เชียงใหม่สัตวแพทยสาร 2557; 12(1): 57-68

Original article

Identification and distribution of gill monogeneans from Nile tilapia and red tilapia in Thailand

Worawit Maneepitaksanti[1,*] Worakrit Worananthakij[2] Pongkochthron Sriwilai[3] Thitiporn Laoprasert[3]

[1]Department of Animal and Aquatic Science, Faculty of Agriculture, Chiang Mai University
[2]Department of Biology, Faculty of Science King, Mongkut's Institute of Technology Ladkrabang
[3]Inland Aquatic Animal Health Research Institute, Inland Fisheries Research and Development Bureau, Department of Fisheries, Chatuchak District, Bangkok

Abstract Gill monogeneans are pathogenic effects on the freshwater, brackish water and marine fishes. Intensive culture can cause the abundant of parasites; especially gill monogeneans. Therefore, the aim of this study was to study the morphology and display the distribution of gill monogeneans collected from moribund Nile tilapia and red tilapia in Thailand. The investigation for gill monogeneans from 57 moribund fish specimens (Nile tilapia, *Oreochromis niloticus* and red tilapia, *O. niloticus* x *O. mossambicus*) in 14 provinces was carried out during June, 2008 to March, 2009. The results revealed all fish examined (18.0 ± 3.8 [7.6-28.0] length, 209.1 ± 119.2 [20.0-540.0] weight) was infested gill monogeneans. Five species of gill monogenean were discovered. (i.e., *Cichlidogyrus tilapiae*, *C. halli*, *C. sclerosus*, *C. thurstonae*, and *Scutogyrus longicornis*). The overall prevalence of these gill monogeneans was 22.8%, 66.6%, 91.2%, 54.4%, and 49.1%, respectively. The highest diversity occurred in Loei, Nakhon Ratchasima, and Nakhon Sawan province. Mean abundance of which was 2.8, 5.3, 13.7, 7.4, and 3.4, respectively. The results of this study display 5 species of gill monogeneans can be found in Thai waters. *Cichlidogyrus halli* and *C. sclerosus* were the most widely distributed parasites, while *C. sclerosus* was found in the highest number. In addition, the taxonomy and distribution of these gill monogeneans from Nile tilapia and red tilapia in fourteen provinces were documented in Thailand for the first time. **Chiang Mai Veterinary Journal 2014; 12(1): 57-68**

Key words: gill monogenean, parasite, Nile tilapia, red tilapia

Address request for reprints: Worawit Maneepitaksanti, Department of Animal and Aquatic Science, Faculty of Agriculture, Chiang Mai University 239 Huay Kaew Rd., Suthep, Muang, Chiang Mai 50200; E-mail address: worawitm@yahoo.com; Article received date: November 18, 2013

Introduction

Nile tilapia (*Oreochromis niloticus* (Linnaeus, 1758)) (Perciformes: Cichlidae) was introduced to Thailand in 1965 from Japan. One year later, it was cultured and contributed to the farmers. This fish was used as a protein source in order to compensate other protein supplies. Afterwards, Nile tilapia has become a popular species for consumption and spread throughout Thailand rapidly. Result from breeding between Nile tilapia (*O. niloticus*) and Mozambique tilapia (*O. mossambicus*) the best strain of tilapia was arised as red tilapia. Generally, the causes of mortality of tilapia in Thailand mainly derive from diseases pathogens (parasites, bacteria, virus, and water mold) or poor water quality. To date intensive culture becomes popular for increasing the productivity. That action makes stressful for fish and develops to disease condition finally (Woo, 1995). However, tilapias were considered to be an introduced species in Thailand then the investigation of pathogens of which, especially parasites, should be conducted. Gill monogeneans were considered as a serious parasite for tilapia cultured, the parasite feeds on epithelial tissue covering the gill lamellae account for tissue damage. Moreover, the haptoral sclerites penetrate deep into the lamellae there is localized degeneration and formation of necrotic foci. Atrophy of gill tissue is occurred. These damages can make deleterious effects on fish hosts (Woo, 1995). Parasitology studies on tilapia in Thailand have been conducted. Some documents reported gill monogeneans found from tilapias (Lerssutthichawal, 2008; Chitmanat, 2009; Thongdon-A, et al., 2012). Unfortunately, those documents lack of illustration and description of parasites then the reliability of which were slight. During 2008 to 2009, massive mortality of tilapias in Thailand was broken out. Variety pathogens were found such as trichodinids, monogeneans, parasitic crustaceans, bacteria, virus, and water mold. Therefore, the aim of the present study is to clarify the fauna of gill monogeneans infecting tilapias in Thailand.

