

Diversity of Freshwater Monogeneans from Siluriform Fishes of Thailand

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ABSTRACT

This study is to document the monogeneans on freshwater siluriform fishes in Thailand. Of the hundred catfish species recorded in Thailand, 44 were examined for gill monogeneans and 40 were found to be infected. Eighty-three monogenean species found in this study belong to seven genera, *Bifurcohaptor* (2 spp.), *Bychowksyella* (8 spp.), *Cornudiscoides* (13 spp.), *Hamatopeduncularia* (2 spp.), *Mizelleus* (1 spp.), *Quadriacanthus* (2 spp.) and *Thaparocleidus* (55 spp.). All these seven genera are placed in *Ancylo-discoididae*. Assuming an average infection of three and two monogeneans per host species, the expected monogenean diversity on Thai freshwater siluriforms is 294 and 196 species, respectively. The present observed diversity represents only 33-50% of the expected diversity. The majority of the monogeneans on Thai siluriforms (76%) were host-specific, while 24% were found on two or more related host species (at generic or family level). About 9% of the fish hosts were free of monogeneans, while 25% had one, 28% had two, 18% had three, and 20% with four or more co-existing species, indicating that co-existing species were common. Co-existing species can be congeners or non-congeners and the number varied from one to eight depending on host species.

INTRODUCTION

Monogeneans are obligate parasites of aquatic and semi-aquatic organisms because they are unable to withstand desiccation (Bychowksy, 1957). Fish forms the main host for the majority of the known monogeneans (Euzet and Combes, 1998; Lim, 1998).

Siluriforms are important species both as food and source of income. Clariids, pangasiids and bagrids are beginning to play an important role in the culture systems in Thailand (Thai Department of Fisheries, 1996). Some species of freshwater catfish are exported to at least 15 countries. They, however, often suffer from parasitic infection. Knowledge of the monogenean parasite fauna would form the baseline data for monogenean studies on the siluriforms of Thailand.

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MATERIALS AND METHODS

Fish collection

In this study 32 localities within 17 provinces around Thailand (latitude 5°37' - 20°27' N and longitude 97°22' - 105°37'E) were chosen to be the collection sites (Fig. 1). Of 98 freshwater siluriform fish species recorded in Thailand, 44 species from 23 genera and 8 families were sampled for monogeneans (see Table 1).

Collection of parasites

Gill monogeneans were collected and mounted on semi-permanent slides using the methods of Lim (1986, 1990, 1991) for study and identification. Host-monogenean data, the pattern of distribution as well as the estimation of species diversity of Thai monogeneans are discussed in this paper.

Table 1. Host-monogenean data.

Bifur.: *Bifurcohaptor*, *Bychow.*: *Bychowskyella*, *Cornu.*: *Cornudiscoides*, *Hamato.*:

Hamatopeduncularia, *Mizell.*: *Mizelleus*, *Quadri.*: *Quadriacanthus*, *Thapa.*: *Thaparocleidus*

Fish host species	No. of fish examined and infected	No. of monogenean species							No. of monogenean genera and species
		<i>Bifur.</i>	<i>Bychow.</i>	<i>Cornu.</i>	<i>Hamato.</i>	<i>Mizell.</i>	<i>Quadri.</i>	<i>Thaparo.</i>	
Ariidae									
<i>Hemipimeldus borneesis</i>	5 (4)	-	-	-	2	-	-	-	1 (2)
Bagridae									
<i>Bagrichthys macropterus</i>	2 (2)	-	-	-	-	-	-	1	1 (1)
<i>Batasio tengana</i>	5 (0)	-	-	-	-	-	-	-	-
<i>Hemibagrus nemurus</i>	42 (33)	2	-	3	-	-	-	3	3 (8)
<i>Hemibagrus wyckii</i>	6 (0)	-	-	-	-	-	-	-	-
<i>Hemibagrus wyckioides</i>	12 (11)	-	-	2	-	-	-	5	2 (7)
<i>Leiocassis siamensis</i>	9 (8)	-	-	-	-	-	-	1	1 (1)
<i>Mystus atrifasciatus</i>	4 (4)	-	-	1	-	-	-	1	2 (2)
<i>Mystus bocourti</i>	5 (4)	-	-	1	-	-	-	1	2 (2)
<i>Mystus gulio</i>	3 (3)	-	-	2	-	-	-	-	1 (2)
<i>Mystus mysticetus</i>	2 (2)	-	-	1	-	-	-	2	2 (4)
<i>Mystus singaringan</i>	9 (8)	-	-	3	-	-	-	1	2 (4)
<i>Mystus wolffi</i>	6 (6)	-	-	1	-	-	-	-	1 (1)
Clariidae									
<i>Clarias batrachus</i>	12 (11)	-	2	-	-	-	1	-	2 (3)
<i>Clarias cataractus</i>	5 (4)	-	-	-	-	-	1	-	1 (1)
<i>Clarias gariepinus</i>	4 (2)	-	-	-	-	-	1	-	1 (1)
<i>Clarias macrocephalus</i>	16 (10)	-	1	-	-	-	1	-	2 (2)
<i>Clarias meladerma</i>	4 (4)	-	2	-	-	-	1	-	2 (3)
<i>Clarias neiuhofi</i>	11 (7)	-	3	-	-	-	-	-	1 (3)
<i>Clarias hybrid</i>	27 (16)	-	-	-	-	-	1	-	1 (1)
Heteropneustidae									
<i>Heteropneustes fossilis</i>	10 (7)	-	1	-	-	-	-	-	1 (1)

