PHARMAQ

European Sea Bass & Gilthead Sea Bream Diseases

- Bacterial Diseases
- Viral Diseases
- Parasitic Diseases

Review: Dr. Emre BERKE
Pharmaq Turkiye Field Technical Support Associate

pharmaq.com

zoetis

WE MAKE AQUACULTURE PROGRESS

PHARMAQ
part of zoetis

Content

zoetis

BACTERIAL DISEASES

Content

zoetis

Aeromonas salmonicida

Disease:

The bacterial fish disease caused by *Aeromonas salmonicida subsp. salmonicida* is called *Furunculosis*. The pathogen is commonly found in wild and cultured fish. The causative agent generally affects salmonid species such as *Atlantic salmon (Salmo salar)* and *Rainbow trout (Oncorhynchus mykiss)*, resulting in high mortality. Apart from these, it has also been isolated from some marine fish and other non-salmonid freshwater fish. Bacterial transmission occurs in 3 ways: through lesions on the skin, gills and intestinal epithelium[1].

Affected Species:

- Sea Bass
- Sea Bream[1].

Diagnosis: Bacteria spreads to the affected tissues, causing hemorrhagic septicemia, fin and soft tissue rot, and the formation of typical furuncules. It usually presents with ulcerative dermatitis in non-salmonid species. The main organs affected by the disease are the spleen, liver and skin. Bacteria grow on blood agar and TSA containing 1% NaCl after 24-96 hours of incubation at 18±1°C. Gram negative, rod-shaped, non motile, oxidase and catalase positive[1].

Treatment & Prevention:

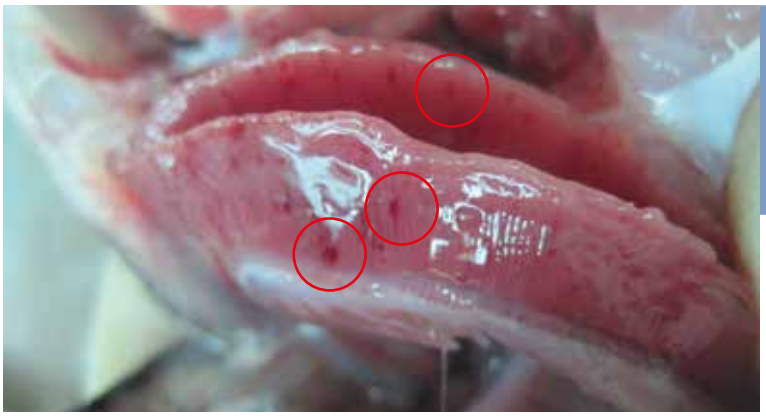
Transmission can occur vertically or horizontally[1]. To prevent vertical contamination, disinfection of fertilized eggs with iodine is recommended[26]. Oil-based autogenous vaccines, on the other hand, have been reported to be effective in preventing and controlling the disease[1]. Treatment is with antibiotics.

References:

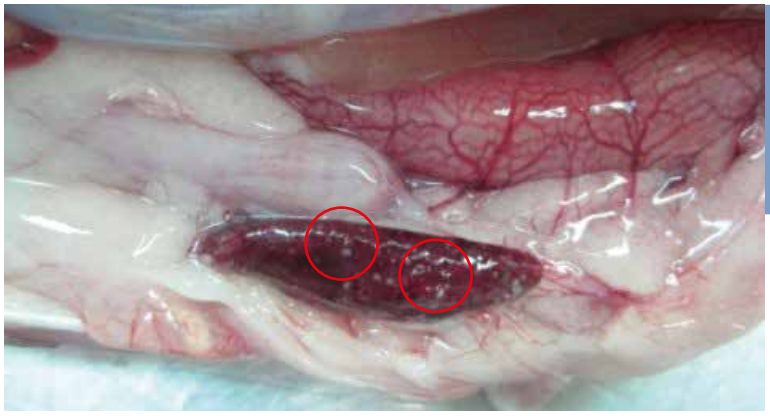
1 26

PHARMAQ
part of zoetis

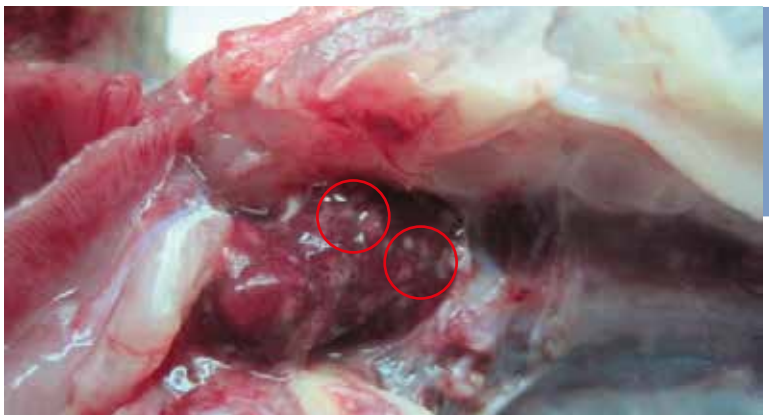
Aeromonas salmonicida



Petechial hemorrhages (circles) and increased mucus in the gill.



Splenomegaly and multiple granu-lomas (circles) in the spleen.



Granulomas (circles) in the kidney.

Aeromonas salmonicida on blood agar containing 2% NaCl.

zoetis

Aeromonas veronii

Disease:

Aeromonas veronii, is an emerging pathogen for the aquaculture industry. It has been isolated from ornamental fish, as well as from many aquaculture fish species. The disease was first isolated in sea bass in 2008 in Greece. While it was seen that it generally affected fish over 200 grams when it was first isolated, today this figure has decreased to fish under 50 grams. The disease is generally seen in the summer months, when the water temperature is above 21°C. In some cases, the total mortality can exceed 50%[2].

Affected Species:

- Sea Bass

Diagnosis: Sick fish are generally apathetic and slow-moving. In later stages, they have an icteric appearance (jaundice) due to the high level of hemolytic activity of the pathogen. Numerous granulomas are observed especially in the spleen and kidney. Liver necrosis and widespread hemorrhages are seen. Lesions can also be seen in the muscle tissue. It produces caseous necrosis on the skin. Bacteria can also be found in areas of the kidney that are not granulomas[2]. The main organs affected by the disease are kidney, spleen and liver[27]. Inoculation from kidney, bacteria grow in TSA containing 2% NaCl, blood agar and Aeromonas isolation agar (AIA) supplemented with ampicillin after 24–48 hours of incubation at 25°C[2–27]. Bacteria are gram negative, rod-shaped, oxidase and catalase positive. Depending on the bacterial strain, they can be motile or non motile[2].

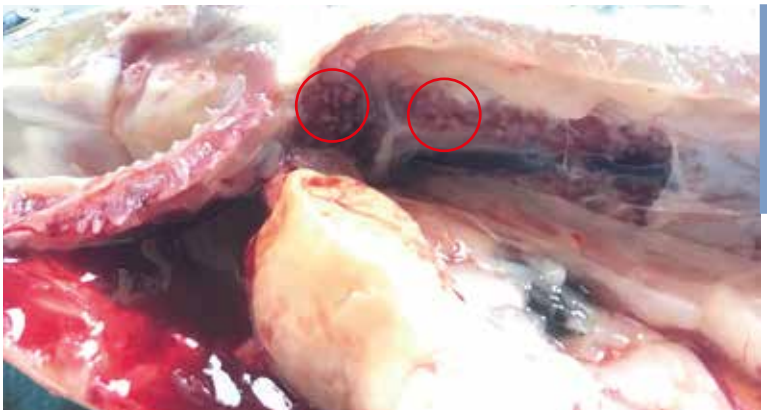
Treatment & Prevention:

The main predisposing factors for the disease are temperature shock, low dissolved oxygen level, high ammonia content and similar factors that negatively affect the water quality, as well as manipulations that will stress the fish. In addition, regions with water currents are in a more risky position for the disease because Aeromonas species likes low salinity waters, rivers, etc. Aeromonas veronii is sensitive to many antibiotics and these antibiotics are used in the treatment[27].

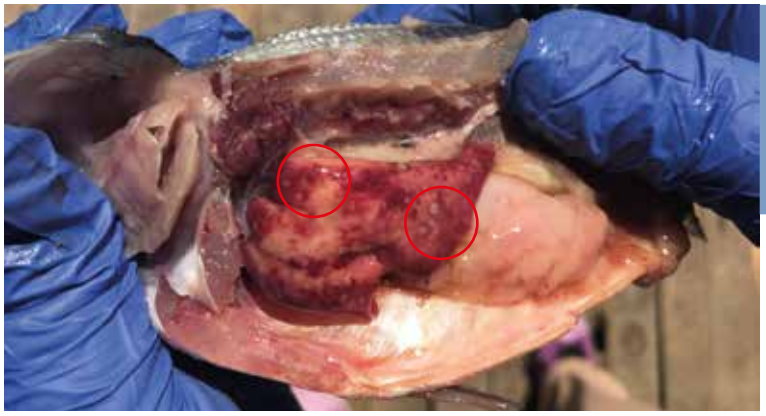
References:

2 27

Aeromonas veronii



Multiple granulomas (circles) in the kidney.



Hemorrhage and granulomas in the liver (circles).

Splenomegaly and multiple granulomas (circles) in the spleen.

Ecchymotic hemorrhages on the skin (circles).

zoetis

Epitheliocystis (Chlamydia–like Organism)

Disease:

Members of the *Chlamydiaceae* are small obligate, intracellular parasites and used to be considered viruses. However, due to the presence of DNA, RNA and ribosomes, and the ability to make their own proteins and nucleic acids, they are now considered to be true bacteria. They have an inner and outer membrane and lipopolysaccharide layer similar to Gram–negative bacteria, but lack a peptidoglycan layer[49]. Gill epitheliocystis, infection of the gill epithelium by chlamydia–like organisms, has been reported worldwide in numerous fish species from both freshwater and marine environments[50]. Mortality due to the causative agent is the result of respiratory distress caused by inflammation, cellular proliferation leading to hyperplasia, and necrosis of the gill lamellae surrounding the cysts. Although there is little data available on fish mortality attributable to *Epitheliocystis*, mortality rates as wide as 4%–100% have been reported. To date, mortalities caused by the diseases have only been described in cultured fish and have been characterized mainly in juvenile fish following a rapid onset of disease. Fatal infections have been reported[51].

Affected Species:

- Sea Bass
- Sea Bream.

Diagnosis: Macroscopically, *Epitheliocystis* appears as white nodular lesions on the gills and skin. Microscopically, infected epithelial cells gradually enlarge and contain spherical cysts filled with bacteria that are basophilic and encapsulated by a membrane[51]. There is no culture method for the causative agent. If histologic methods are not used in the diagnosis, the disease may be missed. In some cases, the causative agent can be detected by native examination, but histopathology is required for definitive diagnosis[52].

Epitheliocystis (Chlamydia–like Organism)

Treatment & Prevention:

Epitheliocystis infections are more common in cultured fish than in natural fish. This suggests that culture conditions may exacerbate *Epitheliocystis* due to increased fish density, water quality deterioration, nutrients and/or stress. The prevalence of the causative agent increases during the summer months due to increased water temperature. The age–dependent morphology of *Epitheliocystis* cysts has been reported in bream, with granular cysts in 0.7–2 g fry, granular and amorphous cysts in larger fry, and only amorphous cysts in 400 g bream. It has been suggested that fish age may play a role in the transition between the different developmental cycles of cysts. Oral antibiotic treatment has yielded favorable results[52].

