

Encysted Digenean Metacercariae (white and yellow grubs)

I. Causative Agent and Disease

White and yellow grubs, caused by several species of digenean trematodes (flukes) have cercarial forms that penetrate the skin of fish, where they encyst and develop into metacercariae, appearing as white or yellow nodules in the flesh. The most common worms present in freshwater are *Clinostomum* spp. (yellow grub) and *Posthodiplostomum minimum* (white grub). In the marine ecosystem there are many species of trematodes that produce white and yellow cysts in fish.

II. Host Species

Many North American fish species are second intermediate hosts for the freshwater white and yellow grubs. Similar or the same species occur in Europe, South America and Asia. Also, numerous species of marine fish worldwide can be parasitized with metacercariae that produce white and yellow cysts.

III. Clinical Signs

Infested fish exhibit white or yellow nodules in the flesh that can vary greatly in size.

IV. Transmission

Fish are infested by exposure to fresh or seawater containing parasitized snails or other invertebrates. The actively swimming cercariae shed by the invertebrate penetrate the skin of the fish and/or travel to other target tissues where they develop into metacercariae. The definitive hosts for freshwater white and yellow grubs are fish eating birds where adult worms occur in the mouth, throat or intestine. The life cycle is completed by release of eggs into the water with saliva or feces. The eggs hatch into miracidia which parasitize the inver-

tebrate hosts. The inclusion of many other trematode species, especially in the marine environment, involves more hosts including birds and mammals as final hosts while fish can be a second intermediate host, paratenic host or the final host.

V. Diagnosis

Presumptive diagnosis is by the observation of white or yellow cysts containing metacercariae in the skin, fins or viscera of fish. Freshwater white grubs are 1-1.5 mm and yellow grubs are 3-8 mm. The smaller white grub encysts in visceral organs, especially kidney, liver and heart. The yellow grub is more common in skin, fins and musculature. In marine fish the nodules may vary considerably in location and size due to the many different trematode species. Confirmation is by observing metacercariae in the cysts of wet mount preparations or histological sections. *Tetracotyle* is a collective larval genus for several genera and species of trematodes having characteristics of the family Strigeidae. More precise genus and species identification is based on tissue site of encystment and morphological characteristics of the metacercariae. DNA sequencing has also become an important method for identifying these parasites

VI. Prognosis for Host

Most metacercarial infestations are relatively non-pathogenic. Encystment in visceral organs may cause significant pathology and fish mortality when infestation intensity is high. Grub-infested flesh also produces inferior product quality in commercial and farmed fish.

VII. Human Health Significance

Generally, these worms are consid-

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ered to infect only poikilotherms, but there have been cases in Japan, Korea and SE Asia where metacercariae of *C. complanatum* have parasitized humans from eating affected fish. The Center for

Disease Control recommends cooking fish at 67°C for 5 minutes or freezing fish at -20°C for at least 7 d to kill worm parasites before ingestion.



Left: Yellow grub-like encysted metacercariae (arrow) in the pericardial cavity of a sheefish; **Right:** Strigeid-type trematode larva teased from a cyst on the left, resembles a *Tetracotyle* of an *Ichthyocotylurus* sp., X 10.



Left: Yellow grub-like metacercariae encysted in the peritoneal lining and musculature of a rainbow trout; **Right:** Metacercariae encysted in the skin of a starry flounder causing numerous raised nodules.