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* (*Hypseleotris bipartita*) | 3,956 | 6 | 8 |
| Bacto (*Chonophorus melanocephalus*) | 201 | 2 | 101 |
| Bagsan (*Ambassis miops*) | 5,204 | 2 | 16 |
| Birut (*Eleotris melanosoma*) | 3,208 | 0 | 0 |
| Ipon (Fry) (*Sicyopterus* sp.) | 15,159 | 0 | 0 |
| Guppy (*Poicelia reticulata*) | 310 | 0 | 0 |

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

Table 1

Human intestinal flukes reported in Southeast Asia.

| Species | Distribution | Source of infection |
|---|---|---|
| **Family Echinotomatidae** | | Feshwater snail tadpole |
| *Echinostoma ilocanum* | Philippines<br>Indonesia<br>Thailand | |
| *E. lindoense* | Indonesia | |
| *E. malayanum* | Thailand<br>Philippines<br>Malaysia<br>Singapore<br>Indonesia | |
| *E. revolutum* | Thailand<br>Indonesia | |
| *Epistmium caninum* | Thailand | Fish |
| *Hypoderaeum conoideum* | Thailand | |
| **Family Fasciolidae** | | Aquatic vegetation |
| *Fasciolopsis buski* | Vietnam<br>Thailand<br>Laos<br>Kampuchea<br>Indonesia<br>Philippines<br>Malaysia<br>Singapore | |
| **Family Heterophyidae** | | Fish |
| *Haplorchis pumilio* | Philippines<br>Thailand | |
| *H. taichui* | Philippines<br>Thailand | |
| *H. vanissimus* | Philippines | |
| *H. yokogawai* | Philippines<br>Indonesia<br>Thailand | |
| *Procerovuom calderoni* | Philippines | |
| *Stellantchasmus fulcatus* | Philippines<br>Thailand | |
| **Family Lechithodendriidae** | | Dragonfly naiads |
| *Phaneropsolus bonnei* | Indonesia<br>Thailand | |
| *Prosthodendrium molenkampi* | Indonesia<br>Thailand | |

Table 1 (Continued)

| Species | Distribution | Source of infection |
|---|---|---|
| **Family Microphallidae** | | Shrimp |
| *Carneophallus brevicaeca* | Philippines | |
| Family Paramphistomatidae | | Aquatic vegetation |
| *Gastrodiscoides hominis* | Thailand | |
| **Family Plagiorchiidae** | | Insect larva |
| *Plagiorchis* harinasutai | Thailand | |
| *P. javensis* | Indonesia | |
| *P. philippinensis* | Philippines | |

Adult worms are intestinal parasites of humans and pigs. The first intermediate host are planorbid snails of the genera *Hippeutis, Gyraulus*, and *Segmentina*. This life cycle involves only two hosts, as metacercariae encyst on the surface of any objects in water, especially vegetation. Fresh aquatic plants, therefore, are the main source of infection. Water plants frequently eaten raw by people in the region include morning glory (*Ipomoca aquatica*) and water caltrop (*Trapa bicornis*). Worm distribution is restricted to areas where pigs and water plants are raised closely together (Cross, 1969).

**Family Heterophyidae**

Human infection with heterophyid flukes in Southeast Asia is confined to the subfamily Haplorchinae. Four species of *Haplorchis (H. pumilio, H. taichui, H. vanissimus* and *H. yokogawai*), a species of *Procerovum, P. calderoni*, and *Stellantchasmus fulcatus* are known. All species are reported in the Philippines. Four species are reported in Thailand, with the exception of *H. vanissimus* and *P. calderoni*. One species, *H. yokagawai* was reported in Indonesia (Waikagul, 1985).

Fish serve as the second-intermediate host of the heterophyid flukes and many native populations in the region eat raw fresh water fish, not marine fish. There are several heterophyid species reported in animals in the region, *Heterophyopsis continua, Pygidiopsis* sp. and *Stictodora* sp. (Waikagul *et al*, 1985; Ito *et al*, 1962).

**Family Lecithodendriidae**

Two species of trematodes in this family are reported in man in Indonesia and Thailand. They are *Prosthodendrium molenkampi* (Lie, 1951) and *Phaneropsolus bonnei* Lie, 1951. They were first found at an autopsy in Indonesia in 1942 by Lie (1951). Manning *et al* (1971), reported human cases of these species from northeast Thailand and Laos. Radomyos *et al* (1984) recovered a large number of worms in the stool of many people from northeast Thailand after treatment of praziquantel.

Infection is acquired by ingesting encysted metacercariae from dragon fly larvae (naiads) of the Family Libeluidae (Vajrasthira and Yaemput, 1971).

*Phaneropsolus bonnei* was described as having a genital pore and ovary on either side of the body. These features correspond to two species described by Looss (1899), *P. sigmoides* and *P. longipenis*. The specimens of *P. bonnei* should be restudied since it is possible that they also consist of two species.