References:

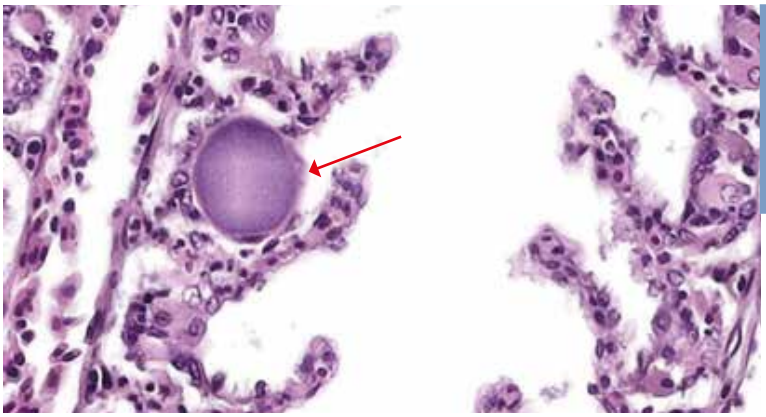

49


50

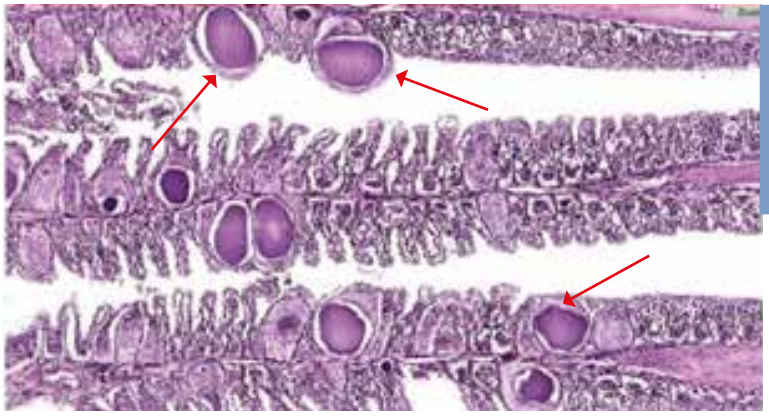

51


52

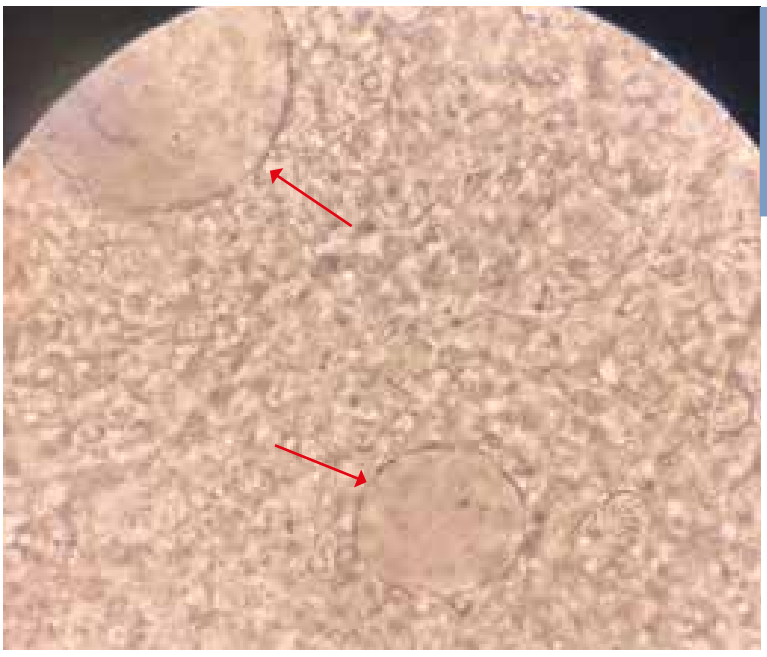
Epitheliocystis (Chlamydia–like Organism)



Gill epitheliocystis histo–pathology, (sea bream).



Dense epitheliocystis in the gill, histopathology (sea bream).



Gill epitheliocystis fresh smear, (sea bream).

Mycobacterium marinum

Disease:

Mycobacteriosis or "*Fish tuberculosis*" is a chronic progressive disease that affects fish worldwide. *Mycobacterium marinum* is the most common Mycobacterium species known to infect fish in freshwater, brackish and saltwater environments. The most severely affected organs in cultured fish are the spleen and kidney, with enlarged visceral organs and skin ulcers rendering infected fish unmarketable[3].

Affected Species:

- Sea Bass[3]
- Sea Bream.[28]

Diagnosis: Sick fish are cachectic and have abdominal swelling. Apart from these, lethargy, pale gills and skin necrosis can also be seen by external examination. In internal organs, enlargement of the spleen, and grayish-white nodules in the kidney and liver are seen. Almost all tissues such as eyes, gills, internal organs, muscles and fins may be susceptible to the disease[4]. Observation of growth in Lowenstein Jensen medium at temperatures ranging from 30-37°C may take from 2 weeks to 8 weeks[29]. Bacteria can be detected on Ziehl-Neelsen staining of histological sections. It is gram-positive, rod-shaped, and non motile[3].

Mycobacterium marinum

Treatment & Prevention:

Fish affected by the disease can live asymptomatically for a long time. Contamination can occur from untreated wet feeds. Therefore, feeding with wet feed should be avoided. Apart from this, good hygiene and bio-security practices should be followed. Excessive stocking density and overfeeding should be avoided. There is no widely accepted treatment method and control of the disease limited to culling of affected populations and disinfecting the tanks and equipment in which these fish were held[4].

References:

3 4 28 29

Photobacterium damselae subsp. piscicida

Disease:

Photobacterium is divided into two subspecies, *Photobacterium damselae subsp. piscicida* and *Photobacterium damselae subsp. damselae*. *Photobacterium damselae subsp. piscicida* is considered the primary agent for acute Photobacteriosis of fish. *Photobacteriosis* is a bacterial septicemic disease that is observed in many different fish species worldwide and causes high mortality[30]. The disease has caused significant economic losses in sea bass and sea bream, which have been grown in the Mediterranean region since 1990[4].

Affected Species:

- Sea Bass
- Sea Bream

Diagnosis: There are two forms of the disease, acute and chronic. In the acute form, sick fish are found dead at the bottom of tanks or cages with very few clinical signs. Blood vessels in the secondary gill filaments are sometimes visible, with slight darkening in color, skin ulcers, and abdominal swelling. Splenomegaly, visceral petechiae, and necrotic enteritis are also typical internal signs of the disease. In the chronic form, there are granulomas in the internal organs, especially in the spleen and kidney[4]. Growth can be observed in BHI agar containing 1%NaCl and blood agar containing 3%NaCl when incubated for 24 hours at 25°C. The bipolar image obtained in Gram staining may provide an idea for the preliminary diagnosis of the disease. The bacteria are gram negative, rod-shaped, motile, oxidase and catalase positive[30].

Photobacterium damselae subsp. piscicida

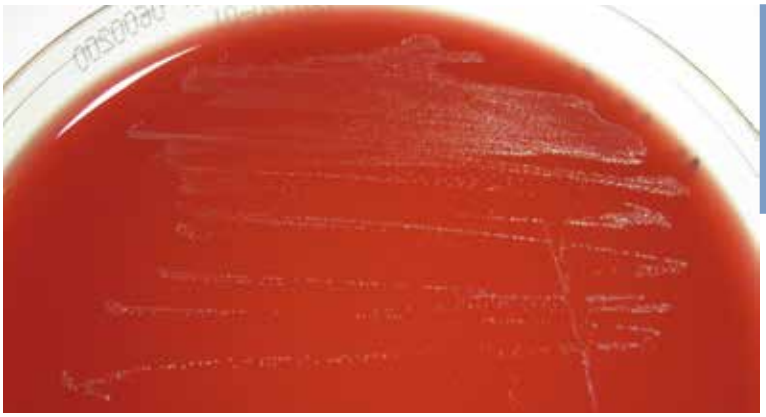
Treatment & Prevention:

Early diagnosis of the pathogen is critical to take adequate precautions to prevent vertical or horizontal transmission of the disease. Commercial vaccines can be administered by injection or immersion and provide effective protection against the disease. Immunostimulants such as lysozyme and β-glucan may also increase the resistance of fish against diseases. In its treatment, many antibiotics can be administered orally or by bath[4].

References:

4 30

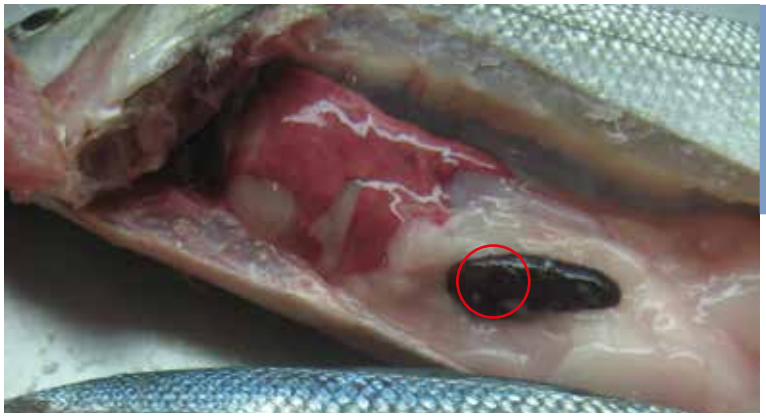
Photobacterium damselae subsp. piscicida



Photobacterium damsela subsp. piscicida colonies in blood agar containing 2% NaCl.

Splenomegaly and multiple granulomas on spleen (sea bream).

Multiple granulomas and splenomegaly in the spleen and hemorrhage in the liver (circles).



Splenomegaly (circle).

Pseudomonas anguilliseptica

Disease:

Pseudomonas anguilliseptica is an important pathogen that affects a large number of different fish species produced in brackish and salt water worldwide[31]. It is seen when the water temperature drops below 11–12°C. The causative agent has been associated with *Winter disease* in sea bream[5]. Although *Winter disease* is seen as a multifactorial syndrome, its aetiology is still not clear but the fact that *P. anguilliseptica* is often detected in fish diagnosed with *Winter disease* suggests that this bacterium has an important role in the etiology of the disease[28].

Affected Species:

- Sea Bream

Diagnosis: The external appearance of the fish is generally normal, except for a frequently observed abdominal swelling. Acidic fluid observed in the peritoneal cavity is the most common finding in the internal organs. The liver is pale in color and easily fragmented, and petechial hemorrhages are observed in some cases. The kidneys are hemorrhagic and the intestines are congestive with fibrinous yellowish exudate. Growth can be observed in 7 days at 22°C on blood agar, TSA and Mac Conkey agar by incubation from liver and kidney[5]. Molecular methods are recommended for the identification of colonies. The presence of pathogen can also be detected from tissue samples by real time RT-PCR. The bacteria are gram negative, filamentous rod-shaped, non motile, oxidase and catalase positive[5].

Treatment & Prevention:

There is no commercial vaccine developed against the agent[32]. Antibiotics are used in treatment, but treatment will become more difficult due to reduced feed intake at low water temperatures[5].

Pseudomonas anguilliseptica

Appearance of internal organs.

Abdominal swelling due to acidic fluid in the peritoneal cavity.

References:

5 28 31 32

Tenacibaculum sp. (Flexibacter sp.)

Disease:

Tenacibaculum sp., formerly known as *Flexibacter*, has two important species, *Tenacibaculum maritimum* and *Tenacibaculum dicentrarchi*, isolated from sea bass[4]. *Tenacibaculum maritimum* has been isolated from both sea bass and sea bream[33]. The prevalence and severity of the disease increase at temperatures above 15°C and salinity from ‰30 to ‰35. Disease onset can be caused by environmental factors (physical and chemical stress), biological factors (high stocking density, incorrect feeding strategy, and manipulations), and host-related factors (skin surface condition). Adult and juvenile sea bass may be affected by the disease, but fish between 2–80 grams are most susceptible to the disease and a rapid transition may occur from the early detection to the advanced stages when ulcerative lesions occur[4].

Affected Species:

- Sea Bass
- Sea Bream

Diagnosis: It forms pale foci with yellow borders that rapidly transform into severe necrotic lesions on the body surface, base of the fins, in and around the oral cavity, eyes, and sometimes on the gills. A large number of thin, long gram-negative rod-shaped bacteria can be detected in microscopic examination of tissue taken from the periphery of the lesions[6]. Isolation of the bacterium occurs by incubation on Flexibacter maritimus medium and marine agar prepared with sea water for 48–72 hours at 20–25°C[33]. Molecular methods are recommended for the identification of colonies. The presence of pathogen can also be detected from tissue samples by real time RT-PCR. The bacteria are gram negative, filamentous, motile, oxidase and catalase positive[33].

Tenacibaculum sp. (Flexibacter sp.)

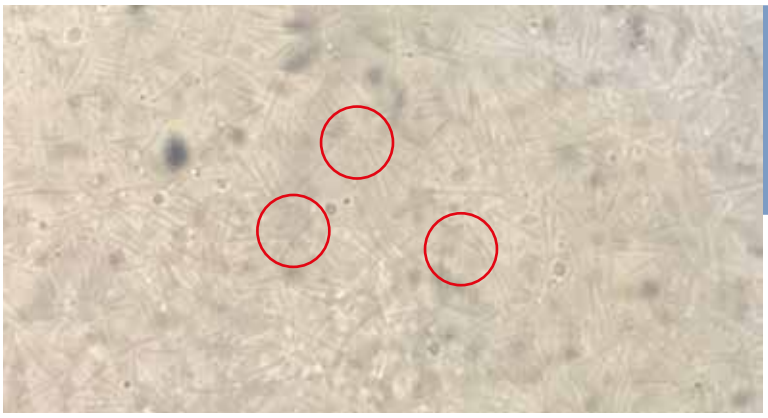
Treatment & Prevention:

Although high stocking density and avoidance of overfeeding reduce the incidence of the disease, the most effective method of prevention is immunoprophylaxis. There is no commercial vaccine for *Tenacibaculum* produced for sea bass and sea bream yet. The treatment of the disease is with antibiotics and bath treatments are more effective than oral treatments. The use of disinfectants or, if possible, changing the temperature or salinity ratio can be used to reduce the morbidity of the disease[4].

