corneal ulcerations or cataract).

Internal Signs

- Not applicable

Diagnosis

Histology

- Retinal degenerative lesions are mainly observed on the posterior part of the retina
- Increased thickness at various levels
- Decreased cellular density

Prevention

- Maintain suitable farming conditions
- Ensure sufficient vitamin supply in the feed
- Removed and dispose of blindfish to stop secondary infections spreading throughout the population.

Treatment

- No treatment available

Action

- No legal action is required.

Planktonic blooms

- Plankton is a term which encompasses a variety of organisms and includes the eggs and larvae of fish, larval and juvenile stages of many organisms and single groups of unicellular organisms or a mixture of algae, diatoms or dinoflagellates.
- Many dinoflagellate species (e.g. *Alexandrium*) are known to produce toxin(s) and may result in "red tides" in many areas of the world.
- The very high numbers of some phytoplankton species which bloom in coastal waters produce oxygen, through photosynthesis during the day.
- However, during the night the same organisms consume oxygen and produce carbon dioxide and can seriously deplete oxygen levels in the water column

Susceptible species

- All fish species are susceptible to the effects of, or contact with planktonic blooms, but especially fish reared in sea cages.

Temperature

- Blooms generally occur following periods of sunshine and still waters (the summer months)

Mortality

- Reports show that fish reared in cages in contact with blooms undergo up to 100% mortality.
- Surviving fish may die later from secondary infections
- Mortality may result from
    - physical damage to the gill epithelium
    - contact with the robust silicate skeleton of diatoms (e.g. Chaetoceros, Distephanus)
    - direct effect of toxins released into the water

Clinical picture

Behavioural Changes

- Affected fish congregate at the water surface
- Fish gasp for air (respiratory distress)
- They produce irregular gill movements
- Erratic swimming patterns may be followed by periods of lethargy.

External Appearance

- Often there are no other clinical signs except flaring of the operculae and the gills may be full of debris.

Internal signs

- Not applicable

Diagnosis

- Water samples need to be examined for the presence of organisms in planktonic blooms which can be identified through microscopical examination of water samples.
- Gill wet mounts and mucus samples should be examined from affected fish.

Prevention

- Phytoplankton blooms occur naturally and cannot be prevented.
- During periods when blooms are evident, fish should not be fed and all handling or disturbance to the fish kept to a minimum.

Treatment

- Towing cages to clean water is possible, though not always practical and may result in high mortality.
- Dead fish should be removed when possible to avoid further complications due to secondary infections.

Action

- No legal action is required.

Contact with jellyfish

- Tide and wind action may push large swarms of jellyfish against the sides of sea cages
- Swarms of jellyfish present particular hazards to farmed fish and several reports describe this phenomenon and the outcome for farmed salmonids.
- Other swarms of jellyfish consist of small animals which therefore may be eaten by fish.

Temperature

- Many jellyfish occur during the warmer summer months of the year, large swarms may also collect during spring and autumn.

Mortality

- Acute and high mortality may occur.

Clinical Picture

Behavioural changes

- Potential respiratory distress
- Damage to the respiratory area of the fish may contribute to mortality.

External Appearance

- Contact with the specialised stinging cells (nematocysts) can produce "whiplash" type markings of the fish body which frequently appear black as melanin is deposited

Diagnosis

- Examination of the jellyfish using morphological characteristics.

Prevention

- It is not easy or even feasible to prevent jellyfish coming into contact with farmed cages.

Action

- Remove dead or moribund fish, and jellyfish from sea cages
- Gloves should be worn before handing jellyfish.

SEA BASS PARASITIC INFECTIONS

- **Flagellates**
  - ***Amyloodinium ocellatum***
  - ***Cryptobia* sp.**
  - ***Ichthyobodo (Costia*)**

- **Ciliates**
  - ***Chilodonella / Brooklynella***
  - ***Tetrahymena* (fresh water) / *Uronema* (marine water)**
  - ***Trichodina* sp.**
  - ***Tripartiella* sp.**
  - ***Trichodinella* sp.**
  - ***Glossatella / Apiosoma***
  - ***Cryptocaryon irritans***

- **Myxosporidia**
  - ***Ceratomyxa labracis***
  - ***Ceratomyxa diplodae***
  - ***Sphaerospora testicularis***
  - ***Sphaerospora dicentrarchi***

- **Nematodes (*Anisakis* Sp.)**

- **Monogenean**
  - **Monogenean ecto-parasites**
  - ***Seranocotyle labrachis***
  - ***Dactylogyrus* sp.**
  - ***Gyrodactylus* sp**
  - ***Diplectanum aequans & lauberi***

- **Isopoda (Cymothoidae)**
  - ***Nerocila orbignyi***
  - **SEA LICE: *Ceratothoa oestroides* (Risso, 1826) (Isopoda: Cymothoida)**
- **ACANTHOCEPHALA (Spiny headed worms)**
- **Crustacea**
  - ***Lernaocera branchialis***
  - ***Lernaeenicus labracis***
  - ***Colobomatus labracis***
  - ***Lermnathropus kroyeri***
  - ***Caligus minimus & elongatus***
  - ***Caligus* sp.**

FLAGELLATES

Amyloodiniosis 'Velvet disease' *by Amyloodinium ocellatum*

Epidemiology

- One of the most devastating parasitic diseases in temperate and tropical mariculture because of the nature of its life cycle and rapid propagation, in fish confined in tanks or ponds
- The morphology, cytology and reproductive cycle of the parasite were described in the 1930s (Brown (1931, 1934) in fish held at the London and New York (Nigrelli, 1936) aquaria.
- *Amyloodinium ocellatum* is a dinoflagellate highly adapted to parasitism, able to infect virtually every species of teleost fish, causing epidemics over a wide range of salinities, from brackish water to full-strength seawater, and in temperatures from 17°C to 30°C.
- It parasitizes primarily gills but also attacks skin.