Materials and Methods

Two species of tilapias, Nile tilapia (*Oreochromis niloticus*) and red tilapia (*O. niloticus* x *O. mossambicus*) from 14 provinces (i.e., Chiang Mai, Uttaradit, Loie, Sakon Nakhon, Chaiyaphum, Nakhon Ratchasima, Kamphaeng Phet, Nakhon Sawan, Uthai Thani, Nakhon Nayok, Prachin Buri, Suphan Buri, Nakhon Pathom, and Phatthalung) were brought to Inland Aquatic Animal Health Research Institute, Department of Fisheries of Thailand by farmers or the staffs of fisheries department from June 2008 to March 2009. Either moribund or ice packing tilapias were examined. One side of gills were removed from the fishes and examined with stereoscopic microscope. Gill monogeneans were taken from the gills and transferred into a drop of ammonium picrate-glycerin for the sclerotized structures (Ergens, 1969). Morphological terminology for description is based on Douëllou (1993). Drawings of the parasites were made with the aid of a drawing tube attached to a compound microscope. Average measurements (all in micrometers) are followed by the range in parentheses. The ecological

terms are defined by Bush et al. (1997): prevalence is a percentage of infected fish in a sample, and mean abundance is an average number of parasites per host examined.

Results

The result from fifty-seven fish samples (18.0 ± 3.8 [7.6-28.0] length, 209.1 ± 119.2 [20.0-540.0] weight), two genera, five species of gill monogeneans were discovered (i.e., *Cichlidogyrus tilapiae*, *C. halli*, *C. sclerosus*, *C. thurstonae*, and *Scutogyrus longicornis*). (Table 1)

***Cichlidogyrus tilapiae* Paperna, 1960** (Fig. 1)

Description (10 specimens measured): Body slender, tapering at posterior of body, 464.0 (400.0–530.0) long and 79.8 (75.0–90.0) wide. Cephalic lobe with 4 pairs of head organs. One pair of eyes with lens. Mouth not observed. Pharynx spherical, 21.5 (20.5–22.0) in diameter. Haptor ellipsoid with 2 pairs of hamuli and 7 pairs of hooklets. Ventral hamuli similar to dorsal hamuli in shape. Ventral hamuli 26.6 (25.9–26.9) long, with broad base and shaft; outer root narrow; inner root broad. Dorsal hamuli slightly longer, 31.2 (30.8–31.7) long; outer root short; inner root elongate. Hamulus filament present. Ventral bar U-shaped, 40.0 (38.8–40.8) in transverse length, with indented membranous extensions. Dorsal bar slightly arched; branches pointed; appendages slender, 25.5 (25.0–25.8) long. Hooklets small; pair 2 shortest without base, other pairs with short base; hooklet lengths 13.1 (12.9–13.2), 11.6 (11.3–11.8), 16.4 (16.0–16.6), 17.1 (16.9–17.4), 13.9 (13.5–14.1), 14.4 (14.0–14.7) and 13.3 (13.0–13.6), respectively, for pairs 1–7.

Simple shape copulatory organ located one-third of total length from anterior extremity of body; copulatory tube straight and wider at base, 28.2 (22.0–31.7) long; accessory piece almost straight with sharp hook at terminal end, 24.7 (20.0–26.3) long. Vagina could not be observed. Vitelline follicles well-developed and co-extensive with intestine. Mehlis' gland and uterine pore could not be observed.

Hosts: Oreochromis niloticus and *O. niloticus* x *O. mossambicus* (Perciformes: Cichlidae).

Site of attachment: Gills.

Localities: Loie, Sakon Nakhon, Nakhon Ratchasima, Nakhon Sawan, Nakhon Nayok, Suphan Buri (Table 1).

