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# Fungal Infections of Farmed Salmon and Trout

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by

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## Introduction

Fungal infections (mycosis) frequently occur in wild and farmed salmonid broodstock as a consequence of stress and sexual maturity as well as affecting eggs and juvenile fish. Within this taxonomically diverse group there are examples of secondary as well as primary causative agents of disease. The former generally infect the body surface, often covering large areas, and the latter usually infect and multiply within the host tissues. A further, although arbitary, division of such fungi may be related to the age of the fish (eg eggs, broodstock) and whether infection occurs in fresh or salt water. The purpose of this pamphlet is to describe the most frequently occurring fungal diseases of farmed fish, to consider the consequence of such outbreaks to farmed rainbow trout and Atlantic salmon and to advise on the appropriate methods of treatment.

## *Saprolegnia*

The most frequent reports involving fungal infections in the culture of salmonid species are attributed to those of fresh water Oomycetes, of which the representatives of the genus *Saprolegnia* are the most significant. The two principal species involved in disease outbreaks are *S. parasitica* and *S. diclina* and these may affect eggs, alevins, parr, smolts and adult fish.

Other genera within this class include *Achlya, Aphanomyces* and *Pythium,* but only infrequent outbreaks among teleost fish have been attributed to these and they are not therefore included in this pamphlet in any further detail.

A cottony-white mycelium on the integument of the fish and the surface of eggs makes preliminary identification of this fungus relatively easy. This fungus grows by producing long filamentous strands each of which individually is called a hypha. Culture on hemp seeds in water produces typical hyphae which in turn produce motile spores which distinguish this genus from other classes of fungi. On affected broodstock the early lesions appear as circular focal patches on the head and dorsal areas of the body surface which progressively spread laterally to join adjacent infections (Plate I.I). The rate at which these lesions develop is determined by such factors as the water temperature and condition of the fish. Diseased fish become increasingly lethargic with a loss of equilibrium shortly before death, when 40—50% of the body surface may be covered. The gills, olfactory pits and eyes may also become infected. Precocious parr are particularly susceptible to this infection and can die rapidly once the fungus has colonised the epithelium. Dead eggs are frequently infected and it is important that they are removed quickly because the hyphae will rapidly spread to adjacent living eggs.

In most outbreaks there is likely to be one or possibly several predisposing factors that will initiate fungal infections of this type. They include pollution, low water levels, overcrowding, mechanical trauma and the failure to remove moribund or dead fish or ova, as well as the result of infection by another bacterial, viral or parasitic agent. Another predisposing factor is sexual maturity. Precocious male parr are particularly prone to saprolegniasis, and in wild salmon and trout *Saprolegnia* infections are common prior to, during and after spawning.

Histologically the hyphae can be seen to colonise and penetrate first the outer and then the deeper skin layers before sometimes even penetrating the musculature. There is some evidence that under certain conditions *Saprolegnia* spp. are not opportunistic facultative parasites but can act as primary pathogens. Such primary saprolegniasis has been reported in cultured eels. Among a commercially reared population of Atlantic salmon first feeding fry mortalities have occurred as a direct result of infection by *S. diclina.* A variable mortality over a six week period resulted in a loss in this population of 27%. Hyphae and other debris blocked the pharynx and the hyphae had grown outward over the gill lamallae, preventing feeding and normal respiratory movements. This infection resulted in necrosis of the gill lamellae and distension of the opercular cavity (Plate I.II).

Many chemicals, including dyes, have been tested for their effectiveness in controlling *Saprolegnia* infections. These include malachite green, copper sulphate, crystal violet, sodium chloride and potassium dichromate. The use of zinc free malachite green remains the most popular treatment because it is inexpensive and effective for fungal skin infections. It is, however, considered mutagen and care should be taken in handling the dry powder. A prophylactic treatment of 2 mg per litre during egg incubation is recommended. When treating a large number of fish a bath or flush method is the most economic, using 1—5 mg per litre daily. For small numbers of fish a dip treatment of 30 seconds using 60—65 mg per litre is advised. Patches of fungus on broodfish can be cleared by appling the malachite green directly to the affected area through a syringe while the fish remains in the water; this results in the now green-coloured fungus sloughing from the fish within 24—28 hours. All such bath or flush treatments should be tested on a small number of animals before large numbers are considered for treatment. The maintenance of fish under good husbandry conditions, ie correct feeding, good water quality and avoidance of overcrowding, will undoubtedly help to prevent this disease occurring.

