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**A JUVENILE WADING-BIRD MORTALITY EVENT IN
URBAN JACKSONVILLE, FLORIDA, ASSOCIATED
WITH THE PARASITE *Eustrongylides***

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Eustrongylidosis is a parasitic infection of fish-eating birds associated with nematodes of the genus *Eustrongylides*. Three species of *Eustrongylides* nematodes have been reported in waterbirds worldwide, but large outbreaks in the United States have largely been associated with *E. ingnotus*. *Eustrongylidosis* has caused large die-offs of nestling wading birds in coastal rookeries in Virginia, Indiana, Delaware, Louisiana, Texas, and Florida (Wiese et al. 1977, Roffe 1988, Spalding et al. 1993, USGS 2013). Infection from *E. ingnotus* can have devastating impacts on rookery reproductive success, in one Florida colony resulting in 80% nestling mortality (Spalding et al. 1993). Herons and egrets (Ardeidae) seem to be the primary definitive host in Florida (Spalding and Forrester 1993).

The life cycle of *Eustrongylides* spp. consists of infected birds depositing nematode eggs through their feces into aquatic environments. The nematode eggs are eaten by oligochaetes, the first intermediate host. The eggs hatch in the oligochaetes and the larvae migrate into the blood vessels. Infected oligochaetes are then consumed by small fish, such as *Gambusia* spp., which act as the second intermediate host. The

larvae further develop in this host and may be found encapsulated in the mesentery, intestines, or reproductive organs (Coyner et al. 2003a, USGS 2013). Larger fish, reptiles, and amphibians, the transport hosts, feed on infected small fish and are consumed by the bird host. The infective larvae reach sexual maturity within the bird, which completes the life cycle (USGS 2013).

Gross lesions from infection seen in young infected birds include raised tunnels in the digestive tract, where nematodes reside (Figs. 1 and 2), with openings to allow parasite eggs to be excreted through the bird's feces (USGS 2013). Parasites will eventually perforate the digestive tract, usually at the ventriculus (Spalding and Forrester 1993, USGS 2013). This can occur within several hours after the bird has consumed infected fish (Spalding and Forrester 1993). Peritonitis, septicemia, emaciation, hemorrhage, and organ dysfunction have been documented to cause death in infected birds. In nestlings, mortality can occur within 2 days of parasite infection (Spalding et al. 1994). Die-offs usually occur during the nesting season, and young are affected disproportionately more than adults (Spalding and Forrester 1993, Spalding et al. 1994, USGS 2013). As birds age and infections become more chronic, eustrongylidosis can contribute to, rather than cause, death. Resolved lesions have been found in adult birds,



Figure 1. Digestive tract of a Great Egret (*Ardea alba*) with raised tunnels caused by an infection of *Eustrongylides* sp. from the Jacksonville die-off in 2013.

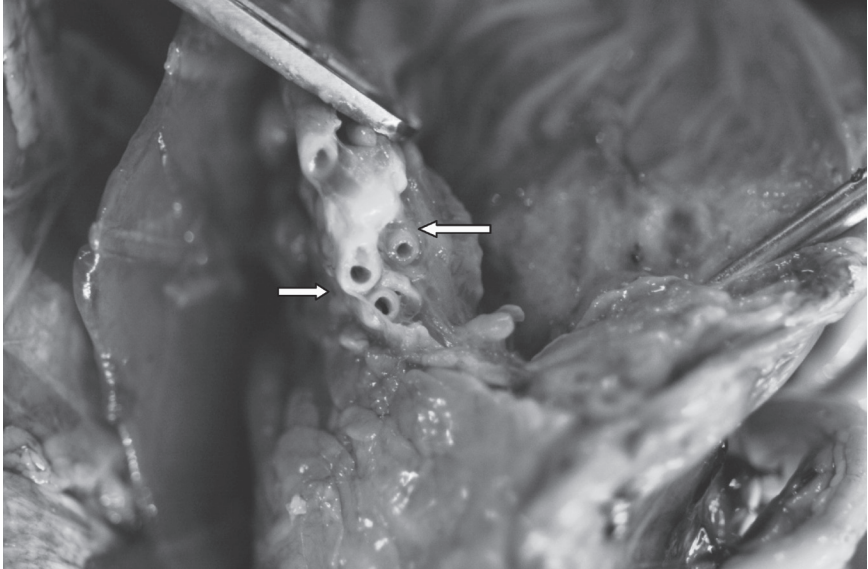


Figure 2. Cross-section of the ventriculus of a Great Egret (*Ardea alba*) infected with *Eustrongylides* sp. from the Jacksonville die-off in 2013.

suggesting a greater number of parasites might be necessary to cause mortality in adults (Spalding and Forrester 1993) and that infection is not necessarily associated with mortality, particularly in older birds (USGS 2013).

