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Infestations of the Trematode *Bolbophorus* sp. in Channel Catfish

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Digenetic trematodes infest many types of fish and are common in cultured fish in areas frequented by fish-eating birds. In the past, most trematode infestations in cultured channel catfish were caused by either *Clinostomum complanatum* (“yellow grubs”) or *Diplostomum spathaceum* (“eye flukes”). Such infestations are rarely more than a nuisance, though severe infestations of yellow grub may make fish unsuitable for processing.

Recently, a digenetic trematode identified as *Bolbophorus* sp. (hereafter referred to only as *Bolbophorus*) has been reported in commercially raised channel catfish from Louisiana, Mississippi and Arkansas. Evidence indicates that *Bolbophorus* infestations have caused high mortality rates and decreased production in channel catfish. The management strategies discussed here for the control of *Bolbophorus* apply to other digenetic trematodes with similar life cycles.

Life cycle and vectors

As with other digenetic trematodes, *Bolbophorus* has a complex life cycle involving one final host and two intermediate hosts. The life cycle (Fig.1) begins when the adult trematode, which lives in the gastrointestinal tract of the American white pelican (*Pelecanus erythrorhynchos*), releases eggs that are then deposited into ponds when the birds defecate. The eggs hatch to produce miracidia that infest the first intermediate host, the ram’s horn snail (*Helisoma* sp., Fig. 2). The miracidia mature in the snail and eventually release larval trematodes called cercariae. The cercariae infest and encyst in fish to form metacercariae (Fig. 3). The life cycle is completed when pelicans eat infected fish and metacercariae develop into adult flukes.

Some digenetic trematodes may have several different final and intermediate hosts. Studies to date, however, indicate that the only final and intermediate host for *Bolbophorus* are the pelican and the ram’s horn snail, respectively. Without these hosts the life cycle of the trematode cannot be completed.

Many different species of fish-eating birds from locations across North America have been necropsied and examined for the presence of *Bolbophorus*. Some of the birds sampled were from ponds in Louisiana and northwestern Mississippi containing severely

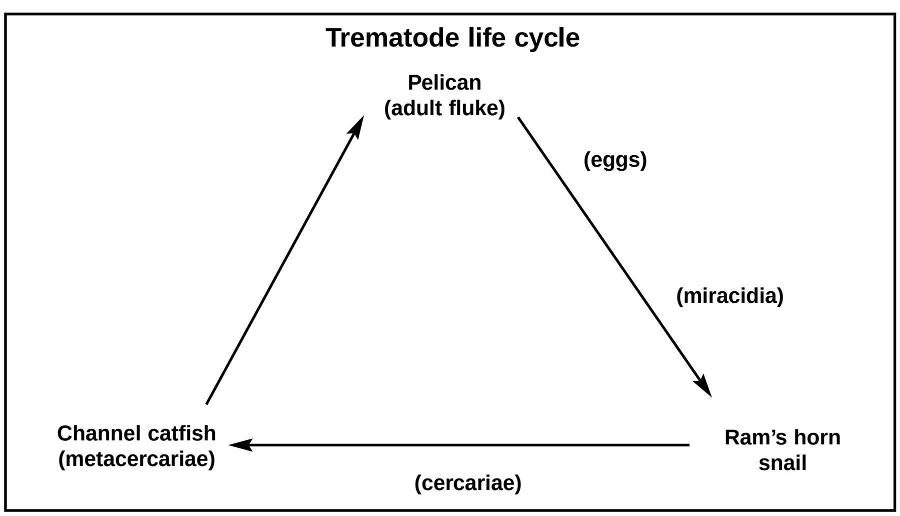

Figure 1. Life cycle of Bolbophorus *sp.*

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infested fish. With the exception of one case, the adult fluke has been found only in American white pelicans. The adult fluke was found in a single brown pelican (*Pelecanus occidentalis*), but it is not known whether this bird can serve as a viable final host.

Since this trematode appears to be endemic in the American white pelican population, the primary factor in its spread is the presence of these pelicans in a given area. Fish-to-fish transmission of digenetic trematodes is not possible. Therefore, transferring affected fish from pond to pond will not transmit the disease to other fish. The trematodes in fish can not complete their life cycle and will die if the infested fish is not eaten by a pelican. It is also highly unlikely that enough cercariae could be transferred from pond to pond via equipment or transport water to create an economically damaging level of infection.

