Whirling Disease – *Myxobolus cerebralis*

Whirling disease, a potentially lethal infection of salmonid fish, is caused by the myxozoan parasite, *Myxobolus cerebralis*. Rainbow trout, *Oncorhynchus mykiss,* are particularly susceptible. This Eurasian disease, first observed in North America in the 1950's, is a good example of how an invasive microbial species can cause serious environmental and economic impacts.

Taxonomy

Phylum ▪ Myxozoa

Class ▪ Myxosporea

Order ▪ Bivalvulida

Family ▪ Myxobolidae

Identification

Distinguishing Characteristics:

- ▪ Morphology of Myxospores Produced in Salmonids
  - ▪ Spore shape is broadly oval (Fig. 1)
  - ▪ Range in size is 7.4–9.7 µm in length and 7.0–10.0 µm in width
  - ▪ Spore consists of two valves that are joined along a sutural ridge; depressions border each side of the ridge (Fig. 1)
  - ▪ Anterior end has 1–2 openings; coiled filaments emerge through openings
  - ▪ Each filament consists of 5–6 coils
- ▪ Disease Characteristics in Salmonids
  - ▪ Young fish most susceptible
  - ▪ Symptoms of infection include the following structural and behavioral abnormalities:
    - ▪ Shortening of the mandible (the lower jaw) and opercula (the covering of the gills)
    - ▪ Mouth gaping open (Fig 2.)
    - ▪ Hump developing in the back, just behind the head
    - ▪ Tail becoming dark in color (commonly referred to as "blacktail") (Fig. 2)
    - ▪ Tail developing a twist or bend (Fig. 2)
    - ▪ Swimming in circles; the name of the disease is derived from this abnormal whirling behavior
    - ▪ Efforts to swim exhaust fish to the point where they eventually sink to the bottom and die

Fig. 1 A myxospore of *M. cerebralis*.[1]

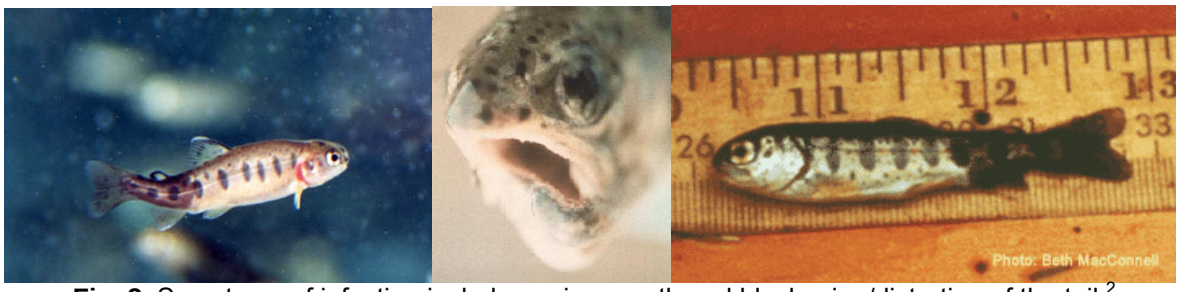

Fig. 2 Symptoms of infection include gaping mouth and blackening/distortion of the tail.[2]

Life Cycle

The life cycle of *M. cerebralis* alternates between two hosts: salmonids and aquatic oligochaetes (Fig. 3)

- Initial host, an aquatic oligochaete worm (e.g., *T. tubifex*) (Fig. 4), ingests myxospores present in sediments
- Myxospores develop into the triactinomyxon form (approximately 3 months at 15°C)
- Triactinomyxon spores are released from oligochaete and become waterborne; infection in oligochaetes does not appear to be lethal.
- A triactinomyxon spore attaches to salmonid, and its sporoplasm enters the epidermis (Fig. 5); infection spreads to cartilaginous tissue.
- Forty days post-infection, multinucleate trophozoites are present in cavities (i.e., lesions) within the cartilaginous tissue
- Nuclei continue to divide, appearing in groups of 12-14 pansporoblasts at 4 months post-infection
- Each pansporoblast develops into 2 spores
- Eight months post-infection pansporoblasts have produced spores that fill cavities (Fig. 6)
- Myxospores (Fig. 1) are released into sediments when fish dies