### *Exophiala*

The first description of this fungal pathogen was made in 1966 and it was given the name *Exophiala salmonis*. This condition affects salmonids reared in salt water and is fairly widespread in the Scottish salmon farming industry. There are several records of this genus occurring as fish parasites in fresh water, suggesting that more than one species is involved or that a single species occupies both environments. Externally the fish affected in the marine environment exhibit erratic swimming movements, which may be followed by whirling and swelling of the eyes. Infected fish may continue to feed normally. A massive distension of the abdomen is generally present owing to the gross enlargement of the posterior kidney. Raised, greyish-white nodules, up to 3.5 cm in diameter, can be noted in the kidney tissue and these areas contain variable quantities of fungal hyphae. The host attempts to wall off the fungus through a marked cellular response and the formation of nodules or a granuloma, although this reaction is not corrulated with the amount of fungal material present. Healing lesions are often fibrous in nature. Hyphae may enter the kidney tubules and blood vessels as well as other organs such as the heart, liver and spleen. The muscle is often affected in heavy infections and turns black as the hyphae penetrate through the muscle fibres (Plate I.III). However, the development of this fungus in the fish musculature has not been recorded as a marketing problem in Scotland.

This disease is often confined to one cage or a small group of cages and rarely throughout the farm. There is some evidence that infection starts from contaminated food.

### *Phialophora*

This systemic fungal infection of Atlantic salmon parr is confined to internal organs. It involves a new species of *Phialophora* which was first recorded in late January 1982 when the fresh water temperature was 5—6°C. Diseased fish showed haemorrhages at the base of the fins, were emaciated and the abdominal area was distinctly swollen. Mortalities continued for three months. Internally, firm whitish-pink fungal masses adhere to most of the internal organs, although principally to the posterior area of the kidney and intestine. Internally the liver and spleen may be pale with severe inflammation of the lower intestine. In culture this fungus is slow growing and the appearance of the colonies suggests that it is a member of the so-called "black yeasts". Since these "yeasts" tend to be opportunistic and present in many environments, infection by this pathogen may come from food which has become contaminated through bad storage.

### *Ichthyophonus*

This fungal parasitic condition is reported from a wide variety of fish species, principally in marine environments, where it is noted as a chronic, internal systemic infection, but also in fresh water. Generally a low level of mortality is recorded but the potentially devastating effects of the disease are likely to be increased in crowded enclosed systems of fish cultivation. This condition has not yet been recorded in marine salmon farms but these fish must be considered vulnerable. There may be no external symptomatic features of *Ichthyophonus hoferi* infection in fish although spiralling, whirling and spinal curvature have been reported. Internally a whitish speckling and the presence of raised nodules on the muscle and internal organs are common features. Extensive invasion of the muscle has made carcasses unsuitable for sale. In some circumstances the gross appearance of the lesions has led to erroneous association of *Ichthyophonus* with other granulomatous conditions. Where epizootics have occurred in fresh

water sites rearing rainbow trout, the inclusion of unpasteurised marine fish as part of the diet has been identified as the source of infection. In the absence of any chemotherapeutic agent avoidance of this disease is the only rational form of control.

### *Dermocystidium*

This group is poorly understood taxonomically. Additional studies may again require reclassification of the genus. *Dermocystidium* outbreaks have been recorded sporadically in farmed and in ornamental stocks as systemic infections of fry and adult fish. Infection of the gill covers and gill lamellae is considered a more typical infection. Small cysts about 1 mm in diameter occur on the gills and may contain a large number of unicellular organisms (hypnospores). In fry, disease outbreaks involving the gills can physically prevent the gill covers from closing and hence mortalities can be very high. The host may be able to contain a small number of spores by forming a fine fibrous capsule around them. However, it appears that many enter the blood system and quickly infect all tissues. In larger fish, rounded glistening white cysts have been reported on the gills as well as the mucosa (Plate I.IV). The multinucleate cells in the internal organs may represent a development stage in the life cycle of *Dermocystidium* species. Disease outbreaks are generally infrequent in salmonid culture and the number of mortalities low. Sources of infection and modes of transmission are currently too poorly understood to offer advice on methods of control.