**Family Microphallidae**

*Carneophallus brevicaeca*, the one species of

# INTESTINAL FLUKE INFECTIONS IN SOUTHEAST ASIA

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**Abstract.** Twenty-three species of intestinal flukes reported in man in Southeast Asia are assigned to seven families: Echinostomatidae, Fasciolidae, Heterophyidae, Lecithodriidae, Microphallidae, Paramphistomatidae and Plagiorchiidae. The majority of species belongs to the Heterophyidae and Echinostomatidae families. Common species are *Fasciolopsis buski, Echinostoma ilocanum, E. malayanum, E. revolutum* and *Haplorchis yokogawai*. The countries where large number of species were reported are Thailand (14 species), Philippines (12 species), Indonesia (8 species) and Malaysia (4 species). Only one species was recognized in Laos, and Vietnam.

Several species reported in man in the other regions, were reported in animals in Southeast Asia. It is possible that these are present in humans but have not yet been reported.

## INTRODUCTION

Helminth zoonoses have been reviewed by a number of authors (Price 1940; Wright, 1947; Witenberg, 1964; Sprent, 1964; Waikagul, 1985; Radomyos, 1986; Harinasuta *et al*, 1987). Infections are not confined to humans, but occur also in animals. To date about 40 species of intestinal trematodes have been reported worldwide. Many species are sporadically reported focally, and are usually restricted to personal culinary habits.

Intestinal flukes are regarded as of less public health importance than flukes inhabiting the liver or other vital organs, as many are asymptomatic. Because of the similarity of many trematode eggs, the diagnosis from fecal eggs tends to be given as the public health important species, or the same as a previously reported species in the area. It is difficult to be certain of a diagnosis from fecal eggs, unless worms are recovered from stool specimens after treatment. Disfigurement might occur to treated worms which could lead to misidentification and the possibility of introducing a false new species. Several reported were given by names only, without descriptions or figures or type depositions. To get factual records, these reports must be critically reviewed.

Intestinal fluke infections in Southeast Asia were reviewed and the list of species is summarized in Table 1.

### Family Echinostomatidae

There are six species in this family which are reported in humans in Southeast Asia. The common species are *E. malayanum* Leiper, 1911 and *E. ilocanum* (Garrison, 1908), which have been reported from several Southeast Asian countries. *E. revolutum* (Froclich, 1802) is reported only in Thailand and Indonesia; *E. lindoense* Sandground and Bonne,1940 is reported only in Indonesia, and *Epistmium caninum* (Verma, 1935) and *Hypoderaeum conoideum* (Block, 1872) have been reported only in Thailand (Lie, 1969; Hadidjaja and Oemijati, 1969; Radomyos, 1986; Harinasuta *et al*, 1987.)

Infections with flukes in the genera *Echinostoma* and *Hypoderaeum* are acquired by eating raw or undercooked snails, tadpoles or frogs containing encysted metacercariae. For *Epistmium*, the second intermediate host is fish.

### Family Fasciolidae

Only one species of this family, *Fasciolopsis buski*, (Lankester, 1857) is reported from the intestine of man in several countries in Southeast Asia. Infections are frequently reported in Thailand, Vietnam and Laos, while only a case or two have been reported from Kampuchea and Indonesia. A few imported cases were reported from the Philippines, Malaysia, and Singapore (Cross, 1969; Harinasuta *et al*, 1987).

this family reported in man, was first reported as an heterophyid, *Heterophyes brevicaeca* by Africa and Garcia (1935), who found cardiac involvement and other complications associated with this infection in man in the Philippines (Africa *et al*, 1935). In 1938, Tubangui and Africa transferred the species to the genus *Spelotrema* in the Family Microphallidae. The position of this species changed many times within the Family Microphallidae, until Velasquez (1975) placed it under the genus *Carneophallus*. She also worked out its life cycle and stated that a freshwater shrimp, *Macrobrachium* sp. is the second-intermediate host. Birds and fish are also definitive hosts.

No other infection in man has been reported since then.

**Family Paramphistomatidae**

In Southeast Asia, human infection with *Gastrodiscoides hominis* (Lewis and McConnell, 1876) was reported once only in Thailand. Surinthrangkul *et al* (1965) reported a case of gastrodiscoidiasis in a 17 year-old female residing in a northern province of Thailand. The adult worm recovered from the stool after treatment was identified as *G. hominis*. The worm inhabits the cecum and is attached to the large intestinal wall by ventral sucker. Several species of rodents, monkey and pig are also infected with *G. hominis* in Thailand. Animal infections are reported from other countries in Southeast Asia.

The life cycle of this worm has not yet been fully described; however, known species in the same family have metacercariae that encyst on aquatic vegetation, frogs, tadpoles, and crayfish (Schell, 1970). Presumably, *G. hominis* has a similar life cycle. Definitive hosts get infected accidentally by ingesting the encyst metacercariae on aquatic plants and animals.

**Family Plagiorchiidae**

There are three species of *Plagiorchis* reported in man in Southeast Asia. *P. philippinensis* was a name proposed by Sandground (1940) for a parasite found in man in the Philippines by Africa and Garcia (1935); they also gave the name, *P. javensis*, to a *Plagiorchis* found in a man in Java, Indonesia. *P. harinasutai* was a species found in man in Thailand (Radomyos *et al*, 1989). The genus *Plagiorchis* consists of a large number of species and differentiation between some of the species appears to be based on insignificant morphological characters, which makes the identification of *Plagiorchis* a very difficult task (Lie 1951).

A source of infection of these species is believed to be fresh water snails that are similar to those serving as hosts for echinostomes.

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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).

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