References:

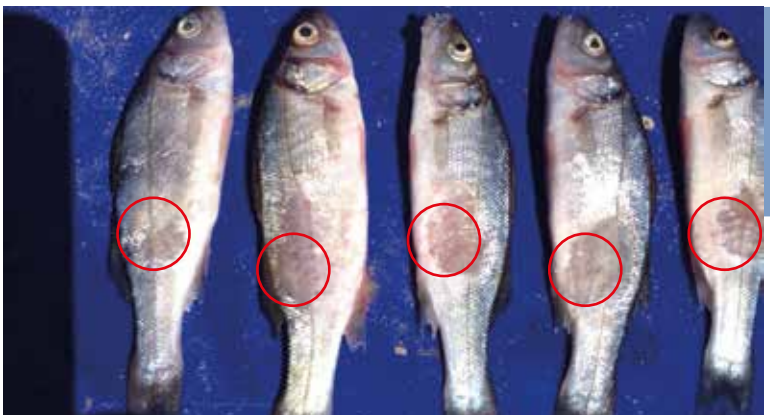
4 6 33

Tenacibaculum sp. (Flexibacter sp.)

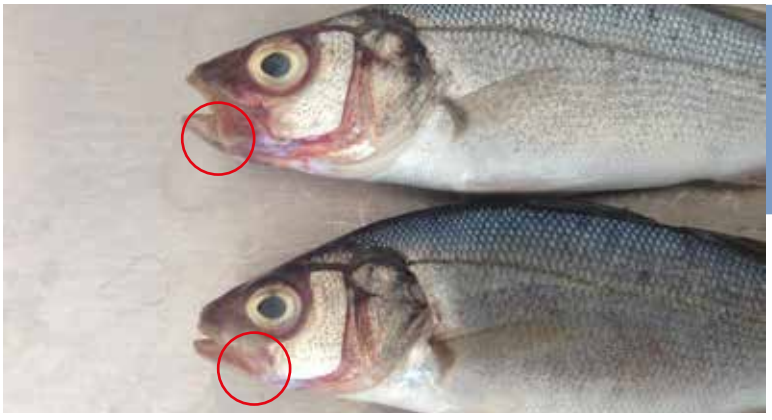


Tenacibaculum sp. on fresh smear (x100).

Gill necrosis (circle).



Ulcers on skin (circles).



Hemorrhages around the mouth (circles).

Vibrio anguillarum

Disease:

Vibrio anguillarum, also known as *Listonella anguillarum*, is the causative agent of *Vibriosis*, a deadly hemorrhagic septicemic disease that affects various marine and freshwater fish and shellfish. Currently, there are 23 different O serotypes (O1–O23) exhibiting different pathogenicity and host specificity. Of these, only the O1 and O2 serotypes and to a lesser extent the O3 serotype are associated with *Vibriosis* in fish. Other *V. anguillarum* serotypes represent mostly non-pathogenic environmental isolates such as sediment, plankton, or seawater. Among the important factors causing *Vibriosis* are; chemical stress (such as water quality, pollution, composition of the diet), biological stress (such as population density, presence of other micro or macro organisms) and physical stress (such as temperature). Vibriosis outbreaks occur at water temperatures above 15°C[7].

Affected Species:

- Sea Bass
- Sea Bream

Diagnosis: Typical external clinical signs of *Vibriosis* include weight loss, lethargy, red rash in the ventral and lateral regions, and swollen dark skin lesions that may ulcerate and bleed. The pathogen is found in high concentrations in the blood and hematopoietic tissues. In the internal organs, the intestines are swollen and filled with a clear liquid. However, in acute epizootics, the infection can spread so rapidly that most of the infected fish die without showing any clinical signs[7]. Isolation of the bacteria occurs after incubation on TCBS and blood agar for 48 hours at 20°C[34]. Molecular methods are recommended for the identification of colonies. The presence of pathogen can also be detected from tissue samples by real time RT-PCR. The bacteria are gram negative, rod-shaped, motile, oxidase and catalase positive[7].

zoetis

Vibrio anguillarum

Treatment & Prevention:

Vaccination of fish by immersion and injection is the most effective method of protection. Alternative protection methods are the use of antimicrobial peptides, probiotic applications, and immunostimulation through nutrition. Many antibiotics are used in its treatment[4].

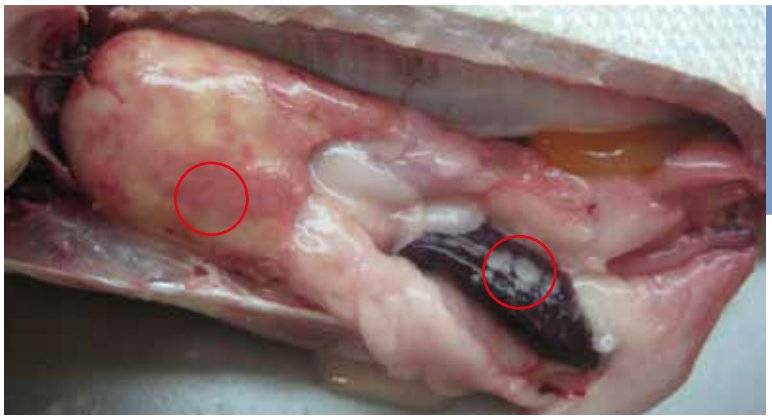
References:

4

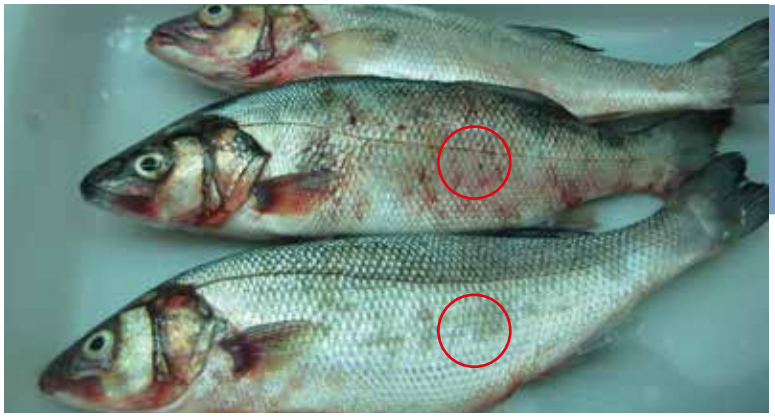
7

34

Vibrio anguillarum

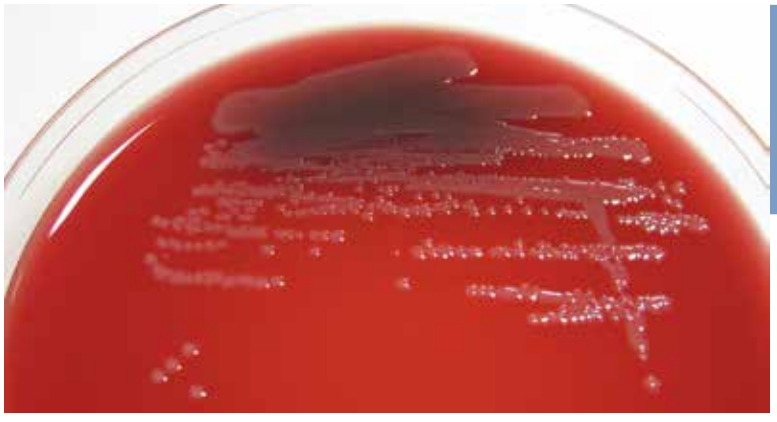


Splenomegaly in the spleen and hemorrhages in the liver (circles).



Skin hemorrhages (circles).

Hemorrhages around the pelvic fin (circles).



Vibrio anguillarum O1 colonies on blood agar containing 2% NaCl.

Vibrio harveyi

Disease:

Vibrio harveyi is a gram-negative bacterium that lives freely in water and has been identified as being associated with algae blooms or intestinal microbiota. As a serious pathogen affecting the aquaculture industry, it has often been isolated in mass mortality events of several vertebrate and invertebrate marine fish and shellfish. *V. harveyi* outbreaks show a significant increase in temperatures above 20°C, and it has been observed that the risk of infection with other pathogens increases with the increase in prevalence[8].

Affected Species:

- Sea Bass
- Sea Bream

Diagnosis: The bacterium is an opportunistic pathogen and transmission occurs horizontally. The periods when water temperature is between 18°C–27°C are most risky. It is generally characterized by systemic hemorrhagic septicemia and abdominal swelling. Congestion of blood vessels and hemorrhages in the liver and spleen are common. Darkening colour of the skin, pale gills, hemorrhages at the bottom of the fins and exophthalmos are other common clinical signs. Isolation of the bacteria occurs after inoculation in TCBS and TSA containing 2.5% NaCl for 48–72 hours at 23°C. Molecular methods are recommended for the identification of colonies. The presence of pathogen can also be detected from tissue samples by real time RT-PCR. The bacteria are gram negative, rod-shaped, motile, oxidase and catalase positive[8].

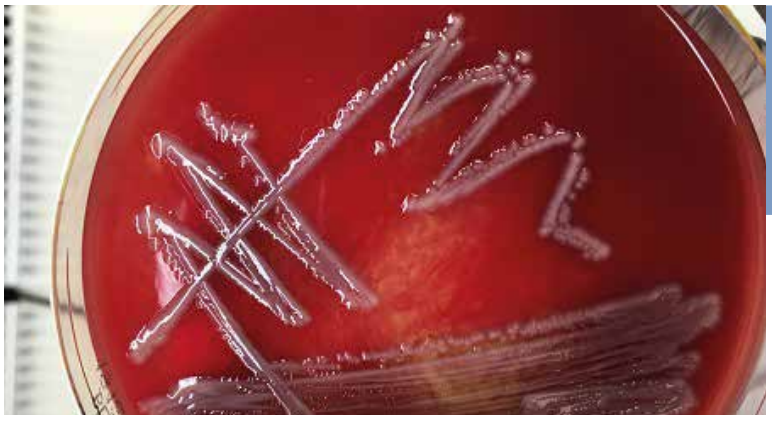
Vibrio harveyi

Treatment & Prevention:

Sea bream are more resistant to disease than sea bass and can be asymptomatic carriers of the disease, causing them to act as reservoirs for the pathogen. Keeping sea bream in the same area with the sea bass increases a risk for the sea bass to be infected with the disease. The prevalence of infections from *Vibrio harveyi* and other *Vibrio* species is expected to increase due to climate change[8]. Due to the intensification of production, antibiotic resistance and climate change, good biosecurity and sanitation measures should be taken on farms to prevent the onset of disease outbreaks and the emergence of new pathogens. In the treatment, feeds prepared with antibiotics selected according to the results of the antibiogram are used[4].

References:

4 8



Vibrio harveyi colonies on blood agar containing 2% NaCl

VIRAL DISEASES

Content

Lymphocystis

Disease:

Lymphocystis is an infectious viral disease manifested by hypertrophy of connective tissue cells in the body and fins. It is frequently seen in ornamental fish as well as freshwater and saltwater fish. It is a DNA virus belonging to the family *Iridoviridae*. Depending on the host type and water temperature, within a few weeks, *Lymphocystis* realizes its hypertrophic growth in the dermal cells, matures and spreads into the aquatic environment by molting with the rupture of the cells[24]. The disease is generally seen in sea bream at temperatures between 22–27°C and heals 30–40 days after the first day of clinical signs in this temperature range. At temperatures below 22°C, the recovery rate is low, but the recovery period is up to 60–70 days[28].

Affected Species:

- Sea Bream

Diagnosis: The disease generally affects the skin, but in severe infections, it can also affect internal organs such as the spleen and heart. On the skin of affected fish, wart-like structures consisting of extremely hypertrophic dermal fibroblasts that can be seen macroscopically. These structures initially appear as white and later appear reddish with vascularization, or grayish due to pigmentation of the epithelial layer in these structures[28]. Affected fish pupulations can be vulnerable to secondary bacterial infections and therefore mortality may occur. The disease can progress with high mortality in juvenile fish between 0.5 and 5 grams. Pre-diagnosis of the disease can be made with clinical findings that can be seen macroscopically. Histopathological examination can reveal whether it has spread to internal organs, and molecular methods can be used for definitive diagnosis[24].

