Geographic Information System of Fish-borne Parasitic Zoonoses Metacercaria from Water Reservoirs under His Majesty's Recommended Project, Phitsanulok, Thailand

Nithikathkul, C.,[1] Wongsaroj, T.,[2] Buntilov, V.[3] and Limsomboon, J.[4]
[1]Graduate Studies Division, Faculty of Medicine, Mahasarakham University, Thailand
E-mail: Nithikathkul@yahoo.com, Choosak@hcu.ac.th
[2]Bureau of General Communicable Diseases, Department of Disease Control, Ministry of Public Health Nonthaburi, Thailand
[3]Faculty of Engineering, Department of Computer Engineering, Mahidol University, Thailand
[4]Faculty of Tropical Medicine, Mahidol University, Thailand

Abstract
Fish-borne infections continue to be a major public health problem, with more than 50 million people infected throughout the world. The watershed development scheme is an extended plan to achieve the objectives of Kwae Noi reservoir under His Majesty's Recommended Project involving a proper water management for consumption all year round. Adequate water will increase the fertility of these areas and provide a suitable breeding place for various forms of aquatic life including fish. The popularity of uncooked, freshwater fish among the indigenous people in regions endemic for fish borne zoonotic parasites represents a continuing public health concern. Current reports indicate that metacercaria of pathogenic heterophyid trematodes are found in freshwater fish. In this study fish were examined for the presence of metacercariae by pressing or crushing using pairs of plexiglass. The infective stage of larvae in fish or metacercariae was detected using a stereo-microscope. Six species of small scale fresh water fish were examined namely, Puntius brevis, Cyclocheilichthys apogon Cyclocheilichthys repasson, Cyclocheilichthys armatus, Puntius orphoides and Labiobarbus lineatus. 5 species of these fish were positive for Opisthorchis viverrini infections (the exception was L. lineatus). However, they were all susceptible species to small intestinal fluke infections, and the infection rates were slightly higher than those of liver fluke infections. The highest prevalence of Opisthorchis viverrini (16.7%) was among Cyclocheilichthys apogon and the highest prevalence of small intestinal fluke infections (60%) was among Puntius brevis. This was in Ban Leam Kak, Wang Thong District, Phitsanuloke province, [N 16 °44' 0.8" E 100°22' 24.0"]. The geographic information (latitude and longitude) associated with the infection rates among susceptible species of fresh water fish was recorded and used to build a geographical information system. A number of environmental parameters such as mean yearly temperature, rainfall level, land use, NDVI, and population density were imported to the system as well. The development of GIS can be useful in establishing a prevention strategy for the transmission of food borne diseases from infected fish in water catchment areas.

1. Introduction

Fish-borne zoonotic liver and intestinal trematode infections are still emerging health problems of human (WHO, 1995, Chai et al., 2005 and Keiser and Utzinger, 2005). The current situation numbers of people infected with food-borne trematodes has been estimated by the World Health Organization (WHO) to exceed 18 million, with the number of people at risk worldwide estimated at more than half a billion (WHO, 2004). These food-borne trematodes are especially prevalent in South East Asia, China and Korea where recent data suggest that there are about 1.5 million people in Korea, 6 million people in China and over 5 million in Thailand infected with liver flukes, either *Clonorchis sinensis* or *Opisthorchis viverrini* (Chai et al., 2005). Over fifty species of food-borne intestinal flukes belonging to the Heterophyidae and Echinostomatidae have been reported from Koran (Chai et al., 2005 and Hong 2012), Thailand (Waikagul and Radomyos, 2005 and Nithikathkul and Wongsawad, 2008) and Laos (Nguyen et al., 2007). Fish-borne infections continue to be a major public health problem, with more than 50 million people infected throughout the world.

