

# CAPILLARIASIS PHILIPPINENSIS: A FISH-BORNE PARASITIC ZONOSIS\*

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**Abstract.** Fish from lagoons in Northern Luzon, Philippines, have been shown experimentally to be intermediate hosts of *Capillaria philippinensis*. Eggs ingested by the fish hatch in the intestines and the larvae double in size in 3 weeks. When fed to monkeys, Mongolian gerbils and birds, the larvae develop into adults and reproduce. Fish from the lagoons or purchased from the market were fed to gerbils and the animals developed patent infections, demonstrating natural transmission of the parasite. Philippine and Thailand populations have the habit of eating uncooked freshwater and brackish water fish and some have been experimentally infected with *C. philippinensis*. These countries report the largest number of cases of intestinal capillariasis. Fish-eating birds are now considered natural hosts for the parasite, fish the intermediate hosts, and humans accidentally become infected by eating infected fish.

## INTRODUCTION

While the epidemic of intestinal capillariasis was occurring in barrios of Tagudin, Ilocos Sur, in Northern Luzon of the Philippines, the source of the nematode infection was thought to emanate from animal life found in the brackish water lagoons located along the coast of the South China Sea. Consequently, thousands of specimens of animals from the lagoons, as well as from the environment, were examined for the parasite, *Capillaria philippinensis*, and although capillarid-like larvae were found, no adult *C. philippinensis* were recovered (Cross *et al.*, 1970). Throughout the years of unsuccessful searching for the intermediate and definitive host, experimental infections were carried out in which embryonated eggs were fed to available wild and laboratory animals in an attempt to establish infections. In one experiment, midge larvae were found to ingest the eggs but no further development occurred. In a follow-up experiment, midge larvae containing eggs were fed to fish and in the fish intestines the eggs

hatched releasing the larvae. Eggs were later fed directly to fish taken from the lagoons in the endemic area, the eggs hatched and the larvae doubled their size. Larvae from the fish were subsequently fed to monkeys and patent infections developed (Cross *et al.*, 1972). Similar studies were carried out using Mongolian gerbils as a definitive host and the life cycle definitely established (Cross *et al.*, 1978). Infections were later established in fish-eating birds (Bhaibulaya and Indra-Ngarm, 1979; Cross and Basaca-Sevilla, 1983).

When larvae from fish were fed to gerbils, they developed into adults within 10–11 days and female worms began to produce larvae in 13–14 days. These larvae developed into a second generation of adults in 22–24 days, and the females began to deposit eggs at about 26 days. Some females continued to be larviparous and produce larvae in order to increase their numbers and to perpetuate the infection; autoinfection is a major part of the intrinsic life cycle. Eggs from oviparous females pass with the feces in order to continue the extrinsic part of the life cycle (Fig 1).

This paper is presented as a brief review of experimental studies conducted to establish the importance of fish in the life cycle of the parasite. Studies with definitive hosts are reported elsewhere (Cross *et al.*, 1972; Cross *et al.*, 1978; Cross and Bhaibulaya, 1983).

\* The opinions or assertions contained herein are the private ones of the authors and are not to be construed as official or reflecting the views of the United States Department of Defense or the U.S. Navy or the Philippine Department of Health.

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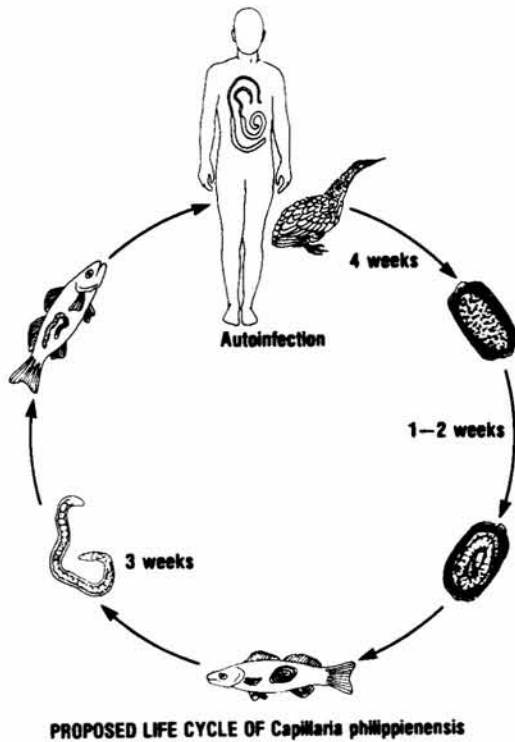


Fig 1 – Experimental life cycle of *Capillaria philippinensis* based upon studies in fish and Mongolian gerbils. [From Cross JH, Basaca-Sevilla. V. *Progress in Clin Parasitol* 1989; 1:105-19 (with permission)].