Remarks: Cichlidogyrus tilapiae was originally described by Paperna (1960) from the gills of *O. niloticus* (as *T. nilotica*), *Sarotherodon galilaeus* (as *T. galilaea*), *Tristramella sacra* and *Tristramella simonis* (as *Tilapia simonis*) in Israel. Moreover, it has been reported from various cichlid fishes from Africa (Ghana, Uganda, Tanzania, Egypt, Zimbabwe, Ivory Coast, South Africa, Tanzania, Burkina Faso), Middle East (Israel), Asia (Philippines, Bangladesh, Thailand, Japan) and Americas (Colombia, Mexico, Cuba) (see Douëllou, 1993; Jiménez-García et al., 2001; Pouyaud et al., 2006; Kohn et al., 2006; Mendora-Franco et al., 2006; Lerssutthichawal, 2008; Boungou et al., 2008; Pariselle & Euzet, 2009; Le Roux & Avenant-Oldewage, 2010; Madanire-Moyo et al., 2011; Akoll et al., 2011; Maneepitaksanti & Nagasawa, 2012).

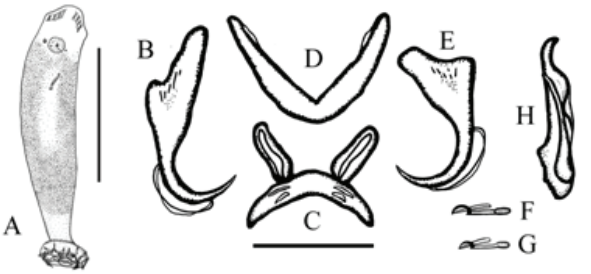

Figure 1 *Cichlidogyrus tilapiae* Paperna, 1960, ventral view. A, whole body; B, dorsal hamulus; C, dorsal bar; D, ventral bar; E, ventral hamulus; F, Larval hook I, G, Larval hook II, H, copulatory organ. Scale bars: A, 250 µm; B-H, 30 µm.

***Cichlidogyrus halli* (Price & Kirk, 1967)** (Fig. 2)

Description (10 specimens measured): Body elongate, 1169.0 (1000.0-1500.0) long and 229.5 (180.0–295.0) wide. Cephalic lobe with 4 pairs of head organs. Two pairs of eyes, the posterior pair with lens. Mouth not observed. Pharynx spherical, 51.4 (46–56.1) in diameter. Haptor ellipsoid, with 2 pairs of hamuli and 7 pairs of hooklets. Ventral hamuli robust, 52.6 (52.0-53.0) long, with massive base and short shaft and point; outer root broad with rounded end; inner root longer than outer. Dorsal hamuli smaller, 43.7 (43.4–43.9) long; outer root wide with rounded end; inner root narrower and much longer than outer root. Hamulus filament present. Ventral bar V-shaped, 75.2 (74.6–75.7) in transverse length, with membranous extensions. Dorsal bar large and massive, 91.4 (90.0–92.7) in transverse length; branches long. Hooklets long; pair 2 shortest without base, pair 1 with short base, other pairs with long base; hooklet lengths, 16.9 (16.8–17.1), 12.1 (11.9–12.3), 37.4 (36.5–37.9), 29.5 (28.9–31.1), 39.3 (38.8–39.8), 36.6 (36.2–36.9) and 34.3 (34.1–34.7), respectively, for pairs 1–7.

Copulatory organ very large and located posterior to intestinal bifurcation; copulatory tube S-shaped, 82.0 (80.4–82.9) long, with irregular base; accessory piece lancet-shaped and shorter, 66.4 (61.0–68.8) long, than copulatory tube. Vagina sub-median. Vitelline follicles well-developed and co-extensive with intestine.

Hosts: Oreochromis niloticus and *O. niloticus* x *O. mossambicus* (Perciformes: Cichlidae).

Site of attachment: Gills.

Localities: Chiang Mai, Uttaradit, Loie, Chaiyaphum, Nakhon Ratchasima, Kamphaeng Phet, Nakhon Sawan, Uthai Thani, Pachin Buri, Suphan Buri, Phatthalung (Table 1).

Remarks: *Cichlidogyrus halli* was originally described by Price & Kirk (1967) (as *Cleidodiscus halli*) from the gills of *O. shiranus shiranus* (as *T. s. shirana*) in Malawi, Africa. It has been recorded from various cichlid fishes from Africa (Malawi, Ghana, Uganda, Egypt, Benin, Guinea, Sierra Leone, Burkina Faso, South Africa, Ivory Coast, Senegal) (see Douëllou, 1993; Pariselle & Euzet, 1997; Pouyaud et al., 2006; Boungou et al., 2008; Pariselle & Euzet, 2009; Le Roux & Avenant-Oldewage, 2010; Mendlová et al., 2010; Madanire-Moyo et al., 2011) from Asia (Japan) (see Maneepitaksanti & Nagasawa, 2012).