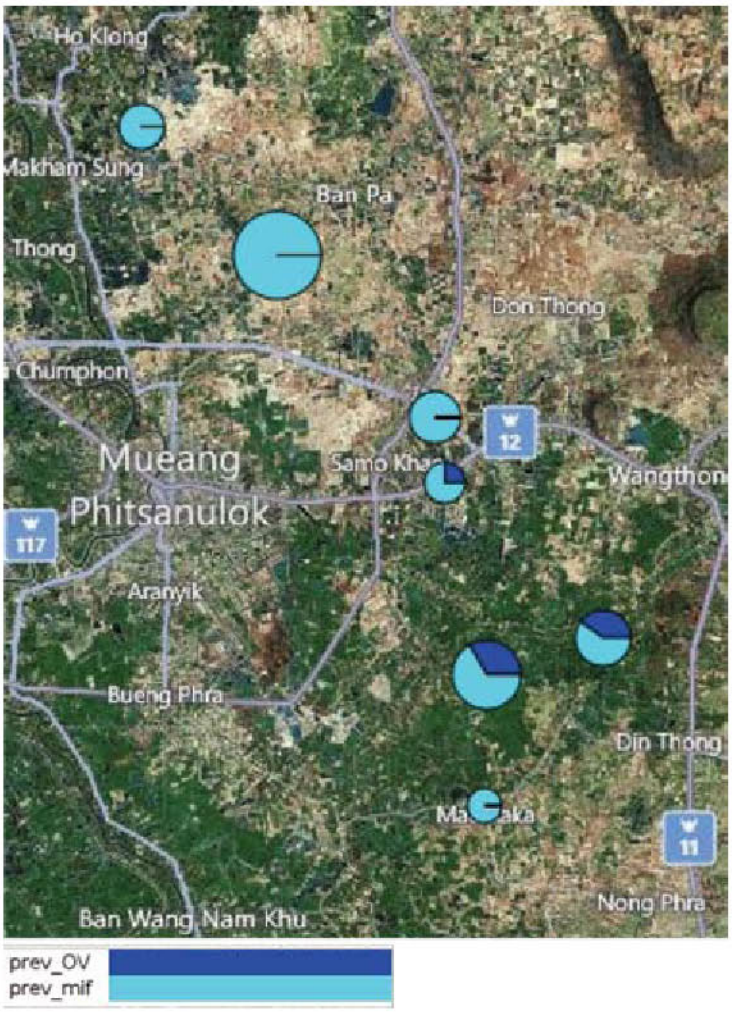

Figure 1: Show a proportion between OV and mif parasites [OV in blue and mif in cyan colour] in water reservoirs, Pitsanulok, Thailand

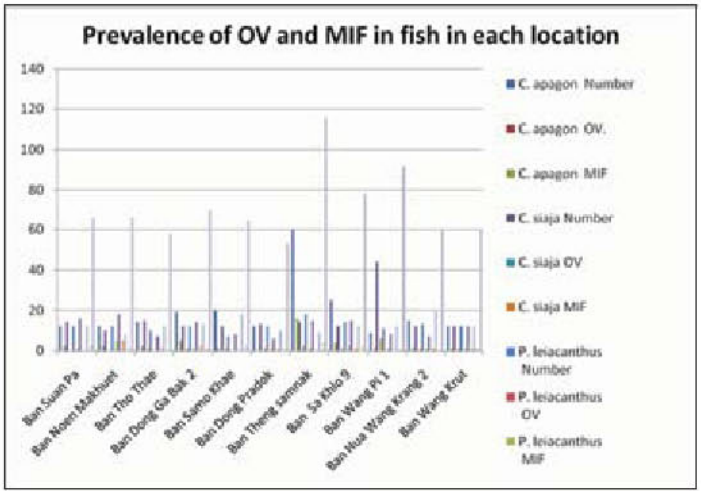

Figure 2: Show prevalence of Opisthorchis viverrini [OV] and minute intestinal fluke [MIF] metacercaria in fishes in eleven locations

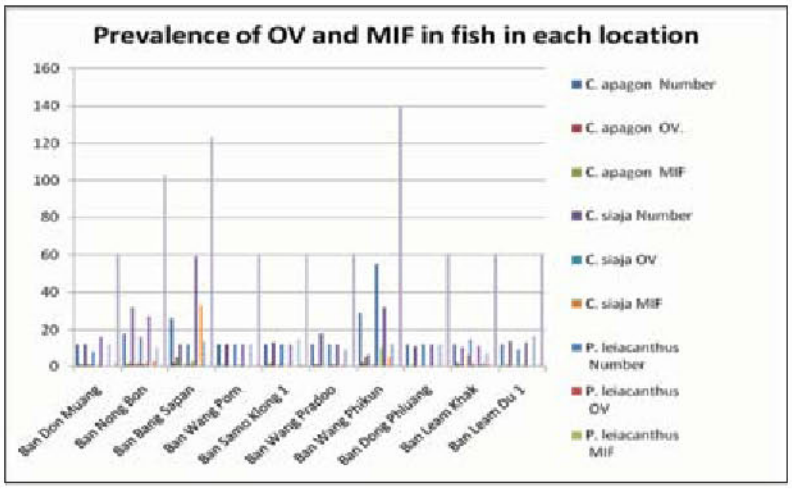

Figure 3: Show prevalence of *Opisthorchis viverrini* [OV] and minute intestinal fluke [MIF] metacercaria in fishes in other ten locations of study area