#### MATERIALS AND METHODS

Eggs used in experimental infections were initially obtained from human feces. In later studies, eggs were often from animal infections. Feces were mixed with water, sedimented and washed several times. The eggs in water were placed into petri dishes for culturing at ambient temperatures. Eggs were found to embryonate in 5–10 days and, when fully embryonated, were placed into a beaker containing aerated water and one or two fish. The fish were found to ingest the eggs from the water.

Prior to being fed to fish, the eggs were placed on microscope slides, covered with coverglasses, and tested for viability. Some of the slides were placed onto ice to provoke hatching, while slight pressure was put on the coverglasses of other slides. By either method,

viable larvae could be observed emerging from the eggs.

The first fish used for experimental infection is known locally as “bagsit” (*Hypseleotris bipartita*) (Fig 2). The fish breeds in the brackish water lagoons; it is especially abundant in the rainy season and is easy to maintain in a laboratory aquarium. Other species of fish from the lagoons were used: “birut” (*Eleotris melanosoma*), “bacto” (*Chonophorus melanocephalus*), “bagsan” (*Ambassis miops*), “ipon” (*Sicyopterus* sp.), and the “mosquito fish” (*Poicelia reticulata*). Goldfish and other commercially available fish from pet stores were

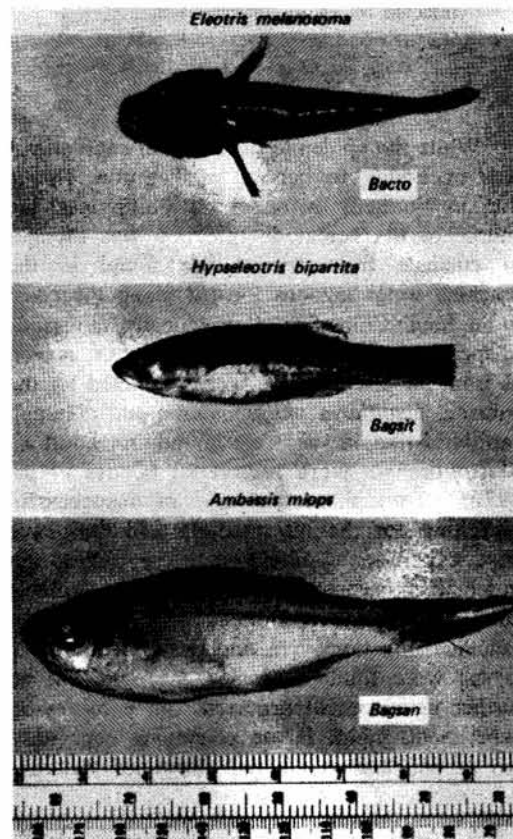


Fig 2 – Fish from lagoons in Northern Luzon in the Philippines, experimentally infected with eggs of *Capillaria philippinensis*. Bagsit have been found to be a natural source of infection. [From Cross JH, Bhaibulaya M. In: *Human Ecology and Infectious: Disease*, 1983; 103–36 (with permission of Academic Press)].

also exposed to infection. The fish were maintained in aerated fresh water aquaria at ambient temperatures and fed commercial fish food.

Fish were killed periodically and examined for larvae. The fish were dissected and various organs and tissues were examined for larvae. The tissues were placed into a petri dish containing saline, teased apart, and the larvae permitted to emerge. The larvae were observed under a dissecting microscope and collected in a pipet and subsequently fed to laboratory animals.