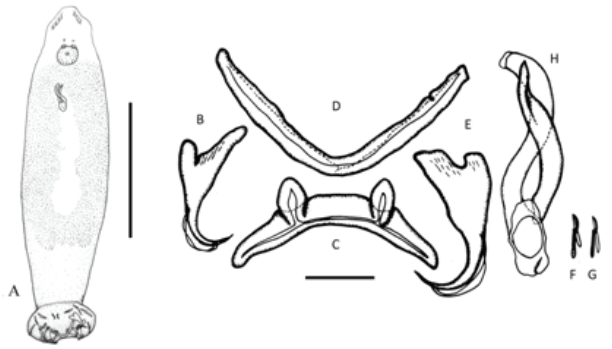

Figure2 *Cichlidogyrus halli* (Price and Kirk, 1967), ventral view. A, whole body; B, dorsal hamulus; C, dorsal bar; D, ventral bar; E, ventral hamulus; F, Larval hook I, G, Larval hook II, H, copulatory organ. Scale bars: A, 500 µm; B-H, 30 µm.

***Cichlidogyrus sclerosus* Paperna& Thurston, 1969** (Fig. 3)

Description (10 specimens measured): Body elongate, 933.7 (610.0–1100.0) long and 189.3 (170.0–210.0) wide. Cephalic lobe with 4 pairs of head organs. Two pairs of eyes, posterior pair with lens. Mouth not observed. Pharynx spherical, 53 (46.3–60.0) in diameter. Haptor rounded, with 2 pairs of hamuli and 7 pairs of hooklets. Ventral and dorsal hamuli of similar size and shape, 31.3 (30.5–31.8) and 29.5 (28.3–30.2) long, respectively, with no distinct roots and strongly curved shaft. Hamulus filament present. Ventral bar V-shaped, 42.5 (40.7–43.9) in transverse length, with rounded extremities. Dorsal bar massive and X-shaped, 39.6 (38.3–41.0) in transverse length; branches wide; appendages pyriform with rounded ends. Hooklets short; pair 2 shortest without base, other pairs with short base; hooklet lengths 16.4 (15.9–16.6), 9.7 (9.3–9.9), 16.1 (16.0–16.4), 16.1 (15.8–16.3), 17.0 (16.8–17.1), 16.6 (16.4–16.7) and 14.1 (13.9–14.2), respectively, for pairs 1–7.

Copulatory organ very large and located posterior to intestinal bifurcation, with large serrated plate; copulatory tube thin and arched, 52.5 (47.1–56.1) long, with tapered end; accessory piece 61.3 (53.7–65.9) long, with finger-like extension. Vagina sub-median. Vitelline follicles well-developed and co-extensive with intestine.

Hosts: Oreochromis niloticus and *O. niloticus* x *O. mossambicus* (Perciformes: Cichlidae).

Site of attachment: Gills.

Localities: Chiang Mai, Uttaradit, Loie, Sakon Nakhon, Chaiyaphum, Nakhon Ratchasima, Kamphaeng Phet, Nakhon Sawan, Uthai Thani, Nakhon Pathom, Phatthalung (Table 1).

Remarks: *Cichlidogyrus sclerosuswas* originally described by Paperna & Thurston (1969) based on specimens from the gills of *O. mossambicus* (as *Tilapia mossambica*), *O. n. niloticus* (as *T. nilotica*), *O. leucostictus* (as *T. leucosticta*), *Haplochromis* sp. and *T. zillii* in Uganda, Africa. The species so far has been reported from various cichlid fishes from Africa (Uganda, Zimbabwe, Egypt, South Africa), Middle East (Israel), Asia (Philippines, Hong Kong, Singapore, Thailand, Japan) and Americas

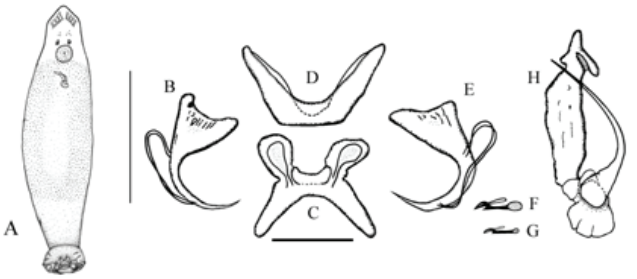

Figure 3 *Cichlidogyrus sclerosus* Paperna & Thurston, 1969, ventral view. A, whole body; B, dorsal hamulus; C, dorsal bar; D, ventral bar; E, ventral hamulus; F, Larval hook I, G, Larval hook II, H, copulatory organ. Scale bars: A, 500 µm; B-H, 30 µm.