[1] http://www.whirling-disease.org/
[2] http://water.montana.edu/topics/fisheries/troutlab/photos.htm#lab

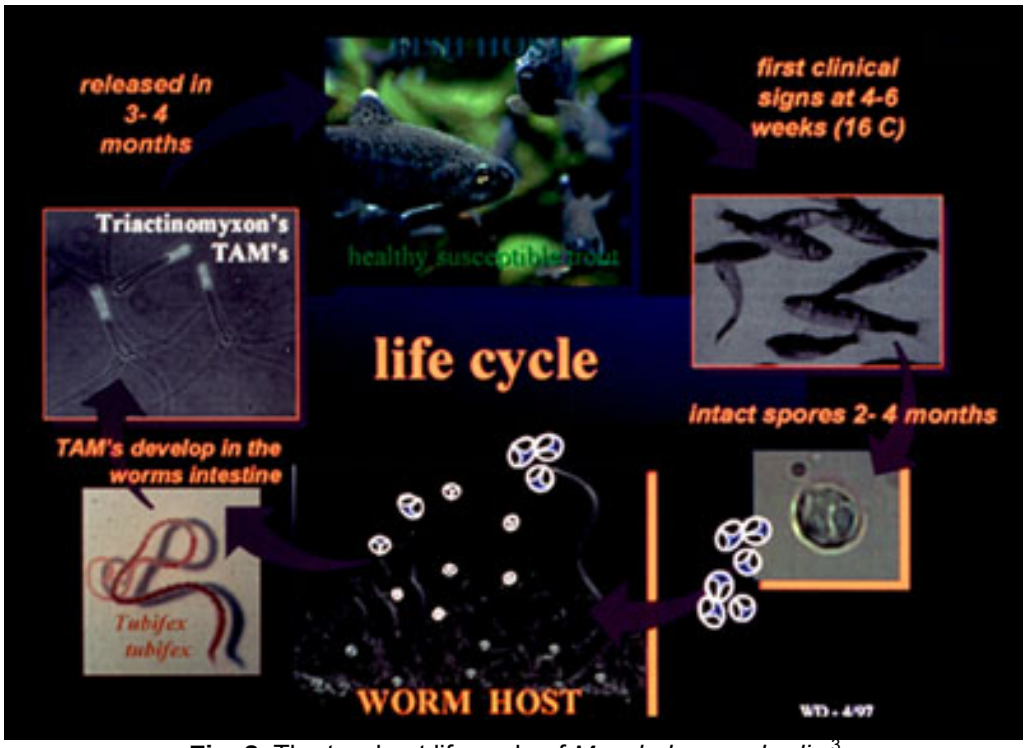

Fig. 3 The two host life cycle of *Myxobolus cerebralis*.[3]

Fig. 4 The initial host is an aquatic oligochaete worm, such as *T. tubifex*.[4]

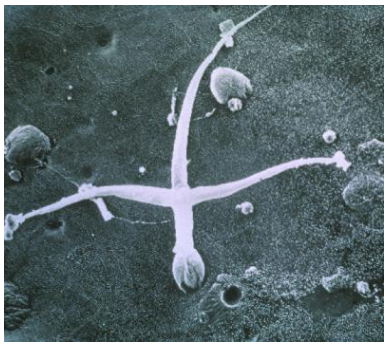

Fig. 5 Triactinomyxon spore, the infectious stage of *M. cerebralis*, penetrating salmonid skin.[5]

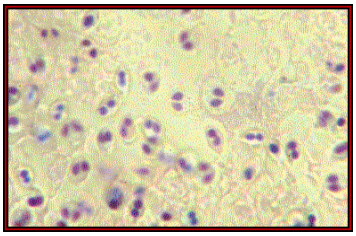

Fig. 6 Histological section of infected cartilaginous tissue from salmonid.[6]

[3] http://www.colostate.edu/depts/coopunit/research.html
[4] http://www.whirlingdisease.org/faq.htm#
[5] http://www.whirlingdisease.org/faq.htm#
[6] http://www.biosci.ohio-state.edu/~parasite/myxobolus.html