Biological life cycle

- Life cycle -three main stages:
  - trophont (parasitic, feeding stage)
  - tomont (encysted, reproductive stage)
  - dinospore (free-swimming, infective stage).
- The trophonts attach to the fish and feed on its epithelia by means of rhizoids. After growing to a size of approximately 100 µm (4-5 days), the trophonts loosen their attachment and drop from the fish, encyst on the substratum and start dividing.
- The reproduction process culminates in 2-3 days at 24±2°C with the release from each tomont of 64-128 infective, highly motile dinospores that, upon finding a suitable host, begin a new life cycle (Paperna, 1984). Lower temperatures lengthen life cycle development.
- Reproduction cycle and tolerance to temperature and salinity of *Amyloodinium ocellatum* (Brown, 1931) (Dinoflagellida) was investigated in the laboratory using postlarval *Sparus aurata* (L.) as fish host and by *in vitro* study of the parasite's reproductive stage.
- Trophont growth was linear by length and exponential by volume, continuous to detachment stage at the size of 50-90 microns in length.
- At 19-24 ^{o}C detachment occurred gradually during 3-5 days after settlement.
- At 16 ^{o}C growth, as well as detachment, was delayed. However, by the 6-7th day trophonts still attached exceeded 100 microns in length.
- When detached, trophonts of any age and size were transformed into dividing tomonts .
- 24-hour old, trophonts less than 25 microns length , however, immediately sporulated with no division.
- The number of divisions to sporulation was related to the size at detachment.
- For reproduction, 18-30^{o} C was the optimal temperature range, although the minimal division time was at 23-27^{o} C.
- Divisions were delayed and sporulation was interrupted at 15 ^{o} C.
- Complete interruption of division and gradual mortality occurred at 8 ^{o} C.
- At 35 ^{o}C the reproduction process of the tomonts was severely damaged.
- Tolerance to salinity was dependent on ambient temperature and was the widest at 24-25^{o}C. Divisions occurred between 1-78 ppt, but uninterrupted division, full yield sporulation and effective infection of fish occurred only between 10 to 60 ppt.
- No division occurred above 80 ppt; however, short-term incubation up to 4 days in salinities up to 180 ppt did not affect division potency.
- Wide variation in tolerance was, however, evident between tested population as well as individual tomont in each population.
- *Amyloodinium ocellatum* may exploit non-piscine hosts for its survival (Colorni, 1994).
- In the wild, because of its relatively short parasitic phase and dispersal of dinospores over a boundless area, damage to the host is presumably limited. *A. ocellatum* trophonts have been observed only rarely on wild fish.
- In the Mediterranean basin, heavy mortalities by *A. ocellatum* in cultured fish were reported in Italy (Ghittino et al., 1980; Barbaro and Francescon, 1985; Aiello and D'Alba, 1986; Balsamo et al., 1993; Cecchini et al. 2001), Greece (Rigos et al. 1998) and on both the Red Sea and Mediterranean coasts of Israel (Paperna, 1980, 1984; Colorni, unpublished data).

Susceptible species

- Sea bream
- Sea bass
- many other Mediterranean and tropical fish

Temperature

- Above 20^0C

Mortality

- Heavy infestations lead to high mortality rates

Clinical picture

Behavioural Changes

- The fish swim near the water surface
- Unco-ordinated swimming.
- Increased respiration if the gills are affected

External Appearance

- The fish become thin
- Display grey patches on the skin and gills
- Sometimes localised small haemorrhages on the gills

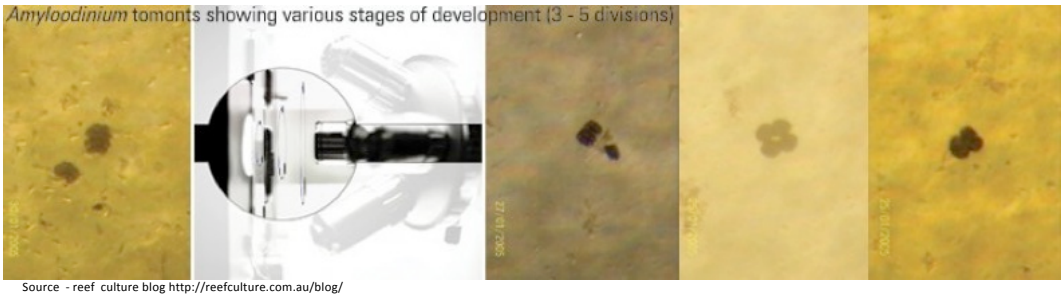
Source - reef culture blog http://reefculture.com.au/blog/

Internal Clinical Signs

- General necrosis and haemorrhages
- Affected gills show hyperplasia.

Diagnosis

- The parasite can be easily observed in wet mounts from gills and skin and appears as pear-shaped or oval trophonts approximately 150µm in diameter.