(Colombia, Mexico, Cuba) (see Douëllou, 1993; Jiménez-García et al., 2001; Kohn et al., 2006; Mendora-Franco et al., 2006; Sanchez-Ramirez et al., 2007; Lerssutthichawal, 2008; Pariselle & Euzet, 2009; Le Roux & Avenant-Oldewage, 2010; Madanire-Moyo et al., 2011; Akoll et al., 2011; Duncan, 1973; Maneepitaksanti & Nagasawa, 2012).

***Cichlidogyrus thurstonae* Ergens, 1981** (Fig. 4)

Description (10 specimens measured): Body slender, 585.0 (480.0–630.0) long and 145.3 (123.0–156.0) wide. Cephalic lobe with 4 pairs of head organs. Two pairs of eyes, posterior pair with lens. Mouth not observed. Pharynx spherical, 36.5 (34.0–39.0) in diameter. Haptor cup shaped, with 2 pairs of hamuli and 7 pairs of hooklets. Ventral and dorsal almost similar in size and shape; except the end of inner root, rounded end of dorsal hamuli while truncated in ventral hamuli, 32.5 (31.5–33.2) and 27.3 (26.3–28.0) long, respectively, with distinct roots and strongly curved shaft. Hamulus filament present. Ventral bar V-shaped, 48.3 (47.6–48.8) in transverse length, with rounded extremities. Dorsal bar X-shaped, 36.7 (34.1–37.8) in transverse length; branches wide; appendages pyriform with rounded ends. Hooklets long; pair 2 shortest without base, other pairs with short base; hooklet lengths 15.4 (15.1–15.6), 13.9 (12.7–14.4), 36.5 (36.1–36.7), 39.2 (38.8–39.5), 39.6.0 (38.7–40.5), 40.3 (39.0–41.5) and 36.4 (35.5–37.3), respectively, for pairs 1–7.

Copulatory organ large and located posterior to intestinal bifurcation; copulatory tube thin and arched, with oval base 51.6 (48.8–53.7) long; accessory piece slightly S-shaped, ending bottle-opener-like 40.1 (39.7–40.5) long. Vagina short tube and arched. Vitelline follicles well-developed and co-extensive with intestine.

Hosts: Oreochromis niloticus and *O. niloticus* x *O. mossambicus* (Perciformes: Cichlidae).

Site of attachment: Gills.

Localities: Chiang Mai, Uttaradit, Loie, Chaiyaphum, Nakhon Ratchasima, Kamphaeng Phet, Nakhon Sawan, Uthai Thani, Phatthalung (Table 1).

Remarks: *Cichlidogyrus thurstonae* was originally described by Ergens (1981) based on specimens from the gills of *O. niloticus* (as *Tilapia nilotica*) in Egypt, Africa. The species has been reported from cichlid fish from Africa (Burkina Faso), and Asia (Thailand) (see Boungou et al., 2008; Lerssutthichawal, 2008).

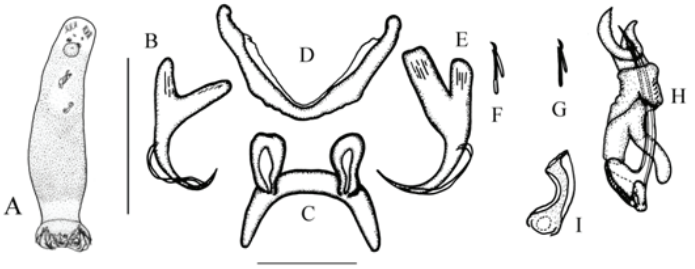

Figure 4 *Cichlidogyrus thurstonae* Ergens, 1981, ventral view. A, whole body; B, dorsal hamulus; C, dorsal bar; D, ventral bar; E, ventral hamulus; F, Larval hook I, G, Larval hook II, H, copulatory organ; I, vagina. Scale bars: A, 500 µm; B-I, 30 µm.