Distribution

Native Range
- Central Europe and northern Asia

North American Distribution
- See Figure 7

Probable Means of Introduction
- Importation of frozen rainbow trout from European destinations
- Transportation of shipments of infected fish

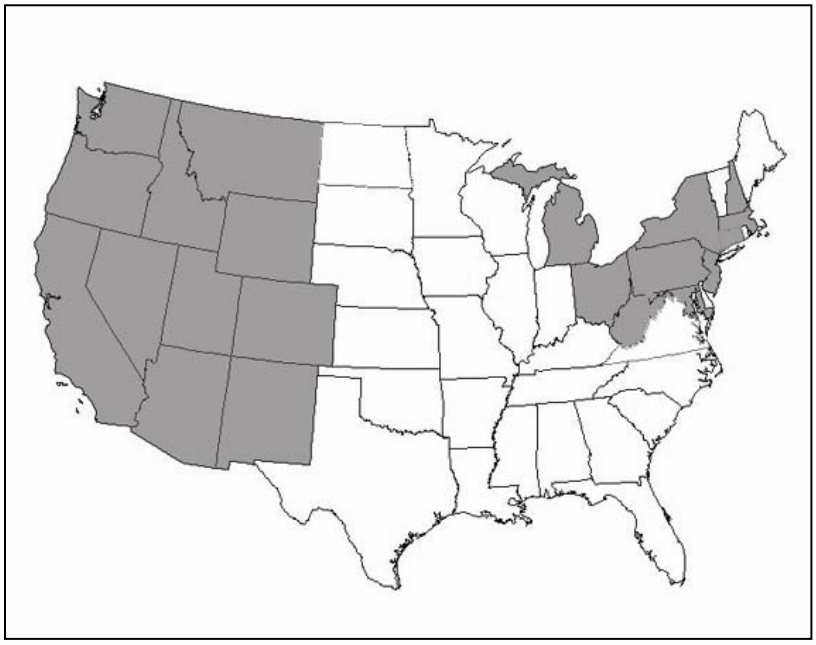

Fig. 7 Whirling disease, indicated by the shaded areas, has spread throughout much of the United States.[7]

Impacts

Negative
- Economic losses to sports fisheries industry
- Both in the wild and in hatcheries, losses to fry and fingerling salmonids, especially rainbow trout

Management

Control Measures
- Since myxospores are capable of remaining viable in sediments for years, can survive passage through the digestive system of piscivorous fish and birds, and tolerate freezing and thawing, it is not possible to eradicate the disease. However, the following may help to control the spread:
  - Adhere to regulations for the importation and transportation of salmonid fish

[7] Jerri Bartholomew (Oregon State University)

- Identify areas of infestation and educate those with access to the area (e.g., anglers, boaters)
- When leaving heavily infested waters, thoroughly clean muddy footwear, boating equipment, and containers (*M. cerebralis* is spread in mud which can adhere to wading boots, fishing apparatus, and equipment). Spraying, wiping, or dipping equipment in a 50% chlorine solution (1 part chlorine to 1 part water) will kill all life stages of the disease. Briefly immersing equipment in nearly boiling water (200°F) is also effective
- Promptly remove decaying fish carcasses from water
- Don't dispose of skeletal parts or entrails in kitchen disposal (spores are capable of surviving wastewater treatment systems)

- Certain oligochaete strains may reduce the number of myxospores present in the water column, thereby acting as a natural biocontrol of *M. cerebralis*
- Rearing young salmonids in well water may prevent exposure to *M. cerebralis* until they are older and more resistant
- Raising salmonids used in the fisheries industry in concrete tanks with no sediment will reduce the oligochaete habitat and the spread of *M. cerebralis*
- Maintaining quality water conditions will reduce the acceptable habitats of *T. tubifex*, the initial host of *M. cerebralis*

Literature

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Web Sites

http://is2.dal.ca/~emelrose/zmelrose/xecol/melrosest.html
Myxobolus cerebralis: The Causative Agent of Whirling Disease in Salmonid Fish

http://www.whirling-disease.org
Whirling Disease Foundation

http://www.colostate.edu/depts/coopunit/research.html
Whirling Disease Research

http://www.whirlingdisease.org/
Montana Whirling Disease Task Force

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