FISH AS THE NATURAL SECOND INTERMEDIATE HOST OF

**GNATHOSTOMA SPINIGERUM**

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**Abstract.** Gnathostomiasis is a helminthic disease most frequently occurring in Thailand. Human infections are usually found to be caused by *Gnathostoma spinigerum*, although five species of the genus *Gnathostoma* exist in Thailand, and three of these are capable of infecting man. In Thailand, 47 species of vertebrates – fish (19), frogs (2), reptiles (11), birds (11) and mammals (4) – have been reported to serve naturally as the second intermediate (and/or paratenic) hosts of *G. spinigerum*. Of these, fish, especially swamp eels (*Monopterus albus*), were found to be the best second intermediate/paratenic hosts: they had the highest prevalence rate and the heaviest infection intensity. However, the scientific names of these fish have been revised from time to time. Therefore, for clarity and consistency, we have summarized the current scientific names of these 19 species of fish, together with their illustrations. We describe one additional fish species, *Systomus orphoides* (*Puntius orphoides*), which is first recorded as a naturally infected second intermediate host of *G. spinigerum*.

**INTRODUCTION**

Several helminthic zoonoses can be transmitted to humans via both marine and freshwater fish. These include capillariasis (caused primarily by *Capillaria philippinensis*), gnathostomiasis (*Gnathostoma spinigerum*), anisakiasis (*Anisakis simplex*), diöctophymiasis (*Diöctophyme renale*), eustrongylidiasis (*Eustrongylides* spp), clonorchiasis (*Clonorchis sinensis*), opisthorchiasis (*Opisthorchis viverrini*), echinostomiasis (*Echinostoma* spp), heterophyiasis (*Heterophyes heterophyes*), metagonimiasis (*Metagonimus yokogawai*), nanophyetiasis (*Nanophyetus salmincola*) and diphyllobothriasis (*Diphyllobothrium latum*) (Beaver *et al*., 1984; Eastburn *et al*., 1987; Eberhard *et al*., 1989; Harrell and Deardorff, 1990; Miyazaki, 1991; Anderson, 1992; Narr *et al*., 1996). In Thailand, fish-borne helminthiases are rather common; the two most prevalent infections among Thai people are opisthorchiasis and gnathostomiasis (Daengsvang, 1980, 1986; Viyanant, 1981; Jongsukuntigul and Imsoonboon, 1998).

Human gnathostomiasis is a disease primarily caused by larval and immature stages of *G. spinigerum* (Daengsvang, 1980; Miyazaki, 1991). However, four other species – *G. hispidum*, *G. doloresi*, *G. nipponicum* and *G. binucleatum* – are also known to cause disease (Araki, 1986; Ogata *et al*., 1988; Ando *et al*., 1988; Nawa *et al*., 1989; Almeyda-Artigas, 1991; Akahane *et al*., 1998; Almeyda-Artigas *et al*., 2000). There have been at least five species of *Gnathostoma* documented in Thailand: *G. spinigerum*, *G. hispidum*, *G. doloresi*, *G. vietnamicum* and *G. malaysiae* (Dissamarn *et al*., 1966; Daengsvang, 1973, 1980; Kamiya *et al*., 1987); however, only *G. spinigerum* is known to be responsible for human infection in the country (Daengsvang, 1980, 1986; Radomyos and Daengsvang, 1987).

In Thailand, 47 species of vertebrates – fish (19), frogs (2), reptiles (11), birds (11) and mammals (4) – are reported to serve naturally as the second intermediate (and/or paratenic) hosts of *G. spinigerum* (Daengsvang, 1980; Rojekittikhun *et al*., 1989a, 1998b). Of these animals, the fish, especially swamp eels (*Monopterus albus*), have been found to be the best second intermediate/paratenic hosts of the worm: they have the highest prevalence rate and the heaviest infection intensity; moreover, they have been found to harbor at least four species of *Gnathostoma* (Daengsvang, 1980; Rojekittikhun *et al*., 1989a, 1998b; Setasuban *et al*., 1991; Akahane *et al*., 1995; Nuamthong *et al*., 1998).

The Department of Helminthology, Faculty of Tropical Medicine, Mahidol University, has conducted a considerable amount of research into *Gnathostoma* and gnathostomiasis. Advanced third-stage larvae from swamp eels and many other freshwater fish are collected regularly. However, the scientific names of these fish have been subject to periodic revision. In the interest of clarity and consistency, we have summarized the current scientific names of these 19...
species of fish with their illustrations. We also describe one additional fish species, Systomus orphoides (Puntius orphoides), which is first recorded as a naturally infected second intermediate host for G. spinigerum.

MATERIALS AND METHODS

Fish

Fish and eels that had grown naturally in endemic areas were the main target of this study. Fish, dead or alive, were usually purchased from local markets in Nakhon Nayok and Prachin Buri; occasionally fish were obtained from several other provinces beyond Central Thailand. The fish were transported to the laboratory in Bangkok. They were measured, weighed, and identified by species.

