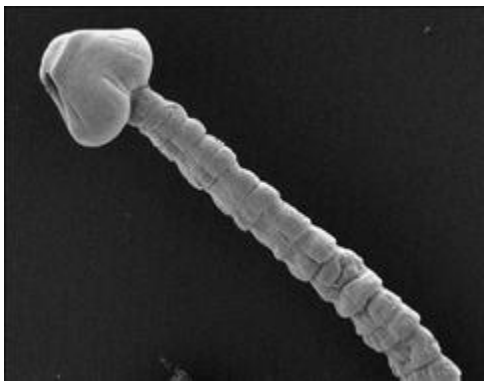
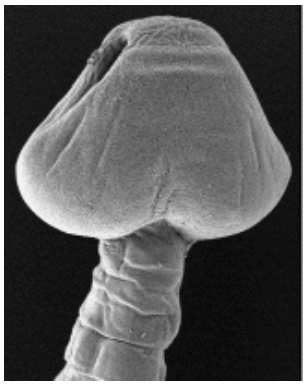
Asian Tapeworm - *Bothriocephalus acheilognathi*

Identification: *Bothriocephalus acheilognathi* is a cestode which parasitizes freshwater fish, particularly cyprinids (Marcogliese, 2008). It can be identified by a fleshy, arrow-head or heart shaped scolex (head region) with a relatively undeveloped terminal disc, and two anterolaterally directed bothria (slit-like openings) which are short and deep (Scholz, 1997). It has no neck; instead, proglottids (body segments) begin directly behind the scolex. The proglottids are relatively elongate and much narrower than the scolex (Scholz, 1997).

Photos: Scolex and cestode.



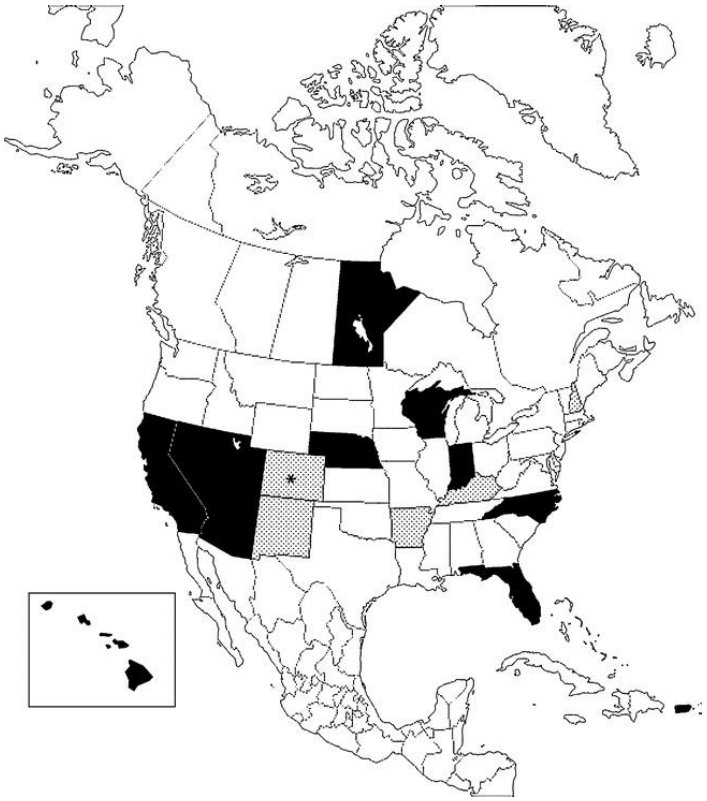
Triangular Scolex and 9 proglottids



Close up of scolex

Multiple Asian tapeworms from gut of Carp. 3" in length.

Native Range: Native to East Asia, *Bothriocephalus acheilognathi* was first described by S. Yamaguti in 1934 from Ogura Lake, Japan (Scholz, 1997).