### RESULTS

Larvae were found only in the digestive tract of fish exposed to infection. On a few occasions, larvae were recovered in the liver, but most were found in the intestines. Larvae were not found in any other organs. The larvae were found to reach full growth after about 3 weeks. Larvae recovered at 3 months were usually the same size as those recovered after three weeks. Larvae directly from eggs varied in size from 130–150  $\mu\text{m}$ ; at 3 weeks and thereafter, were 250–300  $\mu\text{m}$ . Infections in animals only developed with larvae recovered from fish after 3 weeks. On one occasion, larvae recovered

from fish seven months after egg exposure, led to a patent infection in a monkey.

Table 1 presents results from fish experimentally infected with *C. philippinensis* eggs. Eggs hatched in all species of lagoon fish tested, and although other species had a higher percentage infected, the "bagsit" yielded more larvae. These fish, along with the guppies, were able to survive laboratory conditions better than the other species, and the bagsit was used most often since parasite development was best in this species. Goldfish and other pet store fish failed to become infected.

Monkeys and gerbils were usually infected by introducing larvae in saline into the stomach of the animals by a plastic tube attached to a syringe for monkeys and a blunted 18–20 gauge needle on a syringe for gerbils. On some occasions, entire experimentally-infected fish were fed to fasting monkeys and gerbils. These animals do not usually eat fish, but when hungry they eagerly ate the fish. Gerbils would not survive a diet of fish, so they were fed laboratory feed every few days. The monkeys were given laboratory monkey chow the day after being fed fish. Monkeys and gerbils fed fish developed patent infections.

Table 1

Recovery of larvae from freshwater fish experimentally infected with *Capillaria philippinensis* eggs.

Fish	Number examined	Positive		Larvae recovered	
		Number	Percent	Number	Average
Bagsit* ( <i>Hypseleotris bipartita</i> )	5,487	994	13	8,383	8.4
Bacto ( <i>Chonophorus melanocephalus</i> )	22	7	32	10	1.4
Bagsan* ( <i>Ambassis miops</i> )	70	16	23	65	4.1
Birut ( <i>Eleotris melanosoma</i> )	559	69	12	98	1.4
Ipon (Fry)* ( <i>Sicyopterus</i> sp.)	18	11	61	12	1.1
Guppy ( <i>Poicelia reticulata</i> )	210	25	12	265	1.3

\* Often eaten uncooked.

On three different occasions fish taken directly from lagoons or purchased from the market were fed to gerbils and the animals developed patent infections and died.

A large number of fish from the lagoons were also examined for infections and a few were found infected with *Capillaria*-like larvae (Table 2). It was not possible to determine the species of *Capillaria*, however.

DISCUSSION

Although all evidence concerning the life cycle and means of transmission of *C. philippinensis* has been obtained through experimentation, there is strong evidence that fish species are an important source of infection. Eggs fed to fish hatch in the intestine, and larvae from these fish have led to patent infections when given to monkeys, gerbils, and birds. Furthermore, wild caught fish from lagoons or purchased from the markets in the endemic area led to infections in gerbils, thus showing natural transmission. Eggs were not found to hatch in any other animals except fish.

Ilocano populations in the endemic area eat a variety of fish uncooked and most of these fish have been shown to be able to serve as intermediate hosts for the parasite. Female

bagsit, *H. bipartita*, are especially desired when gravid and the abdomen is filled with eggs; the entire fish is eaten raw. Some people like to bite the belly of the bagsan, *A. miops*, and suck out the juices. Therefore, the eating habits of the people are conducive to infection.

In Thailand, Bhaibulaya *et al* (1979) experimentally infected species of fish found in canals, ponds, and a commercial hatchery around Bangkok. They exposed 9 species of fish to *C. philippinensis* eggs and 6 species were found with larvae in 10-30 days. Four of the 6 species are commonly eaten raw by certain Thai populations.

The sources of infections in other reporting countries, Japan, Iran, Egypt, and Taiwan (Cross, 1990), are not known, except in Iran where the patient reported eating fresh water fish raw for medicinal purposes. The eating of raw fish in Japan is a well known practice, and while the raw fish that is eaten is usually from the ocean, at times Japanese also eat fresh water fish uncooked. One of the patients in Egypt reported occasionally eating raw fish.