Source - reef culture blog http://reefculture.com.au/blog/

Prevention

- Disinfection of inlet water in inland fish farms is extremely important in order to avoid dinospores entering the system.
- Treatment of the effluent waste is important. There is evidence that in the surroundings of a fish farm that has been operating for some years without treating its effluents, a low-level infection in local wild fish fauna becomes established.
- Prevention by improving water quality and removing possible lifecycle stages of the parasite; for example, transfer of infected fish to sea cages is a method to rid the fish of this parasite.
- *A. ocellatum* mature trophonts detaching from the host and dinospores excysting from the tomonts, are generally swept away by currents while the distance of the cages from the bottom of the sea prevents re-infection.
- Some evidence indicates that fish become immune to re-infection

Treatment

- There is no commercially available treatment. However, addition of Copper Sulfate ($CuSO_4$) at 0,75mg/L for 12-14 days, or 2-5 minute bath of the fish in freshwater may help to eliminate the parasite.

Action

- No legal action required.

Cryptobia sp.

Epidemiology

- Flagellate of the gill filaments

Susceptible species

- Sea bass
- Sea bream

Temperature

- No specific temperature

Mortality

- Acute or chronic depending on environmental conditions
- Up to 0,5% per day with a maximum about 10% after several weeks

Transmission

- Directly from fish to fish
- The parasite can exist free in water only for short periods

Clinical picture

Behavioural changes

- The affected fish display respiratory distress because of the presence of the parasite on the gills
- Anorexia

External Appearance

- General darkening of the fish.

Internal Signs

- Destruction of the gill epithelium and capillary epithelium resulting in presence of thrombi

Diagnosis

- High power microscopy of wet mounts of gills or fresh mucus
- Presence of small motile parasites
- Parasites can also be seen in stained tissue sections

Prevention

- Good husbandry conditions

Treatment

- Formalin baths during a suspected infection.

Action

- No legal action required.

Ichthyobodo (*Costia*)

Epidemiology

- *Costia*, now scientifically known as *Ichthyobodo necator*, is a typical hatchery flagellate.
- Indirect damage due to decreasing health condition and gill lesions is more important than mortalities

Susceptible species

- All fish species, especially salmonid (trout) fry.

Temperature

- All hatchery temperatures

Mortality

- Mortality only in fry or ornamental fish with moderate to severe infections

Transmission can ocurr from:

- infected fish
- water
- farm equipment
- employees

Clinical picture

Behavioural changes

External appearance

- Slight white-blue cloudy layer on the skin with an increasing mortality rate

Diagnosis

- Microscopical gill or skin scrape preparation at 25x magnification or greater as the flagellated parasite is about the same size as skin cells.
- The parasite is bean-shaped and swims with a staggering movement.

Prevention

- Improved hygiene and biosecurity mesures particularly in hatcheries.
- Checking of the fry for the presence of the parasite

Treatment

- Formalin bath (formaldehyde: 1:4000 or 1:6000 (this means 1ml formalin / 4 or 6lt of water) of the commercially available formalin (37-40%) for 1 hour.
- Salt treatmentis also beneficial to clear the parasite where the recommended salt treatment is 2-3%/1h for trout and 1,5%/1h for cyprinid. Salt does not kill the parasite as effectively as formalin does, but is better tolerated especially by weakened fry.

Action

- No legal action required.

CILIATES

Chilodonella / Brooklynella

- *Chilodonella* sp. causes gill damage and is often associated with secondary infections but it has also been reported to occur in apparently healthy fish.

Susceptible species

- All species and age groups

Temperature

- All temperature ranges

Mortality

- Depends on fish size and infection rate but it can vary

Transmission

- This can be through
  - infected fish
  - water
  - undisinfected farm equipment
  - plants
  - live food for ornamental fish

Clinical picture

Behavioural changes

External appearance

- The fish produce excessive mucus and then a white cloudy layer develops, mostly on the back of the infected fish between dorsal fin and head region.

Diagnosis

- Microscopically on a gill or skin scrape preparation (60-160x).

Prevention

- Only stock clean fish and observe the fish regularly.
- Improve biosecurity.
- Keep low stocking density
- Increase water flow rate.
- Maintain optimal environmental quality and general health conditions of the fish.

Treatment

- Chloride and liming for big ponds show good results
- Treatment of infected fish may include short term formaldehyde bath treatment (1:4000-6000/1-2h)

Action

- No legal action required.

Uronema marinum / Philasterides dicentrarchi

Epidemiology

Susceptible species	
Philasterides dicentrarchi	sea bass
Uronema marinum	Japanese flounder Turbot Red sea bream Bluefin tuna
Tetrahymera sp.	Fresh water species

Mortality

- Up to 100%

Transmission

- *Uronema*: Free living organism that reproduces by binary fission
- Organic material and debris favours development
- Some strains are more pathogenic
- Pathology when balance between parasite density and host resistance shifts

Clinical Picture

Diagnosis

- Ovoid -shaped ciliate parasites (35µm)
- Fresh mounts
- Stained mounts
- Histology sections
- Species identification requires Electron microscopy

Prevention

- Regular fish observation
- Close examination of moribund fish
- Hygiene, cleaning of facilities
- Vaccine development as described in Turbot

Treatment

- Formalin baths to reduce parasite density
- Formalin baths only in the early stage of the infection
- No treatment on systemic infection

Action

- No legal action required.

Trichodina sp.

Epidemiology

- Trichodina species are parasites that are considered to be more a commensal than a genuine ectoparasite.
- These main parasites include *Trichodina, Trichodinella, Tripartiella, Foliella* and differ only in shape, size and number of hooks.

Susceptible species

- All species and age groups

Temperature

- All temperature ranges

Mortality

- Depends on infection rate and fish size, but high mortality rate only occurs in cases of massive invasion

Clinical Picture
Behavioural changes
External Appearance

- Increased mucus production followed by a grey-blue turbid layer on the skin
- Gill injury resulting in swelling and necrosis of the damaged gills.
- In infected fry the fins may also become damaged.