Press preparation (compression) method

The visceral organs of the big fish and the eels were taken out; the liver was cut into small pieces which were firmly pressed between two thick glass plates and then examined under a dissecting microscope or a big hand lens for the presence of gnathostome larvae. All muscles were cut and scraped out of bones and scales (or skins) and examined using the method used for liver tissue. For tiny fish, the whole body was pressed and examined as described above. The collected larvae were cleaned, counted, and identified.

Digestion technique

The livers or muscles of the fish were chopped and put into a container containing artificial gastric juice (1% HCl and 1% pepsin). They were then incubated for 1-3 hours in a water bath at 37 °C with frequent stirring. The digested tissues were washed several times with normal saline by a simple sedimentation technique. The clear sediments were examined under a dissecting microscope.

RESULTS

The 20 species of fish in Thailand that have been found to be naturally infected with G. spinigerum larvae are shown in Table 1. Their previous and current scientific names, common names and Thai names together with the maximum number of larvae per fish are also tabulated. Of note is the fact that of the 20 species of 16 genera, 9 genera and 6 species have been changed. Five species, Boesemania microlepis, Chitala ornata, Mastacembelus armatus, Ompok krattensis and Systomus orphoides, harbored only one larva each. Two species, Micronema apogon and Trichogaster trichopterus, had no record of the maximum number of infected larvae. Swamp eels (Monopterus albus) were the most resilient carrier: 2,582 gnathostome larvae were found in the body of one eel. Systomus orphoides, the red-cheek barb, was for the first time, found to be a natural second intermediate host of G. spinigerum.

Fig 1 shows photographs of the 20 fish with their current scientific and Thai names. Eighteen pictures were taken from fresh specimens, pictures 1.2 and 1.14 were from an illustrated poster (Vidthayanon C. Fishes of Chao Phraya River), and picture 1.16 was drawn by Luang Masya (Smith, 1965). The size of each fish is indicated by a ruler in each picture.

DISCUSSION

Almost all of the 20 fish naturally infected with G. spinigerum larvae feed on both live or decaying animals and plants. The gourami (Trichogaster spp) feeds mainly on tiny living organisms and insects. Therefore, they act more likely as the second intermediate host of the nematode. Eels (Monopterus and Ophisternon), snake-head fish (Channa spp) and catfish (Clarias spp) are carnivorous creatures. Not only do they act as second intermediate hosts, they also serve as paratenic hosts. This, without doubt, increases their chance of becoming more and heavily infected.

The drum fish (Boesemania microlepis) is a marine fish; it can, however, live in fresh water for periods of time. Kasemsuthi et al (1983) have demonstrated how this kind of fish was infected: Java tilapias (Oreochromis mossambica, previously Tilapia mossambica), an amphidromous fish, was collected from the sea at Bang Saen Beach and then orally infected with G. spinigerum larvae after the salinity of the water was reduced to zero. The salinity of the water was then gradually increased to 30 ppt and the fish were examined at days 20 and 40 post-infection. The infection rates were 71.4% and 58.8%, respectively; the corresponding survival rates of the recovered larvae were 87.5% and 52.6%, respectively. The flesh of these infected fish, containing G. spinigerum larvae, was fed to a real marine fish, Epinephelus spp, which was examined about 1-2 months later: it was infected and the larvae were still alive (Kasemsuthi, personal communication). Another experiment done in 1974 by Nithi-Uthai showed that two species of brackish water fish, Mugil sp and Chanos chanos, could be infected with G. spinigerum larvae by both forced- and self-feeding. The percentages of infection were 56.0% and 80.0%, respectively, for forced feeding, and 53.3% and 30.0%, respectively, for self-feeding. However, examination of four species of brackish water fish and...
Table 1
The twenty species of fish in Thailand found to be naturally infected with *Gnathostoma spinigerum* larvae.