Lymphocystis

Treatment & Prevention:

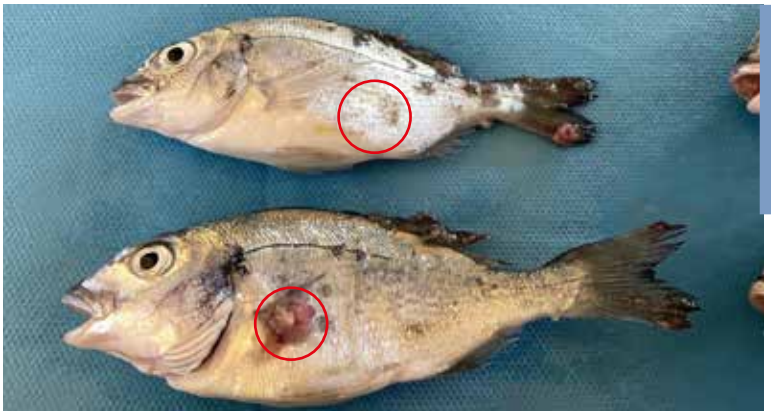
The infection is transmitted to the host by spreading through contaminated water. *Lymphocystis* affects the entire body surface by forming irregularly shaped white masses in sea bream. As the disease progresses, death may occur due to secondary bacterial infections. Therefore, the use of antibiotics during the disease is beneficial in alleviating mortality. Young fish are more susceptible to the disease. Transmission can occur as a result of cannibalism or by biting the lesions in sick fish, so reducing stocking densities and preventing cannibalism can slow the transmission of the disease. Since the disease is also transmitted by the aquatic environment, removing dead fish from the environment is an important control measure. Fish that survive the disease become immune to the disease. There is no effective treatment method against the disease[28].

References:

24 28

Lymphocystis

Lymphocystis in Sea Bream (10gr.)



Lymphocystis in Sea Bream (25gr.)

Lymphocystis in Histology.

Lymphocystis in Histology.

Viral Nervous Necrosis

Disease:

Nervous necrosis virus is the causative agent of "*Viral Encephalopathy and Retinopathy*" disease commonly known as *Viral Nervous Necrosis* (VNN), which causes brain and retinal damage in more than 50 fish species. Nervous Necrosis virus is also known as *Betanodavirus*, a genus of non-enveloped single-stranded RNA virus from the family *Nodaviridae*. In Mediterranean aquaculture, sea bass is one of the most sensitive species, especially in the larval and juvenile stages, and it causes mortality up to 100% at these ages. Sea bream, on the other hand, is less susceptible than sea bass and is a carrier for most strains of the virus. Transmission occurs horizontally or vertically[25].

Affected Species:

- Sea Bass
- Sea Bream

Viral Nervous Necrosis

Diagnosis: VNN outbreaks are often associated with acute mortality. Clinical symptoms are usually accompanied by abnormal swimming behaviors such as turning, lying on the stomach, waiting at the bottom of the tank, rapid swimming movements in circles or straight bursts. Although clinical signs such as mild lesions, excessive swelling of the swim bladder (usually in larvae), traumatic bleeding in the mouth of the body, erosion (usually in large fish) may be seen in sick fish, more often there are no clinical signs are seen in fish in VNN outbreaks[38]. Other clinical findings reported with the disease include; congestion in the head, opacity in the eye, darkening in color, and anorexia. Mortality usually varies between 20–30%, and this figure can go up to 100%. The age of the fish, the strain of the virus and the presence of other stress factors play an important role in mortality. Fish that survive tend to have reduced weight gain and be more susceptible to other bacterial and parasitic diseases. In addition, these fish carry the virus throughout their lives. If the carrier fish experience any stressful situation (such as the sexual maturation), they may start to spread the virus, or show clinical signs again before they die. Clinical findings can be evaluated for histopathological examination for preliminary diagnosis, but molecular methods are used for definitive diagnosis[45].

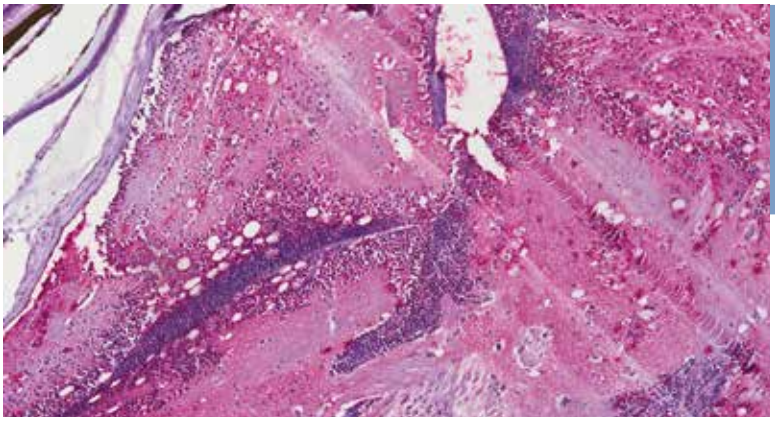
Treatment & Prevention:

Transmission of the disease mostly occurs horizontally, through direct contact with infected fish, infected water, or contaminated equipment. The incubation period and severity of clinical signs depend on both the viral genotype infecting the fish and the water temperature. Stress factors such as excessive stock density, poor quality feed, and mechanical processing of fish (e.g., transport and grading) can affect the severity of the disease and increase mortality. Vertical transmission of the disease has also been described in several species. Fish that have had the disease but have survived will remain as carriers for a long time, and if these fish are selected as broodstock, the disease can also be transmitted to the juveniles. In larvae and juveniles, the disease is particularly severe and can cause almost 100% mortality rate. There are commercial vaccines available against the disease, but there is no effective treatment for the disease[45].

Viral Nervous Necrosis

References:

25 38 45



Vacuoles in the brain (sea bass).

PARASITIC DISEASES

Content

Amyloodinium ocellatum

Disease:

Amyloodinium ocellatum is one of the most important pathogenic parasites affecting fish grown in marine and brackish waters. The parasite produces a powdery or velvety appearance on infected fish, and the resulting disease is often called "*Velvet disease*" or "*Amyloodiniosis*". It has the ability to reproduce rapidly and is not species specific[10].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

There are three phases in the life cycle of the parasite. The fixed or feeding stage, the trophont, remains attached to the skin and gill surface by root–like structures. When the trophont matures, it separates from the host to form a reproductive "cyst" or tomont. This tomont divides to form many free–floating dinospores that can infect a new host[4].

Diagnosis: It mainly infects the gills and less frequently the skin (fins and body) and oral cavity of the host fish. In the Mediterranean region and the Red Sea, high mortality caused by the parasite in sea bass fry has been reported[9]. Infected fish appear stressed and anorexic. Rapid gill movements are observed and fish can gather at the bottom of rearing units. Mortality develops very rapidly and collectively. In addition, large focal areas of erosion are seen on the operculum and tail. The affected skin has a velvet–like appearance, darkening in color, and increased mucus secretion[10]. The preliminary diagnosis can be made in line with clinical findings, but confirmation should be made by examining the skin and gill scrapings under a microscope. The skin and gill scrapings can be stained with lugol solution to make the parasites more visible. Histopathology can also be used for diagnosis, but during fixation many trophonts are likely to detach from tissue, which can be misleading when assessing the intensity of infestation. Molecular methods can be used for diagnosis and infestation severity[4].

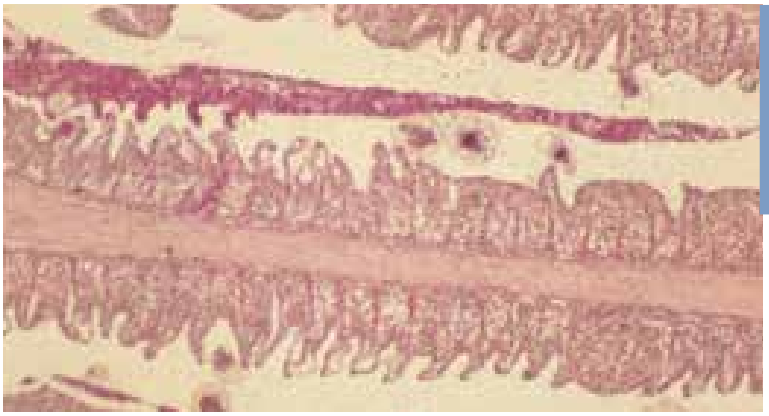
Amyloodinium ocellatum

Treatment & Prevention:

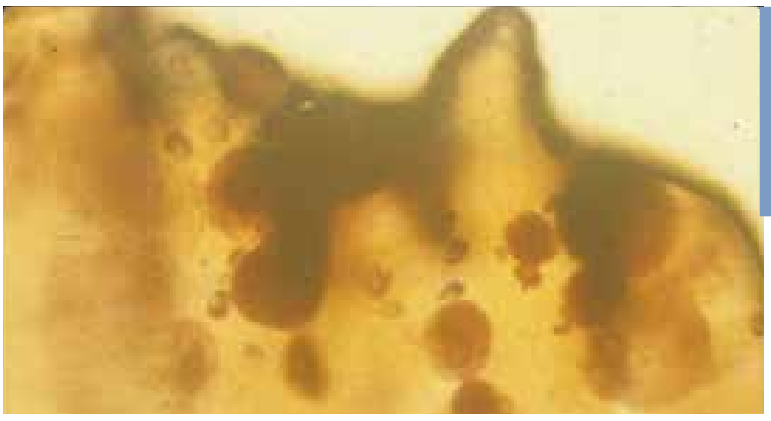
The most risky periods for the disease are when water temperature is between 16–30°C and salinity is between 12–50 ppt. Although bath applications with disinfectants have been used to treat of the disease, full success cannot be achieved. Therefore, protection should be provided by routine disinfection of tanks, pipes and nets. The agents can be easily spread by infected water or fish. Therefore, the water entering the closed systems should be disinfected with UV or ozone, and a quarantine protocol should be applied to the newly introduced fish[4].

References:

4 9 10



Amyloodinium ocallatum, gill, bream
Photographer:
Dr. Francesc Pedros Bover.



Amyloodinium ocallatum, lugol, gill, bream
Photographer:
Dr. Francesc Pedros Bover.

Ceratomyxa spp.

Disease:

Ceratomyxa is the largest genus of myxospores, consisting of approximately 300 species, most of which are found in the gallbladder of marine fish. Low-density myxospores are frequently reported in fish species farmed in the Mediterranean region. Recently, their incidence and infection levels have increased considerably. *Ceratomyxa spp*. infections are generally considered harmless. It is thought that more importance should be given to these parasites in cases of mixed infections. The parasite has been reported in sea bream and sea bass[11].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

There are two different forms of the parasite, actinospore and spore. In transmission, the actinospore form of the parasite infects the host and the parasites pass into the spore form in the host. The parasite is excreted in the spore form, which finds an intermediate host and multiply there and is then released from the intermediate host in the form of actinospores[47].

Diagnosis: Infected fish have been observed to have abdominal swelling, gallbladder can be 3–4 times longer than normal, and bile darker in colour[11]. Parasites can be easily observed by examination of the gallbladder contents. Parasites may become more visible by staining fresh smears and histological sections with Giemsa. Molecular methods are recommended for definitive diagnosis[4].

Ceratomyxa spp.

Treatment & Prevention:

As with many diseases, good husbandry management practices can be helpful in reducing the impact of *Cearatomyxa spp*. and other infections that can be associated with the parasite. In order to prevent the spread of the parasite, the infected fish should not be transfered. In closed and semi-open systems, the inlet waters of the enterprises should be subjected to processes such as filtration, ultraviolet and ozone disinfection, reducing the risk of contamination. The disease is transmitted from fish to fish. Regular and frequent collection of dead or dying fish is beneficial to prevent the transmission of spores from these fish[46]. There is no known effective treatment for the disease[11].

References:

4

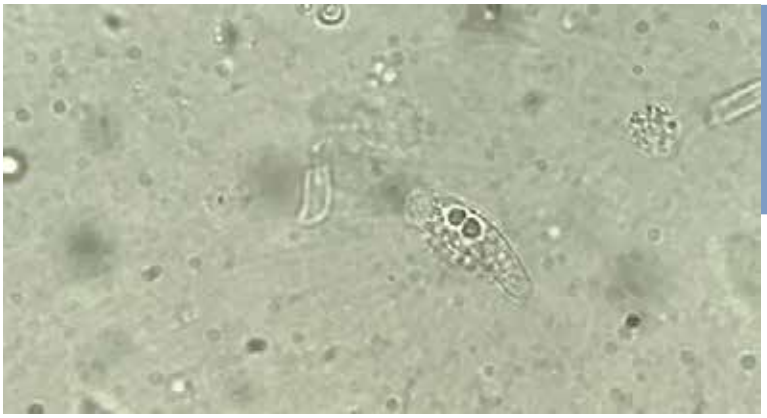
11

46

47

Ceratomyxa spp.