Clinical Signs
Diagnosis

- Microscopic examination at 60-160x magnification
- Gill or skin scrape preparation to look for the presence of the parasite

Transmission

- Infected fish
- Water, farm equipment
- Live food and plants.

Prevention

- *Trichodina* often occurs in combination with poor environmental quality.
- Decrease of general health conditions
- Improved hygience and biosecurity is required, especially important in hatcheries.

Treatment

- Malachite green baths for non-food fish
- Formalin short baths for food-fish species
- Salt treatment has been tested but with low success rate.

Action

- No legal action required.

***Tripartiella sp. & Trichodinella* sp.**

- Smaller than skin *Trichodina*

Glossatella / Apiosoma

Epidemiology

- *Glossatella/Apiosoma* infection is a clear sign of the excessive contamination of the water with organic matter.

Susceptible species

- All species and age groups

Temperature

- Almost all temperature ranges

Mortality

- Acute mortality only occurs with fry with massive infections.

Transmission

- Infected fish but mostly through water with highly organic content and transferred through non- disinfected farm equipment

Clinical picture
Behavioural changes
External Appearance

- Not very clearly defined
- Slight grey-white layer on the skin
- Problems with respiration

Diagnosis

- Microscopic examination of a gill or skin scrape preparation (60-160x).

Prevention

- Quarantine or immersion bath treatment before stocking (best done on the supplying site)
- Improve the environmental quality
- Reduce the loading of organic matter.
- Hygiene in the hatchery should be high and include routine examination of fry.

Treatment

- For treatment see ***Chilodonella / Brooklynella***

Action

- No legal action required.

Cryptocaryon irritans

Epidemiology

- *C. irritans* is a holotrichous ciliate that invades the epithelium of skin, eyes and gills, compromising the physiological function of these organs.
- Previously known only from marine aquaria (Sikama, 1937, 1938; Nigrelli and Ruggieri, 1966; Wilkie and Gordin, 1969; Hignette 1981; Giavenni, 1982)
- *C. irritans* later found its way into commercial operations, becoming one of the most devastating parasites in intensive mariculture (Tareen, 1980; Huff and Burns, 1981; Colorni, 1985; Kaige and Myazaki, 1985: Rasheed, 1989; AQUACOP et al., 1990; Cheong, 1990; Gallet de Saint Aurin et al., 1990; Tookwinas 1990 a, b)
- In the Mediterranean, mortalities by *C. irritans* in cultured fish were reported in Italy and Israel (Colorni, 1985; Diamant et al., 1991) in inland facilities only.
- The disease caused by *C. irritans* is known as Marine White Spot Disease or Marine Ich.

Temperature

- The parasite is found in marine fishes in tropical, subtropical and temperate seas.

Biological cycle

- The parasite has a direct, quadriphasic life cycle, with one parasitic and three off-host stages.
- The trophonts (feeding, parasitic stage) are spheroidal to pear-shaped and revolve continuously within the host epithelium.
- Feeding on body fluids and cell debris, the parasite growth phase culminates when the trophonts spontaneously exit the host after 4-5 days and sink to the bottom (protomonts).
- Then their movements gradually stop moving, adhere to a solid substratum and encystment takes place, with the cyst wall hardening in 8-12 hours (tomonts).
- Tomont development and subsequent theront (infective stage) release are very asynchronous.
- Once a suitable host has been intercepted, invasion is very rapid and often completed within five minutes (Colorni, 1985).

Clinical picture

Behavioural changes

- Severe respiratory distress

External Appearance

- Pinhead-sized whitish vesicles
- mucus hyperproduction
- epithelial hyperplasia
- corneal cloudiness
- skin discoloration
- disruption of the gills' lamellar structure
- In heavy infections, several trophonts share interlocked burrows
- Osmoregulatory balance becomes increasingly difficult to maintain
- Gas exchange in severely damaged gills gradually fails.

Internal Signs

Diagnosis

- Light microscopy of rotating ciliate in wet mounts of gills or skin.
- EvIdence of the ciliate in histological sections.

Prevention

- Treatment of effluents. There is circumstantial evidence that if the parasite appeared in a fish farm that has been operating for some years, and in which the effluents are not treated, a low-level infection is maintained in the surroundings by the local wild fish fauna.
- It is hypothesized that in inland fish farms during every epizootic the parasite is "amplified" and that the effluents release to the sea huge amounts of theronts, which establish a "chronic" infection in the local fish fauna.

Treatment

- Transfer infected fish to sea cages in order to rid the fish of this parasite.
- *C. irritans* mature trophonts detaching from the host and theronts excysting from the tomonts are generally swept away by currents, while the distance of the cages from the bottom of the sea prevents re-infection.

Action

- No legal action is required.