### *Branchiomyces*

Two species of the genus *Branchiomyces* are parasitic on the gill tissues of fish, where they cause a typical "gill rot" at temperatures above 10°C. The course of the disease is usually rapid and is enhanced by high water temperatures and overcrowding. The most frequently affected fish are carp, although tench and pike have been infected. Both brown and rainbow trout are considered susceptible but no outbreak of this disease has been reported in recent years. The invasive fungal hyphae obstruct the circulation of the blood through the gills. Diseased areas may slough off and the host tissue may then become the focus of infection for other fungi such as *Saprolegnia*. Outbreaks appear to be patchy although mortalities up to 50% have been recorded. An increased water flow and good hygiene are recommended for affected fish. Various chemicals have been used to treat branchyiomycosis, and holding fish in malachite green at 0.3 mg per litre for 24 hours is reported as the most successful.

### *Paecilomyces*

On several occasions a fungal infection involving the swim bladder of farmed Atlantic salmon parr has been reported. Grossly the abdomen of such fish is enlarged and the vent area often red and swollen. A large fungal mass is located in the swim bladder and appears to be confined to this organ. The causative agent has been identified as *Paecilomyces farinosus,* which is a known pathogen of insects and reptiles. The source of infection would appear to be from insects landing on the water surface. In all cases examined mortalities have been restricted to a very low number of fish.

### Further Reading

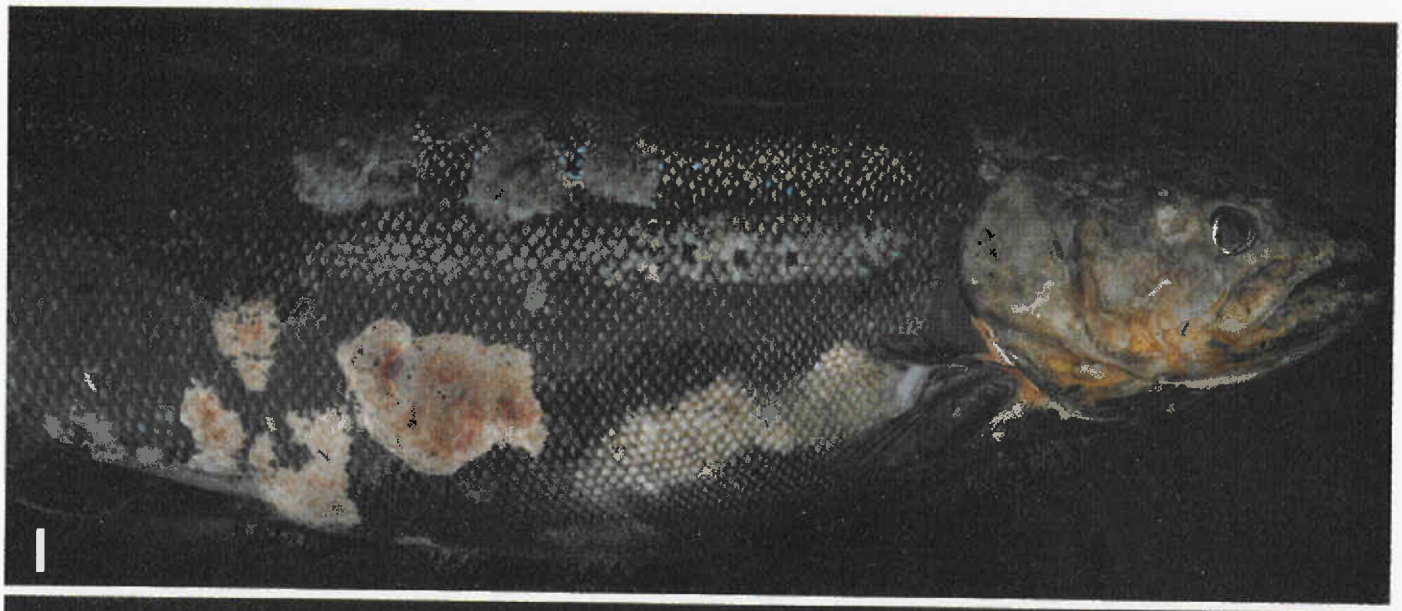
**Bruno, D.W. and Stamps, D.J.** 1987. Saprolegniasis of Atlantic salmon, *Salmo salar* L., fry. *Journal of Fish Diseases, **10**, 513—517.*

**Ellis, A.E., Waddell, I.F. and Minter, D.W.** 1983. A systemic fungal disease in Atlantic salmon parr, *Salmo salar* L., caused by a species of *Phialophora. Journal of Fish Diseases,* **6**, 511—523.