Parasites seen in the fresh smear of the gallbladder contents.



Parasites seen in the fresh smear of the gallbladder contents.

Parasite seen in the fresh smear of the gallbladder contents.

Coccidia – Eimeria spp.

Disease:

Parasites in the genus *Coccidia* have been isolated from many fish species in fresh-, brackish- and saltwater. One or more *Coccidia* species have been isolated from many fish species. Since the host specificity is very low, transmission, especially from fish to fish, is very high[35]. Parasites have been isolated from both natural and farmed fish[12]. To date, *Eimeria bouixi* and *Eimeria dicentrarchi* species[4] have been isolated from sea bass, and *Eimeria sparis* and *Goussia sparis* species[28] from sea bream.

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

The parasite generally has three phases: merogonic, gamogonic, and sporogonic. Parasites in the merogonic stage are called meronts and this is the first stage in the parasite's life cycle. Meronts can usually be identified from histological sections. Meronts are taken into the host by digestion, where they become macrogamont and microgamont and pass into the gamogonic stage. Macrogamonts develop into macrogametes without division, while microgamonts divide into multiple microgametes. Microgametes fertilize macrogametes to form zygotes, and the zygote transforms into oocytes, leading to the sporogonic stage[35]. The oocyte form settles in the digestive system, where sporulation takes place. Therefore, oocytes isolated from the digestive system can be seen in 3 different forms as unsporulated, semi-sporulated and sporulated[12].

Coccidia – Eimeria spp.

Diagnosis: Parasites in different life cycles can be diagnosed throughout the entire digestive tract, but are more common in the first parts of the intestines. While no clinical findings are observed in infected fish, pathological changes can be observed mostly in histological sections. In histological sections, damage to the infected epithelial cells can be observed at the level of necrosis. Parasites in the sporogonic and gamogonic stages can be diagnosed by gross examination, while parasites in the merogonic stage can be detected more often by histology. Micro and macrogametes can also be diagnosed by PAS staining method[12].

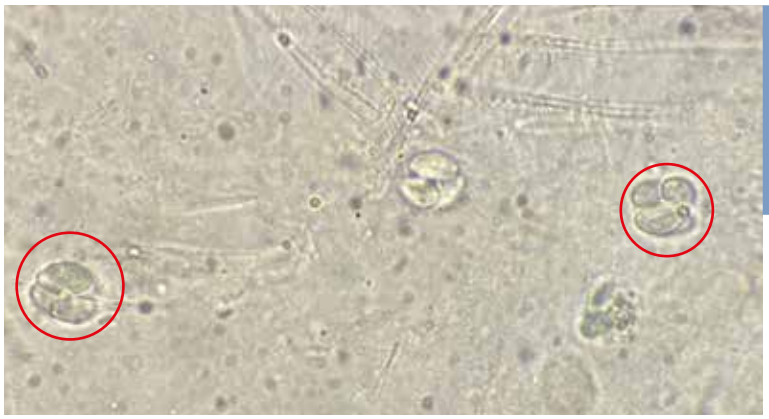
Treatment & Prevention:

Trials with some antibiotics have shown that these agents give positive results in the treatment of parasites, but studies on this subject are very limited.

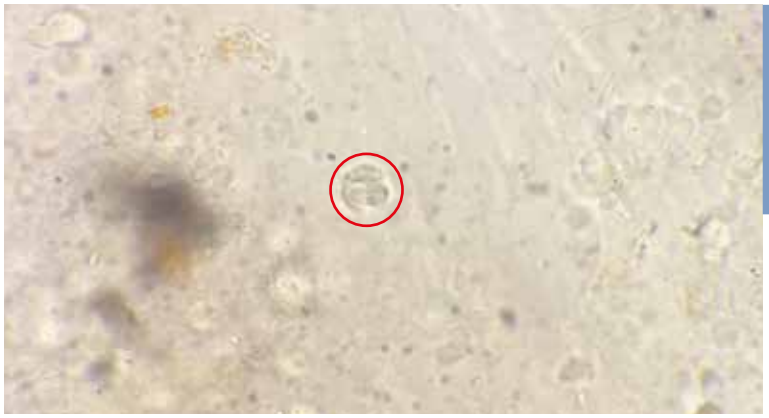
References:

4 12 28 35

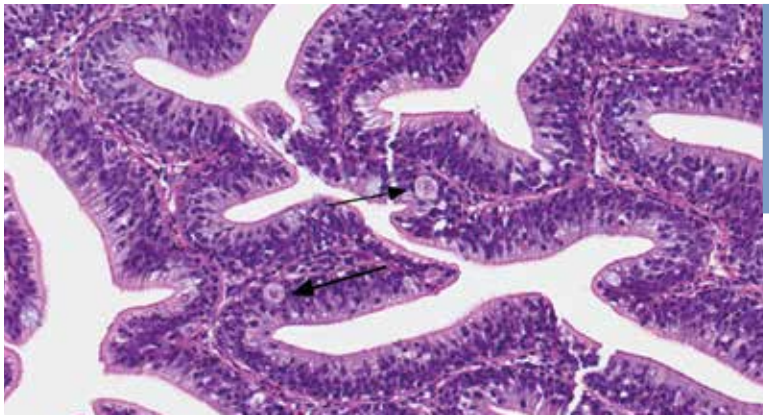
Coccidia – Eimeria spp.



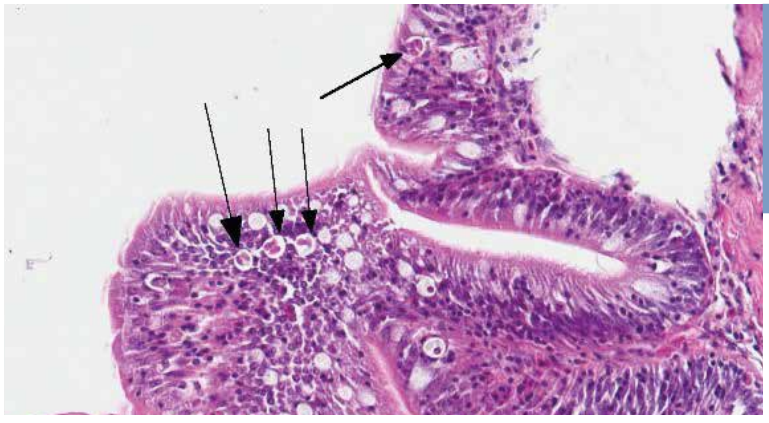
Sporulated oocytes on fresh smear (Intestine).



Sporulated oocytes on fresh smear.



Coccidia agents in histology.



Coccidia agents in histology.

Cryptocaryon irritans

Disease:

Cryptocaryon irritans causes a disease known as "*White Spot Disease*" in marine fish. The parasite has a wide host range and can infect almost any saltwater fish. With the growth of the aquaculture industry, *White Spot Disease* is frequently diagnosed and can cause significant economic losses[13].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

There are different stages in the life cycle of the parasite, that exit inside and outside of the fish. Trophont or parasitic stage is found in the epidermis of fish and feeds on the epithelial layer of the skin, fins and gills. When mature, it leaves as a free-floating protomont and settles on a suitable substrate (sea or tank floor, etc.), then transforms into a tomont or cyst stage, forming a double-layered cyst wall. A large number of tomites are produced inside the tomont, and these tomites are then released and attached to the skin of the fish. Tomites that settle in the epidermis become trophonts and complete their life cycle[13].

Diagnosis: Infected fish have small white spots or nodules on their fins, skin, and gills. In addition, erosion of the fins, a whitish coating on the eye, increased mucus production, abnormal swimming, lethargy, changes in skin colour and flashing may occur. It can be difficult to diagnose the disease, since white spots due to infection are not always visible and other clinical findings are not very specific. To confirm infection, gross examination of the skin, fins, and gills may detect torophont or tomite stages of the parasite. the fragmented macronucleus of the parasite can be easily identified by staining with Giemsa[4].

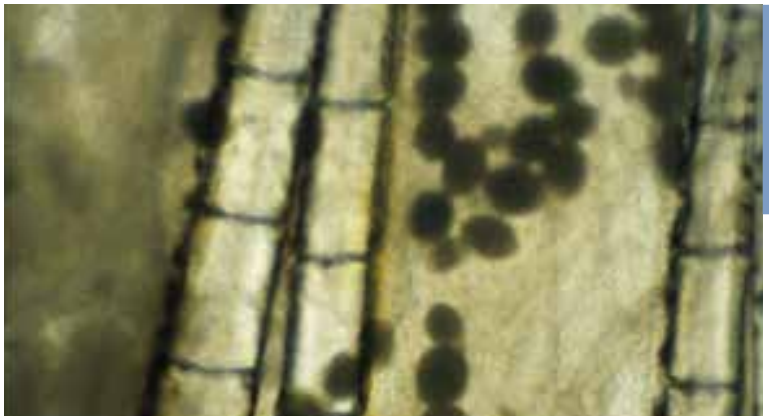
Cryptocaryon irritans

Treatment & Prevention:

White Spot Disease can cause serious problems, especially in closed systems, or in systems with poor water flow where cystic phases can occur. The periods when the water temperature is between 15°C and 30°C are risky periods[4]. The most effective treatment is to transfer fish between tanks (the infected tank is thoroughly dried and disinfected) 4 times at exactly 3 day intervals. It has also been observed that the treatment was successful in bath applications with disinfectants. It has been reported that bath applications applied late at night, when the tomites are released from the cysts and the mature trophonts leave the host as protomonts, are more effective[28].

References:

4 13 28



Cryptocarryon irritans, caudal fin
Photographer:
Dr. Francesc Pedros Bover.

Diplectanum aequans

Disease:

Diplectanum aequans; is one of the most common and important ectoparasites of sea bass and the disease caused by this parasite is called *Diplectanosis*. The way the parasite attaches to the gills causes significant damage to the gill filaments and this damage makes them susceptible to bacterial and viral diseases[14]. Another parasite species from the genus *Diplectanum*, is *Diplectanum laubieri* in sea bass[4].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

The life cycle of the parasite is direct, so fish-to-fish transmission is easy. In aquaculture, the parasite can be seen frequently in periods when the stocking density is high[4]. All monogenean parasites except *Gyrodactylus* reproduce by laying eggs. Females usually carry very few eggs, but they lay an average of 5–60 eggs per day, depending on the age of the parasite[36]. The hatching time of the larvae was determined as 6 days at 20–30°C, 12 days at 15°C, 19 days at 10°C in an experimental study, and no hatching was observed in the eggs after 45 days at 5°C. The maturation period of males in larvae is 3 days at 30°C, 7 days at 26°C, 10 days at 20°C, 16 days at 15.5°C; The maturation period of female individuals was 9 days at 30°C, 15 days at 26°C, 25 days at 20°C, and 35 days at 15.5°C[37].

Diagnosis: The parasite feeds on epithelial cells of the gill and skin. They attach to the host by their haptors and cause degeneration in the area they are attached, causing excessive mucus secretion, hyperplasia of the gill epithelium, degeneration and adhesion of the secondary lamellae, bleeding and inflammation of the epithelial tissue. All of this causes respiratory distress and eventually death when the infection is high. Heavily infected fish exhibit lethargy and close-to-surface swimming movements with gaping mouths. The parasite can be easily detected by gross inspection[4]. In addition, the damage caused by the parasite to the tissues can be evaluated by histological examination[15].

Diplectanum aequans

Treatment & Prevention:

Juvenile bass and broodstock are most susceptible to the parasite. Applications such as poor water quality (such as high turbidity, high organic loading and low oxygen levels), poor hygiene practices (such as tank and pipe cleaning, changing the net) increase the spread of the parasite. High water temperatures are also an important risk factor as the parasite completes its life cycle faster. In its treatment, chemicals are applied in the form of a bath. It would be more effective if these processes were synchronized with net and tank cleaning, especially during the introduction of new fry to the facility[4].

References:

4 14 15 36 37

Diplectanum aequans

4 Diplectanum aequans on the same primary lamellae.

Diplectanum aequans eggs.