North American Range:

Bothriocephalus acheilognathi has been introduced in Europe, Australia, Mexico, the United States and Puerto Rico (Marogliese, 2008). It has also been reported in Lake Winnipeg, Manitoba, Canada (Choudhury et al., 2006). This means that in time this tapeworm can move into Saskatchewan through the Qu'Appelle River.

In the United States, it has been reported in the Colorado and Little Colorado Rivers (Brouder and Hoffnagle, 1997; Clarkson et al., 1997), the Muddy River in Nevada (Heckmann et al., 1993), the Virgin River (Heckmann et al., 1986; Heckmann and Deacon, 1987), the Pecos River and the Rio Grande (Bean et al., 2007; Bean, 2008), the Yampa River (Ward, 2005), the Los Angeles River, Salton Sea, San Jacinto, San Juan, Santa Ana, Santa Clara and Santa Margarita watersheds (Warburton et al., 2002), in Belews Lake, North Carolina (Riggs and Esch, 1987), the Detroit River (Marcogliese, 2008), and the Hawaiian islands of Kauai and Hawaii (Font and Tate, 1994) and O'ahu (Vincent and Font, 2003).

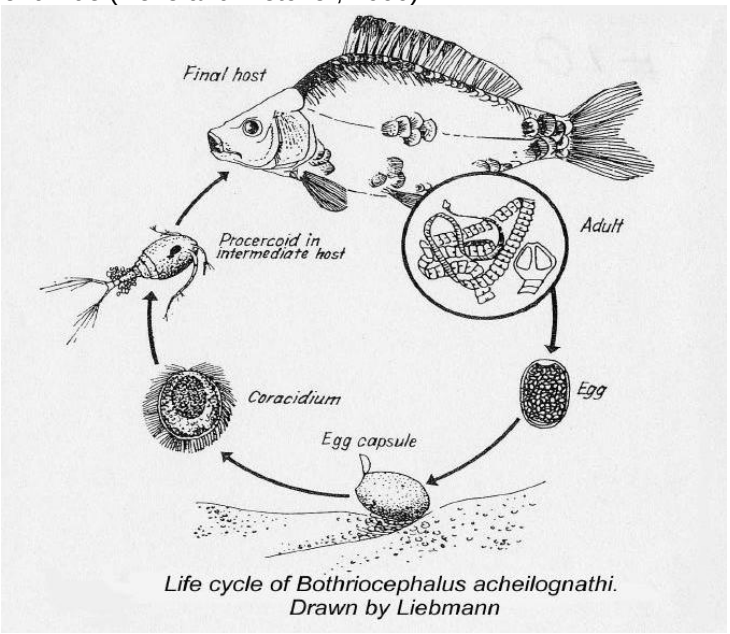
Ecology *Bothriocephalus acheilognathi* has a less complex life cycle than many tapeworm species, requiring only one intermediate host before reaching its final host (Hansen et. al, 2007). The adult worm is an intestinal parasite in fish. It absorbs nutrients directly across the tegument (body covering), competing with the host animal for nutrition (Hansen et al., 2006).

Adult worms are hermaphroditic; each proglottid has a complete set of both male and female reproductive organs and produces eggs through self-fertilization. The eggs are shed into the water with the host's fecal material, where they hatch into free-swimming hexacanth (six-hooked) larvae. Eggs require water temperatures between 12ºC and 37ºC to hatch. Within this range, the amount of time required for hatching varies with water temperature. Eggs tend to hatch within 1-5 days at 28-30ºC, and within 10-28 days at 14-15ºC (Marcogliese, 2008).

The free-swimming larvae, called coracidia, are consumed by cyclopoid copepods (tiny crustaceans). They then burrow into the copepod's haemocoel (body cavity), where they develop into a second larval stage called a procercoid. This process also depends upon water temperature; larvae become able to infect their final host in 11-18 days at 29-31ºC, and in 49 days at 20ºC (Marcogliese, 2008).

While fish are normally infected by consuming infected copepods, there is some evidence that adult worms can be transmitted directly to piscivorous fish that prey on infected fish (Hansen et al., 2007). Once within the host fish's intestine, the larvae mature into adult worms over the course of 21-23 days at 28-29ºC (Marcogliese, 2008).