***Scutogyrus longicornis* (Paperna& Thurston, 1969)** (Fig. 5)

Description (10 specimens measured): Body slender, 677.0 (590.0–755.0) long and 143.5 (133.0–150.0) wide. Cephalic lobe with 4 pairs of head organs. Two pairs of eyes, posterior pair with lens. Mouth not observed. Pharynx spherical, 45 (43.0–46.3) in diameter. Haptor rounded, with 2 pairs of hamuli and 7 pairs of hooklets. Ventral hamuli with wide base, short shaft sharp point and reduced rounded roots; inner root wider than outer root, 33.2 (30.5–34.1) long. Dorsal hamuli similar in size to ventral hamuli, with short shaft and small, curved point; roots well developed; deep groove; outer root narrow; inner root broad and massive, 34.6 (33.6–35.6) long. Hamulus filament present. Ventral bar arched, constant width, with round ends, attached with thin, sclerotised bar in form of vault above ventral bar and ending exactly at ends of bar, 76.8 (76.0–77.3) in transverse length, attached with fan-shaped membranous portion and associated with sclerotised ribbed part. Dorsal bar characteristic with distal ends, with triangular plates connected by narrow bridge supporting 2 extremely long appendages with narrower and rounded extremities28.8 (28.0–29.3) in transverse length. Hooklets long; pair 2 shortest without base, other pairs with short base; hooklet lengths 14.4 (14.1–14.7), 10.9 (10.5–11.2), 28.2 (27.7–28.5), 32.3 (31.3–32.7), 29.2 (28.5–29.9), 32.1 (31.4–32.4) and 30.5 (29.9–31.0), respectively, for pairs 1–7.

Copulatory organ short consisting of slightly bent copulatory tube, with reduced base 29.3 (24.4–32.4) long and a twisted accessory piece bearing well-sclerotised half-moon region in its distal half and with bifurcate extremity with one furca finger-like 49.3 (48.6–50.0) long. Vagina in form of long, thin curved tube irregular shape distally. Vitelline follicles well-developed and co-extensive with intestine.

Hosts: Oreochromis niloticus and *O. niloticus* x *O. mossambicus* (Perciformes: Cichlidae).

Site of attachment: Gills.

Localities: Chiang Mai, Uttaradit, Loie, Sakon Nakhon, Chaiyaphum, Nakhon Ratchasima, Kamphaeng Phet, Nakhon Sawan, Nakhon Nayok, Phatthalung (Table 1).

Remarks: Scutogyrus longicornis was originally described by Paperna & Thurston (1969) (as *C. longicornis longicornis*) based on specimens

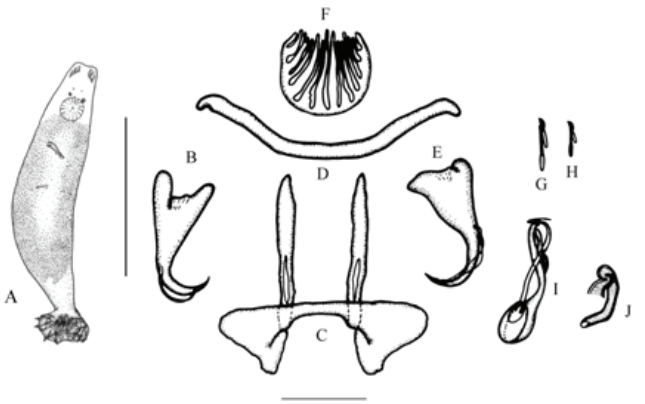

Figure 5 *Scutogyrus longicornis* (Paperna& Thurston, 1969), ventral view. A, whole body; B, dorsal hamulus; C, dorsal bar; D, ventral bar; E, ventral hamulus; F, ribbed portion; G, Larval hook I, H, Larval hook II, I, copulatory organ; J, vagina. Scale bars: A, 500 µm; B-J, 30 µm.

from the gills of *O. n. niloticus* (as *T. nilotica*) in Uganda, Africa. The species so far has been reported from various cichlid fishes from Africa (Egypt, South Africa), Asia (Philippines, Thailand) and America (Mexico) (see Natividad & Auther, 1986; Douëllou, 1993; Jiménez-García et al., 2001; Lerssutthichawal, 2008.