Enteromyxum leei

Disease:

Enteromyxum leei is a myxozoan parasite that reproduces slowly and gradually and settles in the intestinal epithelium of fish. The parasite reproduces from the posterior of the intestine to the anterior[16]. The disease has been reported in sea bass and sea bream. The prevalence and mortality of the disease in rearing conditions is more severe in sea bream[4]. Infection in sea bream can be variable and severe. This can be explained by the importance of host genetics against the disease[28].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

Two different hosts are usually seen in the life cycle of myxospora, but studies on various marine fish have shown that *Enteromyxum leei* is transmitted directly from fish to fish. The developmental stages of the parasite (trophozoites) get into the water with feces and dead fish. The released trophozoites are infective to other fish and thus horizontal transmission occurs. Although it is possible that the parasite can adotp a life cycle with an intermediate host in the wild, it has been experimentally proven that it can be transmitted from fish to fish by the oral route, through contaminated water, and anal route. This mode of transmission supports the spread of the parasite in cultured fish[38].

Enteromyxum leei

Diagnosis: Anorexia is observed after severe enteritis in sea bream, it may cause death of susceptible fish as a result of weakening, growth retardation and mortality in regions where aquaculture is intense. Due to the non-specificity of the clinical findings, the diagnosis of the disease in the presence of clinical findings can be difficult. A quick preliminary diagnosis can be made by examining a drop of feces taken from the anus of live fish with the help of a pipette under a microscope (x40 – x100). In dead fish, the entire digestive system is removed and cut longitudinally, and a sample is taken from the mucosa with the help of a swab and examined under a microscope. In this way, the spread of the parasite can be observed by examining the first, middle and last parts of the digestive system. In addition, diagnosis can be facilitated by Giemsa staining in smear preparations and PAS and Giemsa staining in histological sections. Molecular methods can be used for definitive diagnosis[38].

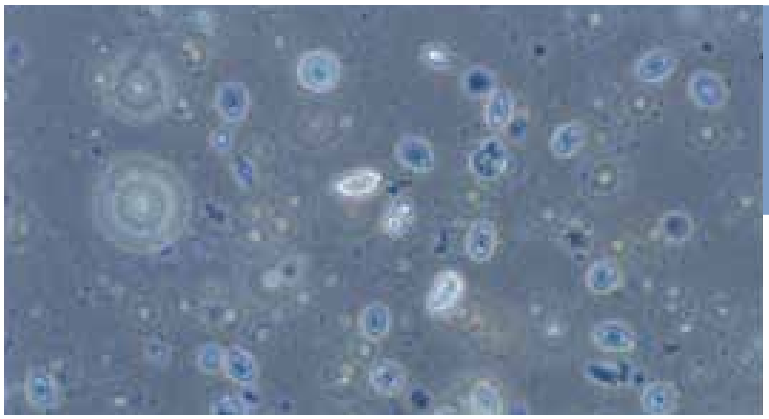
Treatment & Prevention:

There is no effective treatment and protection method against the disease[16].

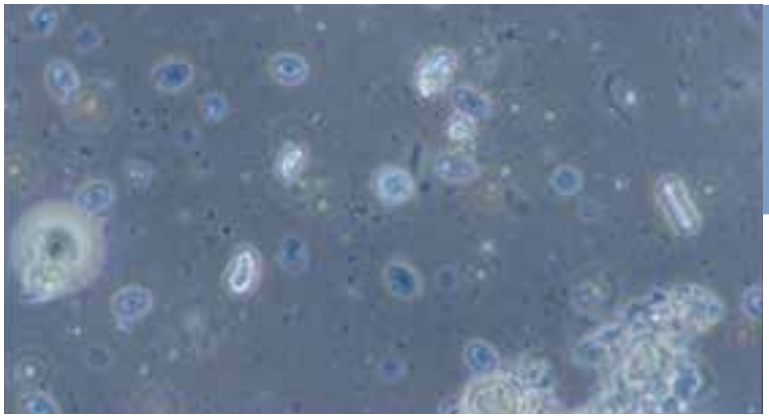
References:

4 16 28 38

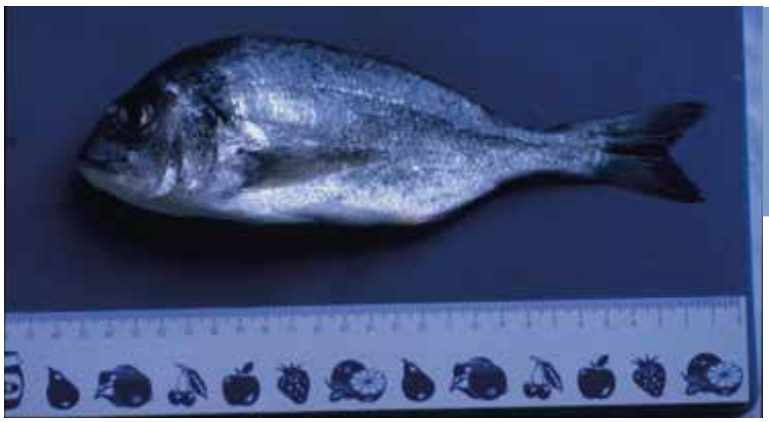
Enteromyxum leei



Enteromyxum leei spores
Photographer:
Dr Francesc Pedros Bover.



Enteromyxum leei spores
Photographer:
Dr Francesc Pedros Bover.



Sea bream cachexia
Photographer:
Dr Francesc Pedros Bover.

Furnestinia echeneis

Disease:

Furnestinia echeneis is a Monogenean parasite species. The parasite attaches to the host via its haptor. The haptor is round and its diameter is almost the same as the width of the body. Contamination between fish occurs through the eggs of the parasite. Although the parasite can be seen all year round, its density begins to increase in the spring[17] and peak in the autumn months.

Affected Species:

- Sea Bream

Life Cycle:

Studies have shown that the prevalence of parasites has a seasonal peak in the autumn period, suggesting that the life cycle of the parasite lasts for 1 year. In many studies conducted in the *Diplectanidae* family, it has been determined that water temperature is the most important abiotic factor among the factors affecting the reproduction of the parasite. The parasite's egg production is thought to occur during the summer months. The larvae that emerge from the eggs in the summer, turn into adults in the infective form in the autumn and cling to the host, and the prevalence of the parasite is seen to peak during in this season[48].

Diagnosis: Affected fish may experience excessive mucus excretion in the gills. Apart from this, no other macroscopic findings are observed. Histologically, separation of epithelial tissue, inflammatory reactions and fusion of secondary lamellae are observed in the areas where the parasite is attached. The parasite is easily visible by gross examination. The damage caused by the parasite to the tissues can be evaluated by histopathological examination[17].

Furnestinia echeneis

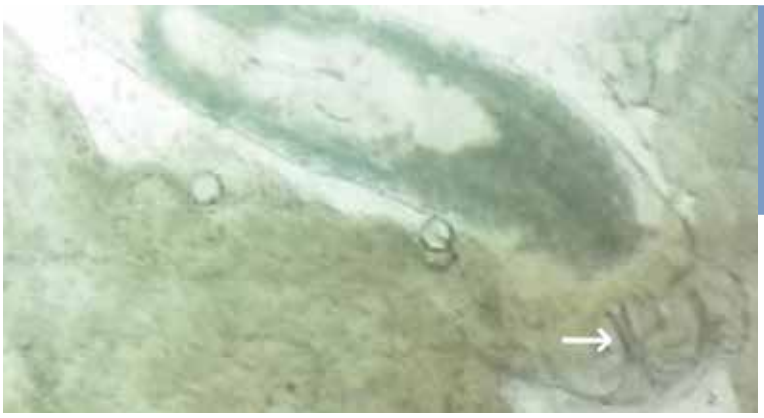
Treatment & Prevention:

Poor water quality (such as high turbidity, high organic load and low dissolved oxygen level)and poor hygiene practices (such as tank and pipe cleaning, changing the net) can increase the spread of the parasite. High water temperatures are also an important risk factor for the parasite to complete its life cycle faster. Chemicals treatments can be applied in the form of a bath. For maximum effect, these processes were synchronized with the net and tank cleaning, especially when stocking new fry into the facility[4].

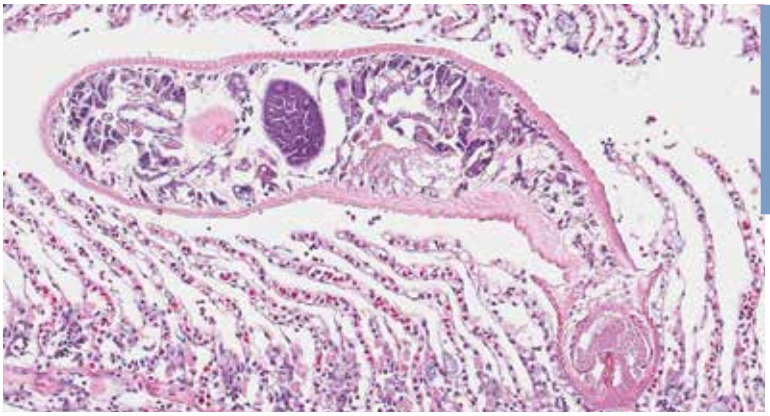
References:

4 17 48

Furnestinia echeneis



Furnestinia echeneis on native examination. The region indicated by the arrow is the haptor.



Furnestinia echeneis in histology.

Furnestinia echeneis on native examination.

Isopod (Ceratothoa oestroides)

Disease:

Ceratothoa oestroides (Cymothoidea, Isopoda) is a crustacean parasite that negatively affects the economic sustainability of farmed fish in the Mediterranean basin. While it causes direct mortality in juvenile fish, it causes growth retardation up to 20% in adult fish. The pathological effects of the parasite are related to the age of the fish. Therefore, juvenile fish are the most susceptible group to mortality following chronic weakening[18]. Adult parasites settle in the oral cavity of the host in pairs. Larval stages and juveniles can be found in the opercular space other than the oral cavity, on the head of the host, behind the eye, on the lateral line, and on the tail[4].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

The life cycle of the parasite is direct. Parasite pairs settle in the oral cavity, where they reach sexual maturity and reproduce. From here, hundreds of young infective stages are released into the water, and these fry complete their development by clinging to new hosts[18].

Diagnosis: The larval stages of the parasite cause significant damage to the skin around the head, eyes, and gill epithelium. Infected fish have anorexia and respiratory distress. In addition, these fish become vulnerable to secondary diseases, which causes a serious increase in mortality rates. Adult parasites cause severe damage to the oral tissue of the host and cause anemia of the host. Adult parasites, which can reach up to 6 cm in length, affect the host's nutrition negatively when they settle in the mouth of the host, and this can result in chronic stress, slowing growth and the formation of secondary diseases. Parasites can be detected with the naked eye in the skin, oral cavity and gills of fish[4].

zoetis

Isopod (Ceratothoa oestroides)

Treatment & Prevention:

The reproduction and hatching rates of Isopods are directly related to increased water temperature, so the prevalence of the parasite increases during the summer months, reaching its peak in July and August, and the prevalence may reach 50% in this period. It is thought that parasites can be transmitted from the wild fish roaming around the cages. Stock management practices such as controlling stock density in juvenile cages, not placing juveniles near large fish that are likely to carry adult parasites in their mouths, and placing cages in areas of deeper water with adequate water flow are essential preventative measures. Due to the sheltered location of adult parasites in the oral cavity, bath applications with chemotherapeutics may be insufficient in treatment, while these applications may be more effective for juvenile parasites[4].

References:

4 18

Isopod (Ceratothoa oestroides)

Ceratothoa oestroides in the mouth and its many juveniles.

Ceratothoa oestroides in the mouth.

Lernanthropus kroyeri

Disease:

Lernanthropus kroyeri is a parasite that is frequently seen on the gills of farmed sea bass. The most important feature of this parasite is that it is larger in size compared to other copepods localized on the gills and can be seen with the naked eye. It has a significant economic impact due to reduction in feed conversion, growth retardation, mortality, loss of product quality and treatment costs. It is seen in the gills of the sea bass in two different structures as female and male. One of the most prominent morphological differences seen in females is the presence of two longitudinal egg sacs. They feed on the mucus, epithelial tissue and blood of the host and can cause the host to become more susceptible to bacterial and viral diseases[19].

Affected Species:

- Sea Bass

Life Cycle:

The prevalence of parasites is observed to increase with water temperature and reached the highest level in spring and summer. These seasonal changes in prevalence indicate that the parasite has an annual life cycle. The development of the parasite in different stages is related to the water temperature[39]. The life cycle of the parasite is direct, and there are nauplii stage, infective copepopid stage, pre-adult and adult stage forms that emerge from the eggs of adult female parasites, respectively[40].