**Richards, R.H., Holliman, A. and Helgason, S.** 1978. *Exophiala salmonis* infection in Atlantic salmon *Salmo salar* L. *Journal of Fish Diseases,* **1**, 357—368.

**Plate I. Fungal infections of farmed salmon and trout.**

I *Saprolegnia* infection of Atlantic salmon broodstock.
II *Saprolegnia* infection of Atlantic salmon fry.
III *Exophiala* infection of the musculature.
IV *Dermocystidium* infection of Atlantic salmon parr.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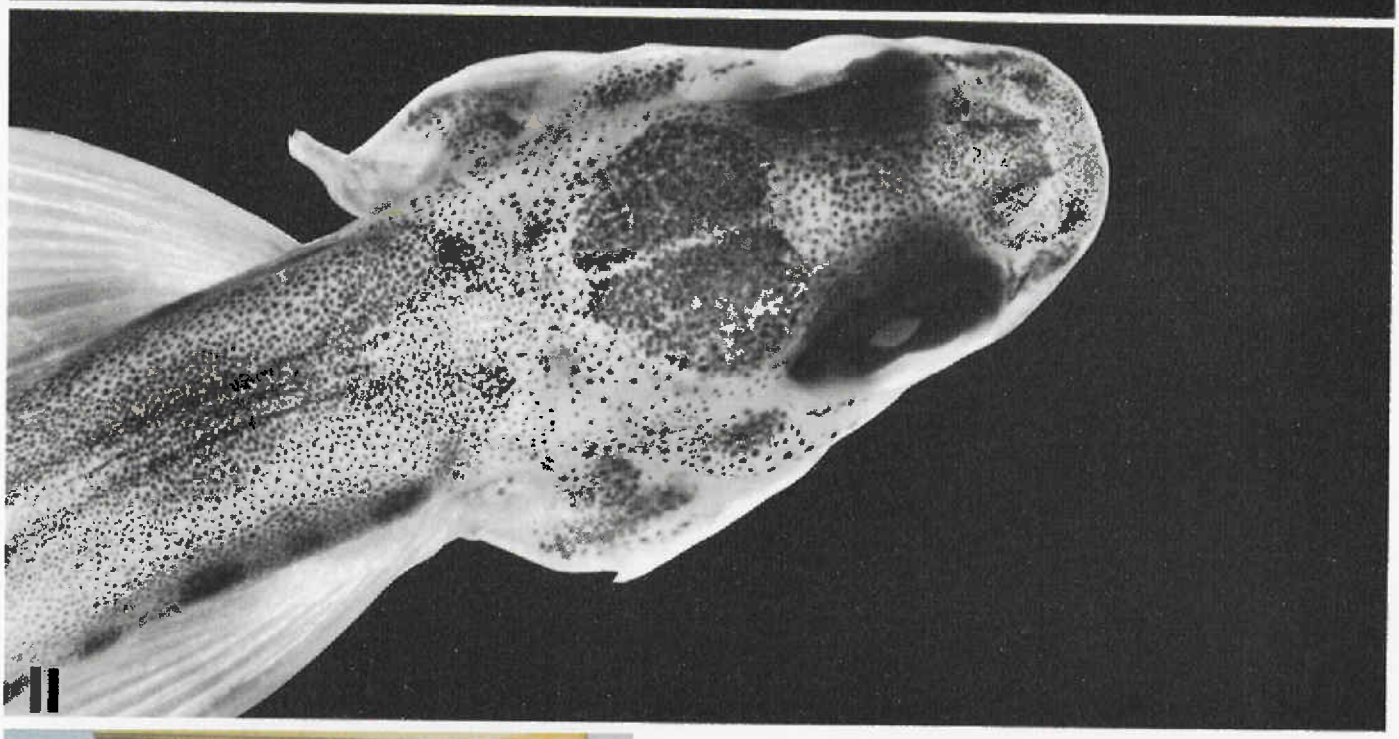
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III


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