MYXOSPORIDIA	
Ceratomyxa labracis	Sea bass
	Gall Bladder
	No serious effect (unless infection spreads to the intestine)
Ceratomyxa diplodae	*Dentex* sp *Puntazzo puntazzo*
	No serious pathology
	If mixed infection with *Myxidium leei* could cause serious mortalities
Sphaerospora testicularis	Sea bass
	parasitizes the gonads of sea bass without inflammatory reaction.
	Affects reproduction
	However, when intensity is high, it can cause total destruction of the organ (Sitjà-Bobadilla and Alvarez Pellitero, 199; Rigos et al., 1999; Athanassopoulou et al. 2004a,b; Mladineo 2003)
Sphaerospora dicentrarchi	Sea bass
	Intestine
	Enteritis
	parasitises all the internal organs of sea bass (*Dicentrarchus labrax* L)
	Spread in Kidney, pancreas, testis (in heavy infections predilection for the gall bladder and the muscular layers of intestine, where it can reach 100% and 70% of prevalence in wild and cultured fish respectively, during summer months (Sitjà-Bobadilla and Alvarez Pellitero, 1993 b, c; Rigos et al., 1999)

Monogenean ecto-parasites

Epidemiology

- Monogeneans, generally known as "ectoparasitic flukes", are commonly found in many wild and farmed fish species.
- The term 'monogenetic' means that an organism has a direct life cycle requiring no intermediate host. Monogeneans may spend their entire lives on one host and usually are functional hermaphrodites.
- In some parasitic species, the prevalence tends to increase with age. The most common monogenean parasites encountered in the Mediterranean area seem to belong to genera *Gyrodactylus, Lamellodiscus, Diplectanum*, and various Microcotylids.
- They have been reported in many wild and farmed Mediterranean marine fish species, in almost all Mediterranean countries, as well as in Norway (Sterud, 2002).

Biological cycle

- Eggs laid by the adults release free-swimming larvae (oncomiracidia) which infect suitable hosts. If they fail to do that, they die.
- After their attachment, they develop to adults. Only Gyrodactylids give birth to live individuals, which are identical to the parents.
- Each parasite species tends to be narrowly host-specific(Wootten 1989; Sasal et al., 2004).
- However, it is reported that this specificity is often lost in aquaculture (Noga, 2000).
- The lesions on the gills and skin are caused by the feeding activity and the action of the attachment organs.
- Microcotylids feed on host's blood and can cause severe anaemia and high mortalities.
- The prevalence in culture species varies from below 10 to over 85%, in some extreme cases when certain factors, such as salinity, temperature, poor sanitation and closeness of association, exist (Rawson, 1976; Gonzalez-Lanza et al., 1991; Noga, 2000; Mladineo, 2004).
- Similar prevalence has been reported for wild fish (Merella et al., 2005).
- Usually, the mortality rate is low, but in cases where the parasitism is severe and the destruction of the gills is extensive, then high mortalities among the infested fish occur (Faisal and Imam, 1990).
- The direct reproduction cycle and the fact that the free-swimming larvae must find a suitable host soon after their hatching indicate that fish at close range are required for the parasites to propagate.
- Some epidemiological studies (Roubal et al., 1996) indicate that the geographical profile of an area plays an important role in the spreading of the parasites. Thus, in offshore ecosystems the parasitic diversity richness and prevalence are usually higher than in estuaries, where placement of experimental cages resulted in transient increase of some species (Roubal et al., 1996).

Susceptible species	
Wild fish	**Farmed fish**
Various Sparidae	Various Sparidae
Drum (*Aplodinotus grunniens*)	Seabass (*Dicentrarchus labrax*)
Spanish mackerel (*Scomberomorus commersoni*)	
Sciaenidae	
Mugilidae	

- However, useful epidemiological data on some monogenean ecto-parasites belonging to the same genera but differences species come from studies in Japan, Black Sea, Australia, N. Zealand and America (Rawson, 1976; Ogawa and Egusa, 1978; Alvaro-Villamar and Ruiz-Campos, 1992; Sharples and Evans, 1995; Roubal et al., 1996; Dmitrieva, 1998)
- Monogenean infestations tend to be endemic, especially in close ecosystems (Duarte et al., 2000). Auto-infestations also exist (Roubal, 1994).

Clinical picture
Behavioural changes

- Anaemia
- Respiratory distress

External Appearance

- Monogenean ectoparasitic infestations usually cause little or no problems.
- High mortalities are recorded only when:
    - the parasitism is severe
    - destruction of the gills is extensive
    - severe anaemia is observed
- Irritation of the gills and skin
- Cloudiness to deep skin ulcers,
- Extensive destruction of the epithelium of the gills
- Ultimately death, especially in younger fish (Noga, 2000).

Internal signs
Diagnosis

- Identification of the parasites is done by observing fresh preparation from the gills and skin.
- Taxonomic identification is usually done only by morphological features, such as attachment organs, presence of eyespots, etc.

Treatment

- Formalin baths
- Antiparasitic treatment

Action

- No legal action is required**.**

Seranocotyle labrachis - present in the gills of sea bass but not pathogenic

Dactylogyrus sp.

Epidemiology

- *Dactylogyrus* is worm-shaped
- Has an attachment organ with 2 big hooks
- Sucker surrounded by a ring of smaller hooks
- *Dactylogyrus* is oviparous, the small brown eggs can often be observed microscopically.

Susceptible species

- All fish species but mainly juvenile in summer
- Carp in warm water temperatures
- Eel and catfish in re-circulation systems

Temperature

- No specific temperature range.

Mortality

- Mainly juvenile fish (carp and rainbow trout) in cases of moderate infections
- Mortalities increase with water temperature.

Transmission

- Infected fish
- Water
- Farm equipment
- Employees

Clinical picture

Behavioural changes

- Respiratory distress

Internal Signs

- No specific signs
- Sometimes the operculae are open (evidence of respiratory problems)
- Mortality

Diagnosis

Microscopically on

- the gill arches and on gill scrape preparations at a magnification of 25x and more
- but rarely on the skin

Prevention

- Stringent hygiene mainly for fry
- Quarantine for eel and catfish for intensive / recirculation systems
- Quarantine for ornamental fish

Treatment

- In recirculation systems (eel or catfish) dactylogyrosis can become a major problem
- Mortality is mainly caused by massive gill inflammation so that a check examination after treatment is recommended.
- Long-term immersion bath using
  - trichlorfon 1g/6m^3
  - water to allow survival of food where fish are dependent on natural food
- Trichlorfon should only be used with permission from appropriate authorities
- Do not use trichlorfon in
  - areas used for water supplies
  - drinking places for animals
- Formaldehyde has only a limited effect
- Use of mebendazole solution, 75-150mg/m^3 in the recirculation water has given good results as a long-term bath.