Diagnosis: The parasite feeds on gill tissues and host blood, causing severe tissue damage. In mild infections, the damage to the tissues is minimal, but severe infections are often accompanied by secondary infections that can result in severe damage to the gill tissues, respiratory, stress, and osmoregulation disorders. Infected fish may swim near the water surface and have increased mucus excretion. Parasites in the gills can be seen with the naked eye. In addition, the destruction of tissues can be evaluated with histopathology[19].

Lernanthropus kroyeri

Treatment & Prevention:

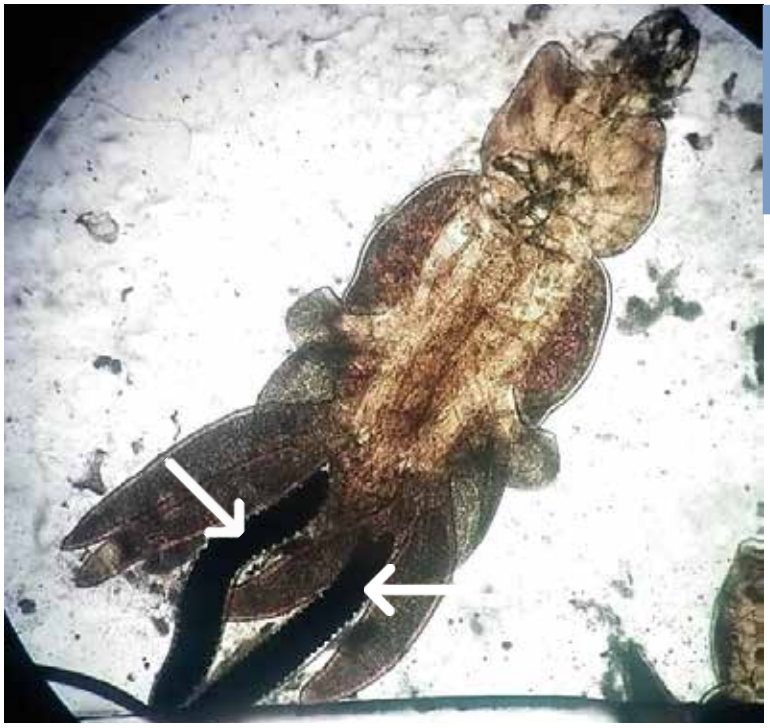
Parasite density in fish may increase with immunosuppression due to heat stress that will occur in fish during periods when water temperatures increase rapidly. During these periods, the fish may need to be supplemented with immunostimulants. It is possible to treat the parasite with the oral use of antiparasitic products[39].

References:

19 39 40

Lernanthropus kroyeri

Numerous *Lernanthropus kroyeri* in the gill filament.



Lernanthropus kroyeri (female). The region indicated by the arrow is the egg sacs.

Sparicotyle chrysophrii (Microcotyle chrysophrii)

Disease:

Sparicotyle chrysophrii is one of the most dangerous Monogenean ectoparasite species for sea bream. It has been reported to cause mortality in farmed fish and is generally associated with other parasites or secondary bacterial infections[20]. The parasite has been isolated from both wild and farmed sea bream. In the studies, the prevalence of the parasite was found in the range of 0%–71% in the Adriatic Sea, and the highest prevalence was determined during the period when the water temperatures were high. Contrary to these data, in the study conducted in Corsica, the prevalence was found to be 20% in spring and 80% in winter[41].

Affected Species:

- Sea Bream

Life Cycle:

Transmission occurs from fish to fish by the eggs and larvae of the parasite. The eggs of the parasite are spindle-shaped and have filamentous projections at both ends that allow them to attach to the epithelium between the gill lamellae and other substrates (cage nets). Larvae hatch from eggs laid by adult parasites in 5–10 days. The larva clings to a new host, where it changes into the adult form[42].

Diagnosis: The parasite attaches to the gills with structures called haptors, and the haptor can extend up to more than half of the parasite's body length. Each hook in the haptor attaches to a secondary lamella, so that an adult parasite hooks onto up to 41 secondary lamellas[20]. Respiratory distress occurs due to mechanical damage caused by these hooks and obstruction of water flow between the gill filaments. Bleeding caused by deterioration of epithelial and vascular structures are pathological effects caused by parasites can result in anemia. Adult parasites and eggs can be easily observed by examining the gill filaments under a microscope[38].

Sparicotyle chrysophrii (Microcotyle chrysophrii)

Treatment & Prevention:

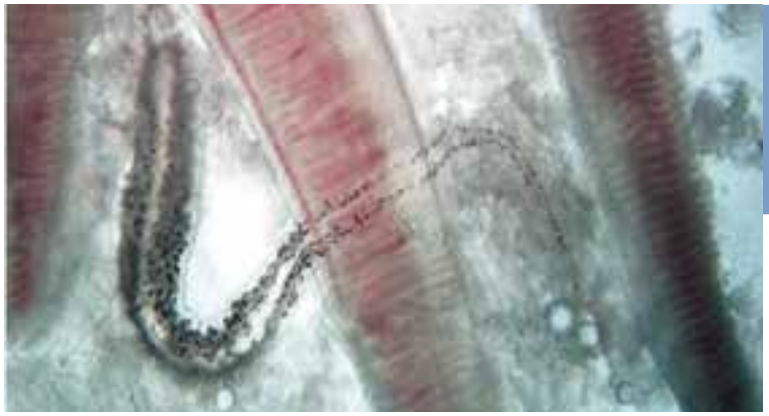
High stocking densities make it easy for parasites to find a host in aquaculture conditions, regardless of season. However, in Monogenean parasite infestations, it is important not only to find a host, but also to be able to attach to the host and stay there, which is related to the health and immune status of the fish. Therefore, good health and immune status of the fish is important in preventing infection. Various chemicals and drugs can be used in the treatment, but there are some points to be considered in the treatment. Parasite eggs are resistant to treatment and therefore treatment should be in two stages; in the first treatment, while the parasites in the adult and larval stages are removed, the eggs will remain. The optimum time between the two treatments was found in studies to be as follows: 10 days at 26°C, 12 days at 22°C, 14 days at 18°C, and 19 days at 14°C[43]. In addition, changing the net together with bath treatment applications is one of the important precautions for protection from the eggs of the parasite[41].

References:

20 38 41 42 43

Sparicotyle chrysophrii

Sparicotyle chrysophrii eggs between lamellae.



Sparicotyle chrysophrii between primary lamellae.

Sphaerospora spp.

Disease:

Sphaerosphora dicentrarchi, is a myxozoan parasite affecting sea bass and sea bream, causing systemic infections in many organs, especially the gallbladder and intestine. The parasite can cause chronic infections, resulting in mortality in juveniles. The prevalence of the parasite ranges from 95% in farmed sea bass to 50–70% in natural sea bass[21]. *Sphaerospora testicularis* is a myxosporean found in the testicles of sea bass, which greatly reduces the reproductive efficiency of males[22].

Affected Species:

- Sea Bass(S. testicularis – S. dicentrarchi)
- Sea Bream(S. dicentrarchi)

Diagnosis: No pathological effects were observed in fish with mild infections of S. dicentrarchi. However, in heavy infections and under stressful conditions, it can become a serious problem in juvenile sea bass. Severe enteritis can be observed in heavily infected sea bass, especially in late summer. Low-level mortality can be observed, usually associated with bacterial infections *(Vibriosis)* or poor environmental conditions. In severe infections, abdominal weakening and wasting in the dorsal region are seen. Males infected with *S. testicularis* experience abdominal bloating due to hypertrophy and ascites in their gonads. The genital opening is enlarged and reddish in appearance. *S. dicentrarchi* can be diagnosed by gross examination and histological examination of the gallbladder, intestine and stomach, and *S. testicularis* by gross examination and histology of the testis and seminal fluid[4].

Treatment & Prevention:

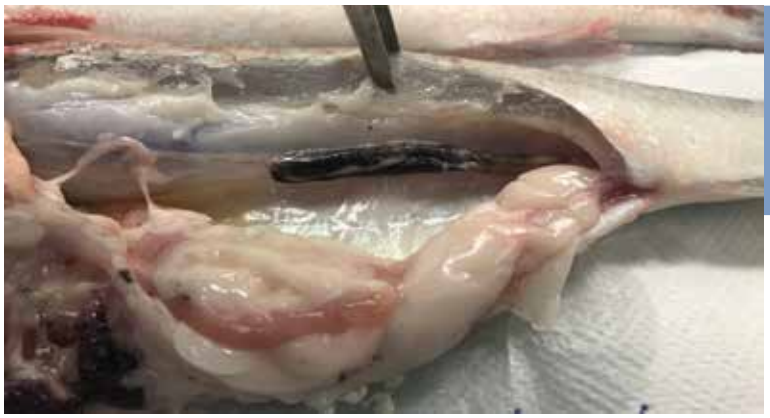
The absence of a difference in prevalence between open and closed systems for *S. dicentrarchi* suggests the presence of common risk factors in these environments. Infection has been observed to increase in warm seasons and in older animals. The main risk factor for *S. testicularis* is the season, as the parasite follows the host's reproductive cycle. There is no effective treatment for both parasites[4].

Sphaerosphora spp.

References:

4 21 22

Gonad (Middle) infected with *S. testicularis*.



Gonad infected with *S. testicularis*.

Trichodina spp.

Disease:

Trichodinid protozoans are parasites localized on the gills and skin in both freshwater and marine environments. *Trichodina sp*. has peritric ciliate and moves by sliding on the fish. They normally feed on bacteria and mucus, and when compared to other parasites, *Trichodinia sp*. are defined as ectocommensal disorders. When the resistance of the host decreases, they increase in number[23].

Affected Species:

- Sea Bass
- Sea Bream

Life Cycle:

There are different types of *Trichodina* that live in fresh water, brackish water and salt water. The parasites reproduce by dividing when they find suitable conditions on the host. Infection occurs by fish-to-fish contact or by the attachment of free-swimming parasites to the host[44].

Diagnosis: *Trichondina* cause damage to the cells lining the epithelial layer of the host's skin and gills. This can result in hyperplasia of gill epithelial cells, shortening and clumping of gill filaments, impairing the osmoregulation of the host. Ulceration can occur on the skin in intense infections, increasing susceptibility to secondary bacterial diseases. The parasite can be detected by gross examination of the preparations samples prepared from the gill and skin[44]. The parasites may become more visible with Giemsa staining of these preparations[4]. Tissues can be examined by histopathology to assess the damage caused by the parasite.

Treatment & Prevention:

The parasite has the ability to multiply rapidly when suitable environmental conditions are provided and the host's immune system is suppressed. Therefore, when diagnosed, it should be treated as soon as possible. The parasite can be treated with chemicals and a fresh water bath[44].

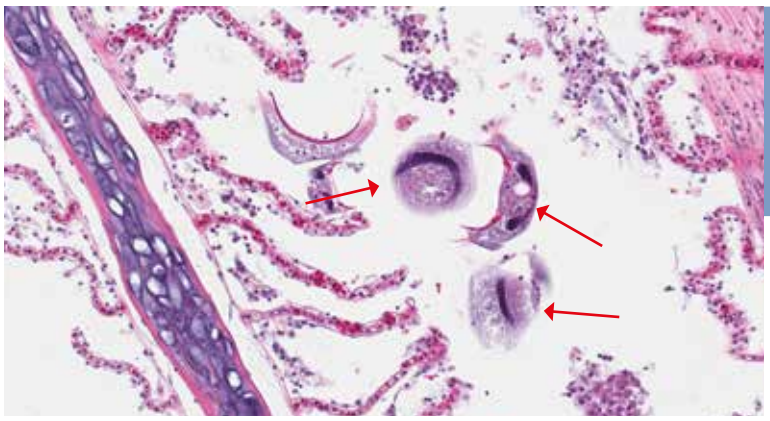
Trichodina spp.

References:

4 23 44

Trichodina sp. on the native examination.

Trichodina sp. on the native examination.



Trichodina sp. on histology.

References

1. Álvarez C.F., Gijón D., Álvarez M., Santos Y., 2016. First isolation of Aeromonas salmonicida subspecies salmonicida from diseased sea bass, Dicentrarchus labrax (L.), cultured in Spain. Aquaculture Reports 4 (2016) 36–41.

2. Katharios P., Smyrli M., Triga A., Dourala N., Varvarigos P., Pavlidis M., Quoc V.H., 2019. Comparative Study on A Novel Pathogen of European Seabass. Diversity of Aeromonas veronii in the Aegean Sea. Microorganisms 2019, 7, 504.

3. Peretz S.R., Colorni A., Sharon G., Ucko M., 2019. Vaccination of European sea bass Dicentrarchus labrax with avirulent Mycobacterium marinum (iipA::kan mutant). Fish and Shellfish Immunology 90 (2019) 317–327.