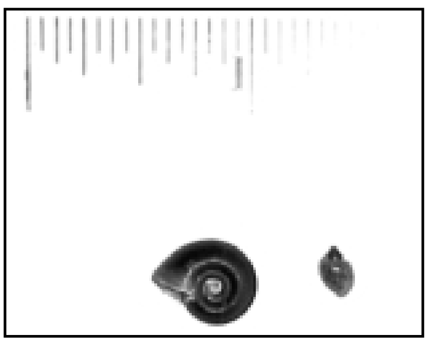

Figure 2. The first intermediate host of Bolbophorus *sp., the ram's horn snail (left). The ram's horn snail should not be confused with* Physa *spp. (right), another common snail found in commercial catfish ponds.* Physa *is not an intermediate host for the trematode.*

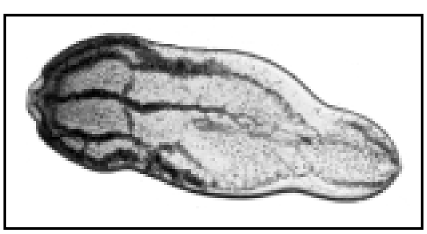

Figure 3. The metacercarial stage of Bolbophorus *sp.*

Clinical signs

Catfish infested with *Bolbophorus* have small (1/32- to 1/16-inch) cysts that can be anywhere in the body but usually appear in the tail (Fig. 4). The cysts are white or red raised bumps either just under the skin or deeper in the muscle tissue.

An infestation may have no apparent effect on production, or it may cause extensive mortalities in smaller fish. The limited research that has been done suggests that *Bolbophorus* causes massive damage to the kidneys and to a lesser extent the liver. In severe infestations of smaller fish, gross lesions may look similar to channel catfish virus disease or enteric septicemia of catfish (distended abdomen with fluid in the body cavity and bulging eyes). Larger fish seem to be less susceptible; lesions are generally limited to those on the skin and fins. However, larger fish that are severely infested feed poorly and may appear emaciated.

Figure 4. Channel catfish fingerling showing cysts with Bolbophorus *sp. metacercariae. (Photograph courtesy of Marco Nicovich, Mississippi State University.)*

Risk assessment

Because *Bolbophorus* can be introduced easily into a commercial facility by infested pelicans, and because it can have serious effects on production, farmers in susceptible areas should take steps to limit the spread of this condition. The American white pelican is a common winter resident in the lower Mississippi Valley, with migrating populations peaking from February through April. Farms that are at the highest risk are those near pelican roosting or loafing areas, such as lakes, rivers, bayous and refuges, and those with high numbers of ram's horn snails. Farmers should scout for snails along shallow areas of vegetated levee banks. Aquatic vegetation should be examined for snails that may be attached to stems or roots.

If a farm is at risk, fish should be examined, especially if fish have decreased appetite that cannot be explained by other diseases or poor water quality. A small cutting seine can be used to collect fish that have been attracted to an area by some feed. Additional sampling should be done during harvest and other seining operations. At least 20 to 30 fish should be examined on site; if any samples have possible *Bolbophorus* infestation, they should be submitted to a fish diagnostic laboratory for confirmation.

Treatments

There is no FDA-approved treatment for fish infested with trematodes. Control is dependent on breaking the life cycle of the trematode. It is impractical to eliminate the free-swimming (miracidia and cercariae) life stages. The only practical treatment is eliminating or reducing the numbers of final or intermediate hosts.

Every effort should be made to discourage predation by birds on commercial catfish operations. (See SRAC publications 400, 401 and 402 for additional information.) Pelicans can be extremely difficult to harass from a pond once they establish a feeding pattern. They feed at night as well as during daylight. Pelicans are protected by federal law; contact the USDA/APHIS/Wildlife Services agency to find out about proper control methods.

In addition to keeping birds away from farms, breaking the trematode life cycle depends on reducing snail populations with a combination of chemical treatments, biological control species, and aquatic weed control. Expensive chemical treatments aren't warranted in ponds with little or no evidence of ram's horn snails. If fish are only mildly affected, conservative measures will likely reduce snail populations sufficiently in affected ponds. However, if a farm has quite a few ponds with infested fish, all ponds with high snail populations should be treated whether or not the disease is present in a given pond. Research has not yet determined whether the severity of infestation correlates to the long-term performance of fish. Producers should evaluate feeding response, length of time to harvest, and mortality rate before making radical management decisions. The key question is: When does the infestation become so severe that it is no longer economically justifiable to maintain infested stocks of fish? Regrettably, there is no simple answer to that question.

On farms where pelicans usually are found, snail numbers should be reduced before pelicans migrate into the region. Snails also should be controlled in late summer or early fall since ram's horn snails burrow into the mud during winter months. Trematode-infested snails that survive the winter can shed cercariae over several growing seasons.

Chemical treatments

Treating pond margins with hydrated lime and / or copper sulfate can be effective in reducing snail populations within the treated zone. Chemical treatments will not eradicate snail populations from a pond, but will reduce the number of snails. Snails will eventually repopulate, so treatments will need to be repeated.