Fish eating birds have been shown by Bhaibulaya and Indra-Ngarm (1979) and Cross and Basaca-Sevilla (1983) to develop patent infections with *C. philippinensis* when fed larvae

Table 2

Recovery of *Capillaria*-like larvae from freshwater fish in the Philippines.

Fish	No. examined	No. positive	No. larvae
Bagsit* ( <i>Hypseleotris bipartita</i> )	3,956	6	8
Bacto ( <i>Chonophorus melanocephalus</i> )	201	2	101
Bagsan ( <i>Ambassis miops</i> )	5,204	2	16
Birut ( <i>Eleotris melanosoma</i> )	3,208	0	0
Ipon (Fry) ( <i>Sicyopterus</i> sp.)	15,159	0	0
Guppy ( <i>Poicelia reticulata</i> )	310	0	0

\* Bagsit from lagoons and market led to fatal infections of capillariasis philippinensis in three gerbils fed whole fish.

from fish or whole fish experimentally exposed to *C. philippinensis* eggs. Most of the birds experimentally infected were migratory birds, and it is believed that in their migration the birds are able to spread the parasitosis and infect indigenous fish. Most of the fish in which larvae develop are small and easily ingested by the birds. On one occasion, a fish-eating bird was found naturally infected with a male *C. philippinensis* (Cross and Basaca-Sevilla, 1983).

Human infections of *C. philippinensis* still occur in the Philippines, but at a very low rate. Infections also continue to be reported from Thailand. Infected persons experience diarrhea, borborygmi and abdominal pain. If untreated, the symptoms become more severe and the patients experience weight loss, weakness, malaise, anorexia, edema and cachexia. The disease persists and diarrhea increases with resulting electrolyte loss and a protein-losing enteropathy. Death usually results in untreated cases. At autopsy many thousands of worms may be found in the intestines (Cross and Bhaibulaya, 1983). Treatment is effective with mebendazole (200 mg twice a day for 20 days) or albendazole (200 mg per day for 10 days) (Cross and Basaca-Sevilla, 1987.) Fluid and electrolyte replacement and a high protein diet are recommended for chronic infections (Whalen *et al*, 1969).

## REFERENCES

- Bhaibulaya M, Indra-Ngarm S, Ananthapruti M. Fresh-water fishes of Thailand as experimental intermediate host for *Capillaria philippinensis*. *Int J Parasitol* 1979; 9:105-8.
- Bhaibulaya M, Indra-Ngarm S. *Amaurornis phoenicurus* and *Ardeola bacchus* as experimental definitive hosts for *Capillaria philippinensis* in Thailand. *Int J Parasitol* 1979; 9:321-2.
- Cross JH, Banzon T, Murrell KD, Watten RH, Dizon JJ. A new epidemic diarrheal disease caused by the nematode *Capillaria philippinensis*. *Industr Trop Health* 1970; VII:124-30.
- Cross JH, Banzon T, Clarke MD, Basaca-Sevilla V, Watten RH, Dizon JJ. Studies on the experimental transmission of *Capillaria philippinensis* in monkeys. *Trans R Soc Trop Med Hyg* 1972; 66: 819-27.
- Cross JH, Banzon T, Singson C. Further studies on *Capillaria philippinensis*: Development of the parasite in the Mongolian gerbil. *J Parasitol* 1978; 64:208-13.
- Cross JH, Basaca-Sevilla V. Experimental transmission of *Capillaria philippinensis* to birds. *Trans R Soc Trop Med Hyg* 1983; 77:511-4.
- Cross JH, Basaca-Sevilla V. Albendazole in the treatment of intestinal capillariasis. *Southeast Asian J Trop Med Public Health* 1987; 18:507-10.
- Cross JH, Bhaibulaya M. Intestinal capillariasis in the Philippines and Thailand. In: Croll N, Cross J, eds. *Human Ecology and Infectious Diseases*, New York: Academic Press, 1983; 103-36.
- Cross JH. Intestinal Capillariasis. *Parasitol Today* 1990; 6:26-8.
- Whalen GE, Rosenberg EB, Strickland GT, *et al*. Intestinal capillariasis. A new disease in man. *Lancet* 1969; 1:13-6.