<table>
<thead>
<tr>
<th>Current scientific name</th>
<th>Previous name</th>
<th>Common name</th>
<th>Thai name</th>
<th>Length (cm)</th>
<th>Max. no. of larvae/fish</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Anabas testudineus</em></td>
<td>Same</td>
<td>Common climbing perch</td>
<td>Pla mo Thai</td>
<td>10-23</td>
<td>14</td>
</tr>
<tr>
<td><em>Arius caelatus</em></td>
<td><em>Tachysurus caelatus</em></td>
<td>Engraved catfish</td>
<td>Pla kot</td>
<td>20-29</td>
<td>5</td>
</tr>
<tr>
<td><em>Boesemania microlepis</em></td>
<td><em>Nibea soldado</em></td>
<td>River drumfish</td>
<td>Pla ma</td>
<td>17-60</td>
<td>1</td>
</tr>
<tr>
<td><em>Channa striata</em></td>
<td><em>Ophicephalus striatus</em></td>
<td>Striped snake-head fish</td>
<td>Pla chon</td>
<td>30-70</td>
<td>153</td>
</tr>
<tr>
<td><em>Channa micropeltes</em></td>
<td><em>Ophicephalus micropeltis</em></td>
<td>Giant snake-head fish</td>
<td>Pla chado</td>
<td>30-75</td>
<td>12</td>
</tr>
<tr>
<td><em>Channa lucius</em></td>
<td><em>Ophicephalus lucius</em></td>
<td>Blotched snake-head fish</td>
<td>Pla krasong</td>
<td>20-65</td>
<td>12</td>
</tr>
<tr>
<td><em>Clarias batrachus</em></td>
<td>Same</td>
<td>Batrachian walking catfish</td>
<td>Pla duk dan</td>
<td>16-40</td>
<td>6</td>
</tr>
<tr>
<td><em>Clarias macrocephalus</em></td>
<td>Same</td>
<td>Gunther’s walking catfish</td>
<td>Pla duk ui</td>
<td>15-35</td>
<td>16</td>
</tr>
<tr>
<td><em>Chitala ornata</em></td>
<td><em>Notopterus chitala</em></td>
<td>Spotted featherback</td>
<td>Pla krai</td>
<td>35-85</td>
<td>1</td>
</tr>
<tr>
<td><em>Kryptopterus cryptopterus</em></td>
<td>Same</td>
<td>?</td>
<td>Pla kha kai</td>
<td>11-16</td>
<td>5</td>
</tr>
<tr>
<td><em>Macrognathus siamensis</em></td>
<td>Same</td>
<td>Spotted spiny eel</td>
<td>Pla lot chut</td>
<td>15-30</td>
<td>8</td>
</tr>
<tr>
<td><em>Mastacembelus armatus</em></td>
<td>Same</td>
<td>Armed spiny eel</td>
<td>Pla krathing dam</td>
<td>20-70</td>
<td>1</td>
</tr>
<tr>
<td><em>Micronema apogon</em></td>
<td><em>Kryptopterus apogon</em></td>
<td>Common sheatfish</td>
<td>Pla nam ngoen</td>
<td>15-77</td>
<td>?</td>
</tr>
<tr>
<td><em>Monopterus albus</em></td>
<td><em>Flota alba</em></td>
<td>Swamp eel</td>
<td>Pla lai na</td>
<td>30-95</td>
<td>2,582</td>
</tr>
<tr>
<td><em>Ompok krattensis</em></td>
<td><em>Ompok bimaculatus</em></td>
<td>Sheatfish</td>
<td>Pla nua on</td>
<td>15-20</td>
<td>1</td>
</tr>
<tr>
<td><em>Ophisternon bengalense</em></td>
<td><em>Synbranchus bengalensis</em></td>
<td>Eel-like fish, Bengal eel</td>
<td>Pla lat, pla lai</td>
<td>25-53</td>
<td>40</td>
</tr>
<tr>
<td><em>Systomus orphoides</em></td>
<td><em>Puntius orphoides</em></td>
<td>Red-cheek barb</td>
<td>Pla kaem cham</td>
<td>8-22</td>
<td>1</td>
</tr>
<tr>
<td><em>Trichogaster pectoralis</em></td>
<td>Same</td>
<td>Snake skin gourami</td>
<td>Pla salit</td>
<td>15-20</td>
<td>5</td>
</tr>
<tr>
<td><em>Trichogaster microlepis</em></td>
<td>Same</td>
<td>Moonlight gourami</td>
<td>Pla kradi nang</td>
<td>6-15</td>
<td>5</td>
</tr>
<tr>
<td><em>Trichogaster trichopterus</em></td>
<td><em>Trichopodus trichopterus</em></td>
<td>Three-spot gourami</td>
<td>Pla kradi mo</td>
<td>5-12</td>
<td>?</td>
</tr>
</tbody>
</table>

* Normal length of common fish (Smith, 1965; Department of Fisheries, Ministry of Agriculture and Cooperatives, 1997).
34 species of marine fish from the Gulf of Thailand and adjacent areas for natural infection of gnathostome larvae did not demonstrate any infection (Nithi-Uthai, 1974).

In Thailand, there are about 145 species of cyprinoid fish (Smith, 1965). Until this study, none had been found to serve as the host of *Gnathostoma*. In this study, the red-cheek barb (*Systomus orphoides*) was shown for the first time to be infected. If a great number of fish of any species were to be subjected to careful examination, it would be more than likely that they too would find their way onto the list of naturally infected second intermediate hosts of *Gnathostoma*.

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REFERENCES


Kasemsuthi R, Panassumpon P, Siriratanachai S.