Gyrodactylus sp

Epidemiology

- *Gyrodactylus* sp. is worm-shaped
- has an attachment unit with two big hooks
- has a sucking organ surrounded by a ring of smaller hooks
- The parasite is viviparous, the "larva" can be seen microscopically (the pair of attachment hooks are recognisable inside the parent parasite.

Susceptible species

- All species, but only presents a significant problem in cases of massive infection

Temperature

- All temperature ranges.

Mortality

- Acute mortality only for fry of ornamental fish with heavy infections

Transmission

- Infected fish
- Water
- Farm equipment
- Employees

Clinical picture

Behavioural changes

- Scrubbing
- Fast swimming movements

External Appearance

Clinical signs

- No specific signs

Diagnosis

- Microscopically in skin scrape preparations
- Rarely observed on gill scrape preparations (25x magnification)

Prevention

- Stringent hygiene mainly for fry as well as quarantine for ornamental fish Routine bath treatment

Treatment

- Treatment only should be used in cases of massive infections.
- Long-term immersion bath using
    - trichlorfon 1g/6m^3 water to allow survival of food where fish are dependent on natural food
- Trichlorfon should only be used with permission from appropriate authorities
- Do not use trichlorfon in areas used for water supplies drinking places for animals
- Salmonids can be treated by immersion bath with formalin, baths may be extended to more than 1 hour.

Diplectanum aequans

Epidemiology

- Fairly common monogenean parasites
- Wide geographical distribution affecting many fish species
- Outbreaks associated with changes in water temperature
- Infections in sea bass reported in the Mediterranean.

Clinical Picture

- These parasites target the gills of the fish where heavy infection can result in 5-10% of losses in juvenile seabass.

Behaviour

- Normal although fish may swim more slowly than non-infected individuals

External Appearance

- Gills can be haemorrhagic and swollen
- Increased mucus production
- Fish can appear slightly paler in colour because of anaemia.

Internal signs

- Liver and spleen can appear pale because of anaemia
- Otherwise all organs are normal in shape, size and colour.

Diagnosis

- Can be confused by the presence of secondary invaders such as bacteria and fungus.
- Presence of the parasite on the gills and epithelium of affected fish, combined with mortality and environmental conditions, is enough for preliminary diagnosis.
- Histology samples to confirm that the parasite is the primary cause of the infection and identify any secondary infections present.

Prevention

- No data available.

Treatment

- Many suitable prophylactic and chemotherapeutic regimes including application of trichlorophon and formalin.

Isopoda (Cymothoidae)
Nerocila orbignyi Anilocra physodes

Epidemiology

- *Nerocila orbignyi* (on sea bass)
- *Anilocra physodes* (on sea bass and sea bream)
- For both parasite species, the adults occur mainly upon the caudal fin and the caudal peduncle
- The larval stages (pulli II) are present in he buccal and opercula cavities and are the actual pathogens

Susceptible species

- In the wild
    - *N. orbignyi* on grey mullets (*Mugil* sp., *Liza* sp.)
    - *A. physodes* on *Boops boops, Boops salpa* and *Diplodus sargus*.

Temperature

- On Mediterranean farms the pathogens *N. orbignyi* and *A. physodes* are mainly seen when the temperatures increase during summer.

Mortality

- Parasitism by pulli II can result in a 20% loss in young fish (up to 10g weight).

Transmission

- Transmission is direct from fish to fish through the water
- Development of the first larval stages takes place in the marsupial pocket of the adult
- Therefore, the life cycle of these isopods can be completed on the same host

Clinical picture

Behavioural changes

- Respiratory distress
- Flared opercula
- Fish gather in more oxygenated areas becoming apathetic and anorexic

External appearance

- The pulli II injure the lamellae, which can lead to necrosis when combined with a secondary infection such with *Flexibacter maritimus*.

Diagnosis

- Direct observation of the adult parasites on the caudal part of the body and pulli II in the buccal and branchial cavity

Prevention

- Prevent the infestation of juveniles using small sized mesh nets around the cages or filter the incoming water tank facilities.

Treatment

- Organophosphates may be effective in controlling these isopoda.

ACANTHOCEPHALA (Spiny headed worms)

Epidemiology

- In heavy invasions Acanthocephalans may perforate the gut wall with their proboscis and cause considerable damage with severe local inflammatory response
- Different Acanthocephalan species.
    - ***Acanthocephalus* sp.**
    - ***Echynorhynchus* sp.**
    - ***Pomphorhynchus* sp.**
    - ***Acanthorygus***
    - ***Pallisentis* sp**

Susceptible species

- All fish species and age groups

Temperature

- Massive invasions are only seen in winter and early spring.

Transmission

- **B**y intermediate hosts - amphipods (essentially *Gammarus*)

Mortality

- Depending on the species of Acanthocephalan, usually not heavy.

Clinical picture

Behavioural changes

External Appearance

- Clear external signs are not evident in live fish

Clinical signs

- On opening the visceral cavity parasites up to 2cm long can be seen macroscopically on the intestinal wall.