4. Vázquez F.J.S., Muñoz-Cueto J.A., 2015. Biology of European Sea Bass.

5. Domknech A., Fernindez-Garayzgbal J.F., Lawson P., Garcia J.A., Cutuli M.T., Blanco M., Gibello A., Moreno M.A., Collins M.D., Dominguez L., 1997. Winter disease outbreak in sea-bream (Sparus aurata) associated with Pseudomonas anguilliseptica infection. Aquaculture 156 (1997) 317–326.

6. Bernardet J.F., Kerouault B., Michel C., 1994. Comparative Study on Flexibacter maritimus Strains Isolated from Farmed Sea Bass (Dicentrarchus labrax) in France. Fish Pathology,29(2),105–111,1994.6.

7. Frans I., Michiels C.W., Bossier P., Willems K.A., Lievens B., Rediers H., 2011. Vibrio anguillarum as a fish pathogen: virulence factors, diagnosis and prevention. Journal of Fish Diseases 2011, 34, 643–661.

8. Firmino J., Furones M.D., Andree K.B., Sarasquete C., Ortiz-Delgado J.B., Asencio-Alcudia G., Gisbert E., 2019. Contrasting outcomes of Vibrio harveyi pathogenicity in Gilthead seabream, Sparus aurata and European seabass, Dicentrachus labrax. Aquaculture 511 (2019) 734210.

9. Marques C.L., Medeiros A., Moreira M., Quental-Ferreira H., Mendes A.C., Pousão-Ferreira P., Soares F., 2019. Report and genetic identification of Amyloodinium ocellatum in a sea bass (Dicentrarchus labrax) broodstock in Portugal. Aquaculture Reports 14 (2019) 100191.

References

10. Seoud S.S., Zaki V.H., Ahmed G.E., Abd El-Khalek N.K., 2017. Studies on Amyloodinium Infestation in European Seabass (Dicentrarchus labrax.) Fishes with Special Reference for Treatment. International Journal of Marine Science, 2017, Vol.7, No.24, 229-246.

11. Rigos G., Grigorakis K., Christophilogannis P., Nengas I., Alexis M., 1997. Ceratomyxa spp. (myxosporea) infection in cultured Common dentex from Greece. Bull. Eur. Ass. Fish Pathol. 17(5), 174, 1997.

12. Gjurčević E., Kužir S., Baždarić B., Matanović K., Debelić I., Marino F., Drašner K., Rosenthal B.M., 2017. New data on Eimeria dicentrarchi (Apicomplexa: Eimeriidae), a common parasite of farmed European sea bass (Dicentrarchus labrax) from the mid-eastern Adriatic. Veterinarski Arhiv 87 (1), 77-86, 2017.

13. Standing D., Brunner T., Aruety T., Ronen Z., Gross A., Zilberg D., 2017. Mortality of Cryptocaryon irritans in sludge from a digester of a marine recirculating aquaculture system. Aquaculture 467 (2017) 134–137.

14. Papapetrou M., Kazlari Z., Papanna K., Papaharisis L., Oikonomou S., Manousaki T., Loukovitis D., Kottaras L., Dimitroglou A., Gourzioti E., Pagonis C., Kostandis A., Tsigenopoulos C.S., Chatziplis D., 2021. On the trail of detecting genetic (co)variation between resistance to parasite infections (Diplectanum aequans and Lernanthropus kroyeri) and growth in European seabass (Dicentrarchus labrax). Aquaculture Reports 20 (2021) 100767.

15. Dezfuli B.S., Giari L., Simoni E., Menegatti R., Shinn A.P., Manera M., 2007. Gill histopathology of cultured European sea bass, Dicentrarchus labrax (L.), infected with Diplectanum aequans (Wagener 1857) Diesing 1958 (Diplectanidae: Monogenea). Parasitol Res (2007) 100:707–713.

16. Piazzon M.C., Estensoro I., Calduch-Giner J.A., Pozo R.D., Picard-Sánchez A., Pérez-Sánchez J., Sitjà-Bobadilla A., 2018. Hints on T cell responses in a fish-parasite model: Enteromyxum leei induces differential expression of T cell signature molecules depending on the organ and the infection status. Parasites & Vectors (2018) 11:443.

zoetis

References

17. Mahmoud N.E., Mahmoud A.M., Fahmy M.M., 2014. Parasitological and Comparative Pathological Studies on Monogenean Infestation of Cultured Sea Bream (Sparus aurata, Spariidae) in Egypt. Oceanography 2014, 2:4.

18. Piazzon M.C., Mladineo I., Dirks R.P., Yebra-Pimentel E.S., Hrabar J., Sitjà-Bobadilla A., 2021. Ceratothoa oestroides Infection in European Sea Bass: Revealing a Long Misunderstood Relationship. Front. Immunol. 12:645607.

19. Khidr A.E.A., Samak O.A.A., Said A.E., Ghoneim A.M., Fahmy S.A., 2014. Structural and Functional Observations on the Appendages of Gill Parasite, Lernanthropus Kroyeri (Copepoda: Lernanthropidae) Infesting the Sea Bass Dicentrarchus Labrax. Nature and Science 2014;12(2).

20. Sitjà-Bobadilla A., Alvarez-Pellitero P., 2009. Experimental transmission of Sparicotyle chrysophrii (Monogenea: Polyopisthocotylea) to gilthead seabream (Sparus aurata) and histopathology of the infection. FOLIA PARASITOLOGICA 56[2]: 143–151, 2009.

21. Xavier R., Severino R., Pérez-Losada M., Cable J., Harris D.J., 2013. First record of Sphaerospora dicentrarchi (Myxosporea, Sphaerosporidae) in Dicentrarchus punctatus. Bull. Eur. Ass. Fish Pathol., 33(1) 2013, 21.

22. Sitia-Bobadilla A., Alvarez-Pellitero P., 1993. Ultrastructural and Cytochemical Observations on the Sporogenesis of Sphaerospora testicularis (Protozoa: Myxosporea) from Mediterranean Sea Bass, Dicentrarchus labrax (L.). Europ.J.Protistol. 29, 219-229 (1993).

23. Colorni A., Diamant A., 2005. Hyperparasitism of trichodinid ciliates on monogenean gill flukes of two marine fish. Dis Aquat Org 65: 177–180, 2005.

24. Kvitt H., Heinisch G., Diamant A., 2008. Detection and phylogeny of Lymphocystivirus in sea bream Sparus aurata based on the DNA polymerase gene and major capsid protein sequences. Aquaculture 275 (2008) 58–63.

References

25. Valero Y., Arizcun M., Esteban M.A., Bandín I., Olveira J.G., Patel S., Cuesta A., Chaves-Pozo E., 2015. Nodavirus Colonizes and Replicates in the Testis of Gilthead Seabream and European Sea Bass Modulating Its Immune and Reproductive Functions. PLoS ONE 10 (12): e0145131.

26. Padrós F., Fioravanti M.L., Ciulli S., Gustinelli A., Zarza C., Acosta F., Rigos G., 2020. Prophylactic practices for Mediterranean farmed fish – V3. PerformFISH, Ref. Ares(2020)2028453 - 13/04/2020.

27. Smyrli M., Prapas A., Rigos G., Kokkari C., Pavlidis M., Katharios P., 2017. Aeromonas veronii Infection Associated with High Morbidity and Mortality in Farmed European Seabass Dicentrarchus labrax in the Aegean Sea, Greece. Fish Pathology, 52 (2), 68–81, 2017. 6.

28. Pavlidis M.A. , Mylonas C.C., 2011. Sparidae Biology and Aquaculture of Gilthead Sea Bream and Other Species.

29. Sette C.S., Wachholz P.A., Masuda P.Y., Figueira R.B.F. da C., Mattar F.R. de O., Ura D. G., 2015. Mycobacterium marinum infection: a case report. Sette et al. Journal of Venomous Animals and Toxins including Tropical Diseases (2015) 21:7.

30. Essam H.M., Abdellrazeq G.S., Tayel S.I., Torky H.A., Fadel A.H., 2016. Pathogenesis of Photobacterium damselae subspecies infections in sea bass and sea bream. Microbial Pathogenesis 99 (2016) 41e50.

31. Romalde J.L., Lopez-Romalde S., Ravelo C., Magarinos B., Toranzo A.E., 2004. Development and Validation of a PCR-based Protocol for the Detection of Pseudomonas anguilliseptica. Fish Pathology,39(1),33-41,2004.3.

32. Vennerström, P. 2015. Pseudomoniasis (P. anguilliseptica) in farmed fish. ICES Identification Leaflets for Diseases and Parasites of Fish and Shellfish. Leaflet No. 63. 4 pp.36.

33. Avendaño-Herrera R., Toranzo A.E., Magariños B., 2006. Tenacibaculosis infection in marine fish caused by Tenacibaculum maritimum: a review. DISEASES OF AQUATIC ORGANISMS, Vol. 71: 255–266,

zoetis

References

34. Larsen, J. L., Pedersen, K., & Dalsgaard, I., 1994. Vibrio anguillarum serovars associated with vibriosis in fish. Journal of Fish Diseases, 17(3), 259–267. https://doi.org/10.1111/j.1365-2761.1994.tb00221.x

35. Davies A.J., BALL S.J., 1993. The Biology of Fish Coccidia. ADVANCES IN PARASITOLOGY VOL. 32 ISBN 0-12-03 1732-X.

36. https://www.fao.org/3/v9551e/V9551E13.htm

37. Cecchini S., Saroglia M., Berni P., Cognetti-Varriale A.M., 1998. Influence of temperature on the life cycle of Diplectanum aequans (Monogenea, Diplectanidae), parasitic on sea bass, Dicentrarchus labrax (L.). Journal of Fish Diseases (1998) 21, 73–75.

38. Fioravanti M., Padros F., 2020. Diagnostic methods for Mediterranean farmed fish. PerformFish, Ref. Ares(2020)2431556 – 07/05/2020.

39. Antonelli L., Quilichini Y., Marchand B., 2012. Lernanthropus kroyeri (Van Beneden and Hesse 1851) parasitic Copepoda (Siphonostomatoidae, Lernanthropidae) of European cultured sea bass Dicentrarchus labrax (Linnaeus 1758) from Corsica: ecological and morphological study. Parasitol Res (2012) 110:1959–1968.

40. Cabral P., Coste F., Raibaut A., 1984. The life cycle of Lernanthropus kroyeri Van Beneden, 1851, a hematophagous Copepod of the gills of the sea bass in wild hosts and experimental infections. Ann. Parasitol. Hum. Comp., 1984, t. 59, n° 2, pp. 189-207.

41. Mladineo, I. (2018). Sparicotylosis. Published on MedAID H2020 project Blog: http://www.medaid-h2020.eu/index.php/2018/06/25/sparicotylosis/

42. Repullés-Albelda A., Holzer A.S., Raga J.A., Montero F.E., 2012. Oncomiracidial development, survival and swimming behaviour of the monogenean Sparicotyle chrysophrii (Van Beneden and Hesse, 1863). Aquaculture 338-341 (2012) 47–55.

43. Villar-Torres M., Montero F.E., Raga J.A., Repullés-Albelda A., 2018. Come rain or come shine: environmental effects on the infective stages of Sparicotyle chrysophrii, a key pathogen in Mediterranean aquaculture. Parasites & Vectors (2018) 11:558.

References

44. Smith S., Schwarz M., 2019. Dealing with Trichodina and Trichodina-like species. Virginia Tech, the Virginia Sea Grant College Program, and Virginia Cooperative Extension.

45. Toffan, A. (2018). Viral Encephalopathy and retinopathy. Published on MedAID H2020 project Blog: http://www.medaid-h2020.eu/index.php/2018/09/06/viral-encephalopathy-and-retinopathy/

46. Woo P.T.K., 2006. Fish diseases and disorders.--2nd ed. CAB International 2006.

47. Bartholomew J.L., Whipple M.J., Stevens D.G., Fryer J.L., 1997. The Life Cycle of Ceratomyxa shasta, a Myxosporean Parasite of Salmonids, Requires a Freshwater Polychaete as an Alternate Host. The Journal of Parasitology, Vol. 83, No. 5 (Oct., 1997), pp. 859-868.

48. Antonelli L., Quilichini Y., Marchand B., 2010. Biological study of Furnestinia echeneis Euzet and Audouin 1959 (Monogenea: Monopisthocotylea: Diplectanidae), parasite of cultured Gilthead sea bream Sparus aurata (Linnaeus 1758) (Pisces: Teleostei) from Corsica. Aquaculture 307 (2010) 179–186.

Notes:

Notes:

Notes:

PHARMAQ

European Sea Bass & Gilthead Sea Bream Diseases

pharmaq.com

zoetis