Common carp (*Cyprinus carpio*) and grass carp (*Ctenopharyngodon idella*) are the principle native hosts for the Asian tapeworm, but it has an extremely low degree of host specificity, and has been found in fish species from 12 families and 6 orders worldwide (Dove and Fletcher, 2000).



Asian Tapeworm Lifecycle

Dr. Terry Dick from the University of Manitoba has found Asian tapeworm (*Bothriocephalus achelignoathi*) in young of the year emerald shiners sampled from the Red River and its outlet area, and adult walleye, sauger, pike and goldeye in Lake Winnipeg. Emerald shiners are the main forage fish for Lake Winnipeg walleye and sauger.

Means of Introduction: *Bothriocephalus acheilognathi* is likely to have been accidentally introduced with grass carp, one of its native hosts, and subsequently spread through the translocation of bait fish (Choudhury et al., 2006; Heckmann et al., 1993). For example, Heckmann et al. (1993) found infected minnows in four bait shops near Las Vegas, NV, that had originated from commercial ponds outside the state.

Status: This parasite has become widespread, and is known in several areas of the United States. It appears to be well established in the lower Colorado River and the Hawaiian islands (Choudhury et al., 2006), and has recently been reported in the Great Lakes (Marcogliese, 2008).

Impact of Introduction: Infection with *Bothriocephalus acheilognathi* has been shown to reduce a fish's ability to cope with stressors such as reduced food availability (Hansen, et al., 2006). Competing with intestinal parasites for nutrients may lead to reduced body condition, anemia, reduced growth and temperature-dependent mortality, especially in juvenile fish. Other known pathogenic effects include intestinal inflammation, protein depletion and altered digestive enzyme activity (Marcogliese, 2008).

The Asian tapeworm is known to infect wild populations of the federally endangered humpback chub (*Gila cypha*), Mojave tui chub (*Siphateles bicolor mohavensis*), Virgin roundtail chub (*Gila robusta seminuda*), and woundfin minnow (*Plagopterus argentissimus*), as well as several other rare and/or endemic fishes in the western United States, including Virgin spinedace (*Lepidomeda mollispinis mollispinis*), roundtail chub (*Gila robusta*), arroyo chub (*Gila orcutta*), and Tamaulipas shiner (*Notropis braytoni*) (Bean et al., 2007; Clarkson et al. 1997; Heckmann et al., 1986; Warburton et al., 2002; Ward, 2005). The federally endangered bonytail chub (*Gila elegans*) has also been shown experimentally to be a suitable host (Hansen et al., 2006). The increased stress of tapeworm infection may severely complicate efforts at conservation and recovery for these species. In Hawaii, at least two of the five native freshwater fish species have been found to be infected (Font and Tate, 1994). This is concerning because geographic isolation makes Hawaiian species inherently vulnerable.

References:

The USGS (United States Geological Survey) website for Biology/Nonindiginous Aquatic Species at http://nas.er.usgs.gov/

Update on the Distribution of the Invasive Asian Fish Tapeworm, *Bothriocephalus acheilognathi*, in the U.S. and Canada by Anindo Choudhury5, Elizabeth Charipar, Patrick Nelson, James R. Hodgson, Scott Bonar, and Rebecca A. Cole published in Comparative Parasitology 73(2):269-273. 2006 doi: 10.1654/4240.1

Photos/Pictures/Diagrams:

Parasites of Invertebrates, Fish, Amphibians, and Mammals in Southern California Original LM and SEM Images by Dr. Boris Kuperman and Dr. Victoria Matey at
http://www.sci.sdsu.edu/classes/biology/bio588/ParasitesSoCA.html

***BOTHRIOCEPHALUS ACHEILOGNATHI* INFECTION OF FISH IN SOUTHERN CALIFORNIA**
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http://www.werc.usgs.gov/sandiego/pdfs/warburton3623.pdf

Diseases of Carp and other Cyprinid Fishes, co-written by Dave Hoole; published in March 2001 by Blackwell Sciences.

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