Diagnosis

- Macroscopic examination after dissection of the intestine
- Different species can be identified by the head (proboscis) shape when observed microscopically (25x)

Prevention

- Random sampling and examination by the fish farmer
    - During the winter season
    - when purchasing new fish
- General pond hygiene and yearly liming.

Treatment

- In some area a medicated feed (Concurat or Mansonil) may be available on prescription after identification of the parasite
- Massive invasions should be controlled
- Such invasions may have also commercially adverse consequences, if consumers see heavily Acanthocephalan-infected guts.

Crustacea

Copepods

- ***Lernathropus kroyeri***
- ***Lernaocera branchialis***
- ***Lernaeenicus labracis***
- ***Colobomatus labracis***
- ***Caligus elongates- Caligus minimus***

Lernathropus kroyeri

Epidemiology

- Gill parasite
- Sea bass juveniles (up to 10g)

Susceptible species

- Hosts include wild and farmed Atlantic salmon species of Pacific salmon, sea bass and sea bream.
- All stages of fish reared in salt water are susceptible to infestation.

Temperature

- Mature lice may be found on fish at all temperatures, but the prevalence of all stages increases rapidly during the summer months.

Mortality

- Significant fish losses due to osmotic stress and other secondary infections occur among farmed stocks if the condition is not treated
- Mortalities after heavy rainfall (degradation of environmental conditions)

Transmission:

- *C. elongatus* marine parasite on many fish species including salmonids and are present in European and Canadian waters.
- *C. minimus* common among cultured sea bass in France Israel and Italy
- Many non-salmonid species also act as hosts for *Caligus* spp., and this group of lice transfer readily from fish to fish.

Clinical picture
Behavioural changes

- Loss of condition

External Appearance

- Early signs (affected salmon) result in small white-grey patches at the base of the head and along the base of the dorsal fins.
- As the lice feed,
    - the underlying dermis is breached with ulceration,
    - haemorrhage and exposure of the musculature of the head and other areas of the body.
- Increased mucus production which can result in affected fish which then commonly develop a loss of condition and secondary infections.

Diagnosis

- Pre-adult and adult sea lice are visible to the naked eye

Microscopy

- Identification of other stages such as the copepopid and calamus stages requires microscopic examination

Prevention

- Farm management practices such as
- fallowing
- low stocking densities in sea cages can help to reduce lice infestations.

Treatment

- Organo-phosphorus pesticide baths are the traditional method for the control of sea lice.
- This contact treatment will remove adult and pre-adult stages, but is not effective against the *calamus* larvae.
- Control requires repeated treatments throughout the year and is subject to practical difficulties including handling and lice resistance.
- However, new approaches to sea lice control are being investigated, including the development of a vaccine use of "cleaner fish", such as the goldsinny wrasse that feed on lice from the body surface of infected fish use of hydrogen peroxide bath treatments.
- Effective control of sea lice using hydrogen peroxide is achieved using 1.5ppt (parts per thousand) for 20 minutes.
- Emamectine is also an effective oral treatment.

Action

- No legal action is required.

Caligus* sp. *C. elongatus*, C. *minimus

- Gills, skin and buccal cavity of most cultured species
- All temperatures
- Rarely causes damage in healthy fish

Nerocila orbignyi

- Affects sea bass

ISOPODA
SEA LICE: *Ceratothoa oestroides* (Risso, 1826) (Isopoda: Cymothoida)

- Intensive fish farming in coastal waters in the Mediterranean provides an ideal environment for isopod parasites, hence, farmed sea bream (*Sparus aurata*), but mostly sea bass (*Dicentrarchus labrax*) infestations by isopods constitute a recurring problem in the Mediterranean (Athanassopoulou et al., 2001, 2004).
- The most common Isopoda parasites affecting Mediterranean fish are *Ceratothoa parallela* in sea bream *Sparus aurata L.* (Papapanagiotou & Trilles, 2001) and *Ceratothoa oestroides*, *Nerocila orbignyi* (Sarusic, 1999) and *Emetha audouini* (Papapanagiotou et al., 1998, 1999) affecting cage cultured sea bass *Dicentrarchus labrax* L.
- *Ceratothoa oestroides* (Risso, 1826) (Isopoda: Cymothoida) is a well-known parasite affecting a wide range of wild fish species. In recent years, it has become a threat to cage-reared fish facilities, where high fish density provides optimal conditions for transmission (Horton and Okamura, 2001a).
- Its impact on fish health and economical gain is significant, varying from growth retardation and decreased immunocompetency to direct loss due to mass mortalities of juvenile fishes (Mladineo, 2003).

Taxonomy

Phylum ARTHROPODA	Order ISOPODA
Subphylum MANDIBULATA	Suborder FLABELLIFERA
Class CRUSTACEA	Family CYMOTHOIDAE
Subclass MALACOSTRACA	Genus CERATOTHOA
Hyperorder PERACANIDA	Species CERATOTHOA OESTROIDES

Susceptible species	
Cultured fish:	Wild fish:
Sea bream (*Sparus aurata*)	Mullets (*Mugil* sp., *Liza* sp.)
Sea bass (*Dicentrarchus labrax*)	Bogues (*Boops boops*)
	Goldlines (*Boops salpa*)
	Striped breams (*Lithognathus mormyrus*)
	White breams (*Diplodus sargus*)
	Sea bass (*Dicentrarchus labrax*)
	Sea bream (*Sparus aurata*)

- *Ceratothoa oestroides* belongs to the Malacostraca. Its body is dorso-ventrally flattened and is lacking a carapace. These parasites are protandrous hermaphrodites, i.e. an individual develops and functions first as a male and then may become a female, the presence of mature females being inhibitory for a further development of males in their neighbourhood.