Discussion

Gill monogeneans are pathogenic for cultured fishes as primary pathogen. The results of this study showed that, five species were found from Nile and red tilapia cultured in Thailand. All these parasites have successfully established in Thailand by fish transportation. First report of all five species from tilapias has conducted by Lerssutthichawal (2008). He collected five species of gill monogenean from tilapias; *Scutogyrus longicornis* (as *C. longicornis*), *C. sclerosus*, *C. thurstonae*, *C. tilapiae*, *C. halli* (as *C. tubicirrus*). Recently, Thongdon-A (2012) studied the seasonal occurrences of five gill monogeneans on the gill of red tilapia from central of Thailand. They have found five species of gill monogenean from Kanchanaburi and Samut Songkhram province. The most dominant species was *C. sclerosus.* The gill parasites demonstrated a 100% prevalence and the highest mean intensity in April. Therefore, this present study confirmed the species occurring on the gill of tilapias in Thailand. Additionally, the most widely distributed parasites were *C. halli* and *C. sclerosus* (11/14 localities), followed by *S. longicornis* (10/14 localities), *C. thurstonae* (9/14 localities) and *C. tilapiae* (3/14 localities). The limitation for *C. tilapiae* may cause by parasite competition on the same habitat or the opportunity of host-parasite interface. The highest mean abundance was *C. sclerosus* (Table 1); this species may have well reproductive development. The presence of the highest diversity of three provinces (Loei, Nakhon Ratchasima, Nakhon Sawan) were demonstrated in this study. It may be plausible that the place of fish origins, poor sanitation, increasing of tilapia culture in

both of cage culture in pond or river may have been cause of parasite diversity. Accordingly, the physical factors such as high water temperature and density of fish stock may induce the fecundity of this parasite also (Woo, 1995). Additionally, the natural tilapia contaminated in culture area may be considered for parasite invasion. Morphologically, *C. tilapiae*, *C. halli*, *C. sclerosus* have been well described by Maneepitaksanti & Nagasawa (2012) based on Japanese specimens, while the several characters of *C. thurstonae* and *S. longicornis* were found in this study; especially the internal organs should be redescribed. Unfortunately, all specimen shave been prepared for sclerotized study. Therefore, these two species must be examined by staining in further study. Based on the information of this finding, the aquaculturist should realize the negative effect of this parasite. Hence, the prevention of fish stock before culture by quarantine or treatment and good sanitation will be useful for Nile tilapia and red tilapia culture.

References

Akoll, P., Fioravanti, M. L., Konecny, R. & Schiemer, F., (2011). Infection dynamics of *Cichlidogyrus tilapiae* and *C. sclerosus* (Monogenea, Ancyrocephalinae) in Nile tilapia *(Oreochromis niloticus* L.) from Uganda. Journal of Helminthology, 86: 302-310

Boungou, M. Kabre, G. B., Marques, A. & Sawadogo, L., (2008). Dynamics of population of five parasitic monogeneans of *Oreochromis niloticus* Linné, 1757 in the dam of Loumbila and possible interest in intensive pisciculture. Pakistan journal of biological sciences., 11: 1317–1323.

Bush, A. O., Lafferty, K. D., Lotz, J. M. & Shostak, A. W., (1997). Parasitology meets ecology on its own terms: Margolis et al. revisited. Journal of Parasitology, 83: 575-583.

Chitmanat, C. (2009). Risk Analysis of Diseases for Tilapia Cage Culture Raised in Upper Ping River. 47th Kasetsart University Annual Conference, March 17-20, (2009). Bangkok: Kasetsart University.

Douëllou, L. (1993). Monogeneans of the genus *Cichlidogyrus* Paperna, 1960 (Dactylogyridae: Ancyrocephalinae) from cichlid fishes of Lake Kariba (Zimbabwe) with descriptions of five new species. Systematic parasitology, 25: 159–186.

Duncan, B. L., (1973). *Cichlidogyrus sclerosus* Paperna and Thurston from cultured *Tilapia mossambica.* Philippine Journal of Systematic Biology, 2: 154–158.

Ergens, R., (1969). The suitability of ammonium picrate-glycerin in preparing slides of lower Monogenoidea. Folia parasitologica, 16: 320.

Ergens, R., (1981). Nine species of the genus *Cichlidogyrus* Paperna, 1960 (Monogenea: Ancyrocephalinae) from Egyptian fishes. Folia parasitologica, 28: 205–214.

Jiménez-García, M. I., Vidal-Martínez, V. M. & López-Jiménez, S., (2001). Monogeneans in introduced and native cichlids in México: evidence for transfer. Journal of parasitology research, 87: 907–909.

Kohn, A., Cohen, S. C. & Salgado-Maldonado, G., (2006). Checklist of Monogenea parasites of freshwater and marine fishes, amphibians and reptiles from Mexico, Central America and Caribbean. Zootaxa, 1289: 1–114.