To be effective, the correct amount of chemical must be applied and the pond margin thoroughly covered. The treatments target snails in a narrow band of water along the pond margin. Snails outside this area will not be affected. The chemical should be applied so that it penetrates through any aquatic vegetation. Areas with thick stands of aquatic vegetation should receive additional treatments. Aquatic weeds located away from the pond margin should be eliminated with an appropriate aquatic herbicide before the pond margin is treated for snails.

Apply chemicals to pond margins only on calm days so that waves don't dilute the chemical too quickly. Do not treat recently stocked fry ponds; fry and small fingerlings may not be able to retreat from the treated area fast enough to avoid direct contact with the chemical.

Hydrated lime

Apply dry hydrated lime at a rate of 50 pounds per 75 to 100 feet of pond bank. Treat a band 3 to 4 feet from the pond edge or 1 to 2 feet beyond any vegetation that extends into the pond. At the prescribed application rate, the pH will increase briefly (10 to 20 minutes) within the application zone but the lime will not affect the overall water quality of ponds with total alkalinity greater than 50 mg / L. The material can be applied with an auger-equipped hopper mounted on a tractor to help cover larger areas in less time (Fig. 5).

Figure 5. Hydrated lime being applied to a pond with a tractor-mounted auger.

Hydrated lime also can be mixed with water and applied as a slurry. This form of hydrated lime is usually prepared at a commercial lime facility and delivered to commercial applicators or individual farmers. The bulk slurry is transferred to a large holding tank at the farm and subsequently pumped to smaller tanks for application (Fig. 6). Formulation rates are 4.0 to 4.7 pounds of hydrated lime per gallon of water. At this concentration, apply 20 gallons of slurry per 100 feet of levee.

Figure 6. Hydrated lime slurry being applied with a pull-behind sprayer.

Copper sulfate

Copper sulfate is applied at a rate of 10 pounds of copper sulfate plus 1 pound of citric acid per 250 feet of pond margin. These dry materials should be mixed with at least 70 gallons of water per 250 feet of pond margin treated. The finished formulation should be applied to a 6-foot band around the pond perimeter. Application equipment is similar to that used for hydrated lime slurry. Copper can be toxic to fish, so farmers should not treat ponds with less than 150 mg / L total alkalinity (as $CaCO_3$). Ponds smaller than 7 acres should not be treated because this recommended rate would exceed rates that can be applied to the whole pond. Using copper sulfate in ponds with heavy algae blooms can also cause severe oxygen depletion because copper sulfate is toxic to phytoplankton. To minimize the impact on algal populations, treat half the pond margin one day and the remainder several days later.

Bayluscide®

Bayluscide® or niclosamide is a molluscicide used in tropical regions of the world to control the spread of the human disease schistosomiasis. It is also used in the Great Lakes region to control sea lampreys. Bayluscide® 70 WP (70% active ingredient in a wettable powder) has been given a Section 18 emergency exemption in Mississippi until November 2003 for control of ram's horn snail in commercial catfish ponds. It is applied at a rate of 1.5 pounds per acre-foot of water. Unlike hydrated lime and copper sulfate, Bayluscide® is applied to the whole pond. At the application rates authorized under the exemption, this pesticide is toxic to non-target aquatic organisms such as fish and aquatic insects. Therefore, Bayluscide® is used to control snails in ponds where there are no fish. Producers should follow all label instructions regarding application rates, pond draining and restocking restrictions.

Biological control

After chemical treatments to reduce snail numbers, biological methods must be used to control snails long-term. Black carp (*Mylopharyngodon piceus*) reduce snails in commercial catfish ponds at stocking rates of 5 to 20 fish per acre. Black carp is a nonindigenous species and its use may be restricted. Consult the proper authorities (a natural resource agency or Extension personnel) before stocking. Redear sunfish or "shellcracker" (*Lepomis microlophus*) may also control snails, but no experimental evaluations have been done. The redear's small mouth may restrict its foraging to juvenile snails, thus extending the time required to significantly reduce snail populations.

Aquatic weed control

Aquatic vegetation creates ideal habitat for snails and may hinder the foraging of species used for biological control. Weeds growing along the margin and submerged in the pond should be eliminated. Grass carp (*Ctenopharyngodon idella*) and aquatic herbicides effectively control aquatic vegetation. The use of grass carp also may have restrictions; as with black carp, consult proper authorities about their use and permit requirements. Producers who have invested time and money in planting soil-stabilizing vegetation along pond margins may want to evaluate the effectiveness of other snail control measures before deciding to eliminate these plantings. For additional information on aquatic weed control, see SRAC publications 360, 361 and 3600.

Although severe infestations of *Bolbophorus* can be economically devastating to a production facility, this disease can be managed with the proper prevention strategies. In summary, every effort should be made to discourage pelicans from feeding in catfish ponds. If pelicans are found in a particular region, farmers should monitor fish stocks for infestations and keep snail populations under control through chemical and biological control methods and aquatic weed management.

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