Temperature

- There is little information with regard to the generation time under different water temperatures and the fluctuations in fecundity.
- Fecundity and hatching rate increase in warmer temperatures, July being the period of optimum isopod proliferation in the Mediterranean (Varvarigos, 1998).

Mortality

- Sea bass up to 10g could exhibit 40% mortalities in certain endemic areas

Biological cycle

- It metamorphoses by molting into the second pullus (pullus II larva, pullus 2 stage, pullus secundus, prehatch 2), where the theracopods are armed with hooks and with cuticle strongly pigmented by numerous chromatophores.
- The second pullus has six pairs of legs and is also not sexually differentiated. When released in search of a new host, the pulli II can be termed "manca larvae".
- Manca larvae either in the plankton or attached to a fish differ from juveniles since they have six pereonal segments and sets of legs.
- After a subsequent molt, the 7th segment and pair of legs appear and then the isopod becomes a "juvenile".

- They function first as males and subsequently as females, according to circumstances. It is difficult to define when a juvenile becomes an "adult" isopod. Stages of males, transitional females and females (ovigerous and non-ovigerous) are referred to in the literature.
- Since they are protandrous hermaphrodites, then technically, only the females may be safely termed adults.
- Regarding the most sensitive age of the fish hosts when the parasites attach in their buccal cavity, empirical observations agree with research results that there is a significant correlation between the rate of infection and the length of the host, fish fry being the evident target for isopod attachment.
- The whole process from attachment onto a host until settling in the buccal cavity takes up about two hours. There is strong competition among the pulli seeking attachment in the mouth of the host.
- Only two pulli may settle in the buccal cavity of the host comprising the pair of future adults. Thus, although in the first phase of infection a fish may be attacked and carry more than two pulli on its body surface and gill cavity, eventually no super-infection is possible and mostly two isopods may be hosted in the buccal cavity on any one fish. *Ceratothoa oestroides pulli II* larvae remain free swimming and capable of infecting a host for about 7 days at 22°C.
- During this period, even in case that after successful settlement the host dies, the isopod larvae immediately abandon the dead fish and are still capable of actively seeking another (not yet molted to the sessile pre-adult form). Later, after firm establishment in the buccal cavity of the host, the parasites are incapable of migrating to another and begin feeding on blood (haematophagous). It is not precisely known what is the future of adults or gravid female isopods if forced to abandon their dead hosts (Woo, 1995).
- The parasites proliferate mostly when the seawater temperature increases during the summer peaking during July and August, when the prevalence of infection in the cages may exceed 50%. There are no reports regarding endemics in wild fish.
- However, the parasites *Ceratothoa gaudichaudii* and *Caligus* sp. as well as worms (Annelida) may be carriers (vectors) for *Piscirickettsia salmo*nis to cultured fish (Correal, 1995; Larenas et al., 1995; Venegas, 1996). There is also evidence that these infections in sea bass in Greece are related (Athanassopoulou, unpublished data).

Clinical Picture

Behavioural changes

- Apathy
- Anorexia
- Respiratory distress.
- Location in mouth, opercula, gills
- Loss of condition - inadequate feeding
- Sea bass up to 10g could exhibit 40% mortalities in certain endemic areas
- In young stocks, the cumulative mortality due to parasitism by the pulli II larvae may run as high as 15% even without any bacterial implications.

External Appearance

- Isopod infestation is confirmed by gross observation of the parasites on the skin, mouth, or in the gill chamber of the fish.
- Some Ceratothoa species may produce tongue replacement in infected wild fish such as *Spondyliosoma emarginatum* and *Diplodus sargus*.
- Their voracious haematophagy and the mechanical damage of their hooks lead to severe inflammation and necrosis of head, eye and gill tissues.
- The adult isopods are haematophagous (feed on blood) and cause anaemia. The parasitised fish have significantly lower erythrocyte counts as well as haematocrit and haemoglobin values.
- Their large size (up to 6 cm in length) may cause atrophy of the tongue, dysplasia of teeth and slackening of the cartilagenous tissues leading to a "bag-shaped" lower jaw.
- Invariably, the presence of large adult parasites in the buccal cavity interferes with the host's feeding, causes chronic stress and results in growth retardation and a predisposition to bacterial and/or endo-parasitic invasions.

Diagnosis

- Routine observation of the parasites on the fish paying particular attention to the mouth operculae and the gills.
- When the sick fish are removed from the water, several isopod larvae may be seen in their buccal and gill cavities and/or on the skin near the operculi. The haemorrhagic and necrotic head tissues are evident when observing the fish in their cage. Injured tissues are frequently invaded by secondary bacterial pathogens, such as *Aeromonas* sp., *Flexibacter* sp., *Vibrio* sp. and this may lead to severe escalation in mortality.
- The leukocyte counts are increased, obviating the host's immune response to the presence of the isopods. In addition, the established adult isopods can cause considerable damage to the mouth tissues with their biting and sucking mouth parts, or their copulation activity.
- Isopod infestation is confirmed by gross observation of the parasites on the skin, mouth, or in the gill chamber of the fish. In addition, they often produce the lesions described above that characterise their presence.

Prevention

- The increase in prevalence of Isopoda is a serious problem, which nowadays affects a number of cage-reared fish facilities in the Mediterranean, where high fish density provides optimal conditions for transmission.

Treatment

- Although management measures can reduce the prevalence rate of these parasites, and new experimental treatments have been tested (Athanassopoulou et al., 2001, 2004) there is currently no effective treatment for Mediterranean fish.

Action

- No legal action is required

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