The water reservoir development project is an extended plan involving proper water management for consumption all year round. Trematodes in the genus *Haplorchis* of the family Heterophyidae were found in the small intestines of various definitive hosts such as humans, dogs, cats, birds and rats. Humans and other definitive hosts were infected by eating raw freshwater fish containing encysted metacercariae. Thus, the purpose of this study was to investigate the geographic information of the prevalence of Heterophyidae metacercariae in freshwater fish. Current reports indicate that metacercaria of pathogenic heterophyid trematode are found in freshwater fish.

2. Methodology

2. 1 Fish Collection

Several species of freshwater fish were captured directly from lake water or bought from the fishermen living nearby the natural reservoirs in the given districts. Capture methods were by net and traditional methods. Taxonomic identification of the fish was characteristically based on the Guidelines and Atlas of Freshwater Fish in Thailand

2.2 Metacercaria Preparation and Identification

To observe the prevalence of fish borne trematode metacercariae the fish were examined for metacercaria by pressing or crushing those using pairs of plexiglass.

2.3 Prevalence of Parasites

The percentage prevalence was calculated as follows:

$$\% \text{ prevalence} = \frac{\text{Number of infected fish}}{\text{Total number of fish examined}} \times 100$$

Intensity was the number of metacercaria per total number of fish. In this study fish were examined for the presence of metacercariae by crushing technique. A GIS database for the study of *O. viverrini* (OV) and Small Intestinal luke (MIF) was implemented using "Quantum GIS" software.

3. Results

The scale of the circles corresponds to the cumulative prevalence of both OV and mif parasites for all fish, divided by the total number of fish. Figure 1. The diagrams show a proportion between OV and mif parasites [OV in blue and mif in cyan colour]. Figure 2 and 3. Show prevalence of *Opisthorchis viverrini* [OV] and minute intestinal fluke [MIF] metacercaria in fishes in different locations.

4. Discussion and Outcome

Six species of small scale fresh water fish were examined namely, *Puntius brevis, Cyclocheilichthys apogon Cyclocheilichthys repasson, Cyclocheilichthys armatus, Systomus orphoides* and *Labiobarbus lineatus*. 5 species of fish were positive for *Opisthorchis viverrini* infections (the exception was *L. lineatus*).

This was in Ban Leam Kak, Wang Thong District, Phitsanuloke province, [The N 16 °44' 0.8" E 100°22' 24.0"]. The geographic information (latitude and longitude) associated with the infection rate among susceptible species of fresh water fish was recorded and used to build a geographical information system. A possible future development of the project is to develop a prediction model of parasite prevalence. The model may have various environmental and geographic parameters such as mean yearly temperature, rainfall levels, land use, NDVI, population density etc. Upon importing the mentioned data in GIS, the prevalence data associated with the coordinates may be used to train the model. Once developed, the model and the GIS could be useful in the establishment of a prevention strategy for transmission of food borne diseases from infected fish in the water catchment area. Fish-borne parasitic trematode infections are commonly found in the northern and northeastern regions of Thailand. Several species of cyprinoid freshwater fish have been reported as secondary intermediate hosts (Kliks and Tantachamrun, 1974, Srisawangwong et al., 1997, Namue et al., 1998, Waikagul, 1998, Sukontason et al., 1999. Wongsawad et al., 2000, Nithikathkul and Wongsawad, 2008 and Hong, 2012). It is well known, generally and widely accepted that the main cause of fish-borne parasitic trematode infections is the consumption of raw or undercooked freshwater fish by the local people. Thai traditional fish foods such as *Lab-Pla*, *Koi-Pla*, *Pla-ra* and *Pla-som* are believed to be the sources of human infections. These undercooked fish preparations cannot provoke the degeneration of the contaminated metacercariae in a short period (Sukontason et al., 1998 and Wiwantanakit et al., 2002). Previous and present studies showed that most cyprinoid fishes were infected with *Haplorchis* metacercariae, implying that the degree of infection of the definitive host would be high in these areas. Further study will use geographic information to apply for public health prevention and control strategy. Our conclusion: the distribution of fish-borne trematode infections is highly focal, dependent on the presence of susceptible first and second intermediate hosts and the socio-economic and behavioral patterns of the definitive hosts. The infections are endemic in areas where raw fish eating habits are deeply rooted in the culture and are difficult to change.