A bird die-off in the Jacksonville area (30° 23' 28.49" N, 81° 40' 54.52" W) was reported to the Florida Fish and Wildlife Conservation Commission (FWC) on 24 July 2013. To our knowledge, an *Eustrongylides* outbreak in this location had never been documented. A majority of the rookery was comprised of Great Egrets (*Ardea alba*) with a small number of Black-crowned Night-Herons (*Nycticorax nycticorax*). The surrounding habitat was urban-suburban with a dense overstory of mature laurel oaks (*Quercus laurifolia*). The rookery is entirely on private property. Active nesting was still in progress during our visit. Seventy-one Great Egret carcasses and 5 Black-crowned Night-Heron carcasses were counted on 24 July 2013. All carcasses in which an age was able to be determined were juveniles or younger, except one adult Great Egret. Residents estimated the initiation of the die-off at about four weeks prior to our visit. They also indicated that die-offs had been common in the past. Spalding and Forrester (1993) and USGS (2013) noted that nestlings infected with nematodes may wander from the nest in a weakened state. This behavior was observed at the Jacksonville site with several young individuals roaming the

ground and low vegetation. However, high winds prior to our visit may have played a role by forcing young out of nests.

Five Great Egret and one Black-Crowned Night-Heron carcasses were collected and sent to the USGS National Wildlife Health Center (Madison, Wisconsin) and Southeastern Cooperative Wildlife Disease Study (SCWDS) (Athens, Georgia) for necropsy. Both labs confirmed the evidence of a disseminated helminth parasite infection and presence of eustrongylidosis in the carcasses. Severe and chronic lesions were noted throughout the caudal coelomic cavity in the vast majority of submitted birds, which consisted of multifocal to coalescing parasitic granulomas throughout the liver, proventriculus, and ventriculus with intralesional nematodes; fibrous adhesions between proventriculus and ventriculus, liver, and body wall; and multiple nematodes perforating the wall of the proventriculus and ventriculus. Bacteria cultures of 3 birds' livers and virus isolation from 1 birds' liver evaluated at USGS showed no significant findings. *Eustrongylides* sp. infection was found in multiple areas of all carcasses submitted. Cause of death was identified as verminous peritonitis attributed to *Eustrongylides* sp.

Prevention of die-offs caused from eustrongylidosis remains difficult. The life cycle of *Estrongylides* sp. is robust, with eggs remaining viable for years and oligochaete hosts remaining infected for long periods. Water quality can play a significant role in the proliferation of the parasite. Eutrophication and warm water are favorable conditions for the persistence and growth of parasites and oligochaetes (Spalding et al. 1993, USGS 2013). Because of the unusually high mortality seen in these epizootic events, Spalding et al. (1993) hypothesized that the very high frequency of parasites associated with die-offs may not reflect the parasites' natural life cycle, but unnaturally high population densities of the parasite in polluted aquatic systems. Coyner et al. (2003b) reported densities of infected fish may decrease as water quality increases. Because many waterways in and around Jacksonville are anthropogenically eutrophic, *Estrongylides ignotus*-infected fish may be common there. Further investigation would be necessary. In addition, eutrophic waterways may attract wading birds due to an increase in biomass and abundant prey (Hoyer and Canfield 1990, Kelly et al. 1993, Frederick and McGehee 1994). It may be difficult to study foraging behavior of wading birds in this region as they are likely using a variety of water sources in the area including streams, rivers, retention ponds, and ditches. The nearest substantial waterway to this rookery site is the Ribault River (about 440 m straight-line), located in the St. Johns River Basin. Readings at various sites along the Ribault River nearest the rookery show low dissolved oxygen concentrations, all reporting below the standard for fresh-water (5.0mg/L), which can indicate eutrophic conditions (Betsy Deuerling, City of Jacksonville, Environmental Quality Division, personal communication).

Biologists and resource managers should be aware of the potential for large die-offs in juvenile wading birds associated with a severe *Eustrongylides* infection and resulting peritonitis. These events should be documented as they happen so the parasites and their impacts to host population dynamics can be better understood. The FWC has an online reporting system (www.myfwc.com/bird) whereby anyone can report bird die-offs in Florida, which are then investigated and permanently logged in a comprehensive database.

Note added July 2014: Approximately two dozen individuals were observed dead at the same site over two visits in July 2014. Gross infection from the *Eustrongylides* sp. infection was confirmed by Florida Fish and Wildlife Conservation Commission, Gainesville, Florida, and the National Wildlife Health Center, Madison Wisconsin, in 1 out of 5 individuals collected and necropsied.

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