Le Roux, L. E. & Avenant-Oldewage, A., (2010). Checklist of the fish parasitic genus *Cichlidogyrus* (Monogenea), including its cosmopoplitan distribution and host species. African journal of aquatic science, 35: 21–36.

Lerssutthichawal, T., (2008). Diversity and distribution of external parasites from potentially cultured freshwater fishes in Nakhonsithammarat,

southern Thailand. In Bondad-Reantaso, M. G., Mohan, C.V., Crumlish, M. & Subasinghe, R. P. (Eds), Diseases in Asian aquaculture VI: 235–244. | Fish Health Section, Asian Fisheries Society, Manila, Philippines.

Madanire-Moyo, G. N., Matla, M. M., Olivier, P.A.S. & Luus-Powell, W. J., (2011). Population dynamics and spatial distribution of monogeneans on the gills of *Oreochromis mossambicus* (Peters, 1852) from two lakes of the Limpopo River System, South Africa. Journal of helminthology, 85:146–152.

Maneepitaksanti, W. & Nagasawa, K. (2012). Monogeneans of *Cichlidogyrus* Paperna, 1960 (Dactylogyridae), gill parasites of tilapias, from Okinawa Prefecture, Japan. Biogeography, 14: 111-119.

Mendlová, M., Pariselle, A., Vyskočilova, M. & Šimková, A., (2010). Molecular phylogeny of monogeneans parasitizing African freshwater Cichlidae inferred from LSU rDNA sequences. Parasitology Research, 107: 1405-1413.

Mendora-Franco, E. F., Vidal-Martínez, Cruz-Quintana, Y. & Prats León, F. L., (2006). Monogeneans on native and introduced freshwater fishes from Cuba with the description of a new species of *Salsuginus* Beverley-Burton, 1984 from Limiavittata (Poeciliidae). Systematic parasitology, 64: 181–190.

Natividad, J. M., Bondad-Reantaso, M. G. & Arthur, J. R., (1986). Parasites of Nile tilapia (*Oreochromis niloticus*) in the Philippines. The First Asian Forum, Manilla. pp. 155-159.

Paperna, I., (1960). Studies on monogenetic trematodes in Israel. 2. Monogenetic trematodes of cichlids. The Israeli Journal of Aquaculture-Bamidgeh, 12: 20–33.

Paperna, I. & Thurston, J. P., (1969). Monogenetic trematodes collected from cichlid fish in Uganda; including the description of five new species of *Cichlidogyrus*. Rev. Zool. Bot. Afr., 79: 15–33.

Pariselle, A. & Euzet, L., (1997). New species of *Cichlidogyrus* Paperna, 1960 (Monogenea, Ancyrocephalidae) from the gills of *Sarotherodon occidentalis* (Daget) (Osteichthyes, Cichlidae) in Guinea and Sierra Leone (West Africa). Systematic parasitology, 38: 221–230.

Pariselle, A. &Euzet, L., (2009). Systematic revision of dactylogyridean parasites (Monogenea) from cichlid fishes in Africa, the Levant and Madagascar. Zoosystema, 31: 849–898.

Pouyaud, L., Desmarais, E., Deveney, M. & Pariselle, A., (2006). Phylogenetic relationships among monogenean gill parasites (Dactylogyridea, Ancyrocephalidae) infesting tilapiine hosts (Cichlidae): systematic and evolutionary implications. Molecular phylogenetics and evolution, 38: 241–249.

Price, C. E. & Kirk, R. G., 1967. First description of a monogenetic trematode from Malawi. Rev. Zool. Bot.Afr., 76: 137–144.

Sanchez-Ramirez, C., Vidal-Martinez, V., Aguirre-Macedo, M. L., Rodriguez-Canul, R. P., Gold-Bouchot, G. & Sures, B., (2007). *Cichlidogyrus sclerosus* (Monogenea: Ancyrocephalinae) and its host, the Nile tilapia (*Oreochromis niloticus*), as bio indicators of chemical pollution. Journal of Parasitology, 93: 1097–1106.

Thongdon-A, L., Limsuwan, C. & Chuchird, N., (2012). Seasonality of gill monogeneans in red hybrid tilapia (*Oreochromis* sp.) cage culture systems in central Thailand. Kasetsart University Fisheries Research Bulletin. 36(3): 43-53.

Woo, P. T. K. (1995). Fish diseases and disorders Vol.1: Protozoan and metazoan infections. CAB international, Canada, 808 pp.