Acknowledgements

The authors greatly appreciate the support received through the Bureau of General Communicable Diseases, Department of Disease Control, Ministry of Public Health (MOPH), Thailand. We would like to thank Dr. Vara Meesomboon and Assistant Professor Dr. Wanchai Phatihutakorn for encouragement, Dr. Louis Royal for editing. Our thanks are also extended to MOPH officers for their generous assistance in organizing and carrying out this project. Our appreciation and thanks are also given to the volunteers for their participation. Authors declared no conflict of interest.

References

Chai, J. Y., Darwin, M. K. and Lymbery, A. J., 2005, Fish-Borne Parasitic Zoonoses: Status and Issues. *Int J Parasitol*. 35(11-12), 1233-1254.

Hong, S. J., 2012, Seasonal Features of Heterophyopsis *Continua* Metacerciae in Perches, Lateolabrax Japonicas and Infectivity to the Final Host. *Parasitol Res*. 110: 1209-1212.

Keiser, J. and Utzinger, J., 2005, Emerging Foodborne Trematodiasis. *Emerg Infect Dis*. 11(10), 1507-1514.

Kliks, M. and Tantachamrun, T., 1974, Heterophyid (Trematoda) Parasites of Cats in North Thailand, with Notes on a human Case Found at Necropsy. *Southeast Asian J. Trop*. Med. Public Health, 5(4), 547-555.

Namue, C., Rojanapaibul, A. and Wongsawad, C., 1998, Occurrence of Two Heterophyid Metacercariae Haplorchis and Haplorchoides in Cyprinoid Fish of Some Districts in Chiang Mai and Lumphun Province. *Southeast Asian J. Trop. Med. Public Health*, 29(2): 401-405.

Nguyen, D. T., Anders, D., Ly, T. L. and Darwin, K. M., 2007, Survey for Zoonotic Liver and Intestinal Trematode Metacercariae in Cultured and Wild Fish in an Giang Province, Vietnam. *Korean Journal of Parasitolog*, 45, 45-54.

Nithikathkul, C. and Wongsawad, C., 2008, The Occurrence of Heterophyid Metacercariae in Freshwater Fish from Reservoirs. *Asian Biomedicine*. 2 (3): 229-232.

Srisawangwaong, T., Sithithaworn, P. and Tesana, S., 1997, Metacercariae Isolated from Cyprinoid Fish in Khon Kaen District by Digestion Technic. *Southeast Asian J. Trop. Med. Public Health*, 28 (suppl 1.), 224-226.

Sukontason, K., Methanithikorn, R., Sukontason, K. L., Piangjai, S. and Choochote, W., 1998, Viability of Metacercariae in Northern Thai Traditional Foods. *Southeast Asian J. Trop. Med. Public Health*, 29(4), 714-716.

Sukontason, K., Piangjai, S., Muangyimpong, Y., Sukontason, K. L., Methanithikorn, R. and Chaithong, U., 1999, Prevalence of Trematode Metacercariae in Cyprinoid Fish of Ban Pao District, Chiang Mai Province Northern Thailand. *Southeast Asian J. Trop. Med. Public Health*, 30(2), 365-370.

Waikagul, J., 1998, *Opisthorchis Viverrini* Metacercariae in Thai Freshwater Fish. Southeast Asian J. Trop. Med. Public Health, 29(2), 324-326.

Waikagul, J. and Radomyos, P., 2005, Intestinal Trematode Infections in Thailand. *Asian Parasitology*, Series Monograph. 1, 103-112.

Wiwanitkit, V., Nithiuthai, S. and Suwansaksri, J., 2002, Motility of Minute Intestinal Flukes, *Haplorchinae* sp. Metacercariae in Fish Dishes Prepared by Different Uncooked Methods. *Medscape General Medicine*, 4(1): 1-5.

Wongsawad, C., Rojanapaibul, A., Mhad-arehin, N., Pachanawan, A., Marayong, T., Suwattanacoupt, S., Rojtinnakorn, L., Wongsawad, P. Kumchoo, K. and Nichapun, A., 2000, Metacercaria from Freshwater Fishes of Mae Sa Stream, Chiang Mai, Thailand. *Southeast Asian J. Trop. Med. Public Health*, 31, 54-57.

World Health Oraganization, 1995, Control of food-borne tramatode infections.World Health Oraganization Technical Report Series No 849. Geneva.

World Health Organization, 2004, Report of Joint WHO/FAO Workshop on Food-borne Trematode Infections in Asia, Ha Noi,Vietnam, 26-28 November 2002, WHO, WPRO, 1-58.