Pangasiidae									
<i>Helicophagus waandersii</i>	7 (7)	-	-	-	-	-	-	3	1 (3)
<i>Pangasianodon gigas</i>	7 (0)	-	-	-	-	-	-	-	-
<i>Pangasianodon hypophthalmus</i>	9 (9)	-	-	-	-	-	-	2	1 (2)
<i>Pangasius bocourti</i>	8 (7)	-	-	-	-	-	-	2	1 (2)
<i>Pangasius conchophilus</i>	10 (10)	-	-	-	-	-	-	4	1 (4)
<i>Pangasius krempfi</i>	2 (2)	-	-	-	-	-	-	3	1 (3)
<i>Pangasius larnaudii</i>	4 (4)	-	-	-	-	-	-	6	1 (6)
<i>Pangasius macronema</i>	11 (11)	-	-	-	-	-	-	4	1 (4)
<i>Pangasius sanitwongsei</i>	2 (1)	-	-	-	-	-	-	1	1 (1)
<i>Pteropangasius pleurotaenia</i>	7 (7)	-	-	-	-	-	-	6	1 (6)
Schilbeidae									
<i>Lrides hexanema</i>	4 (4)	-	-	-	-	-	-	2	1 (2)
Siluridae									
<i>Belodontichthys dinema</i>	4 (4)	-	-	-	-	-	-	2	1 (2)
<i>Hemisilurus mekongensis</i>	1 (1)	-	-	-	-	-	-	2	1 (2)
<i>Kryptopterus bicirrhis</i>	2 (2)	-	-	-	-	-	-	2	1 (2)
<i>Kryptopterus bleekeri</i>	9 (8)	-	-	-	-	-	-	4	1 (4)
<i>Kryptopterus cryptopterus</i>	6 (6)	-	-	-	-	-	-	3	1 (3)
<i>Micronema apogon</i>	5 (3)	-	-	-	-	-	-	2	1 (2)
<i>Ompok bimaculatus</i>	22 (20)	-	-	-	-	-	-	4	1 (4)
<i>Silurichthys hasselti</i>	3 (2)	-	-	-	-	-	-	1	1 (1)
<i>Wallago attu</i>	5 (5)	-	-	-	-	1	-	2	2 (3)
Sisoridae									
<i>Bagarius bagarius</i>	6 (2)	-	-	-	-	-	-	1	1 (1)
<i>Bagarius yarrelli</i>	2 (0)	-	-	-	-	-	-	-	-
<i>Glyptothorax major</i>	2 (2)	-	1	-	-	-	-	-	1 (1)

RESULTS

Host-monogenean data

Eighty-three monogenean species were found on 40 of 44 host fish examined (Table 1). These 83 species belong to *Bifurcophaptor* Jain, 1958 (2 spp.), *Bychowkyella* Achmerow, 1952 (8 spp.), *Cornudiscoides* Kulkarni, 1969 (13 spp.), *Hamatopeduncularia* Yamaguti, 1953 (2 spp.), *Mizelleus* Jain, 1957 (1 sp.), *Quadriacanthus* Paperna, 1961 (2 spp.) and *Thaparocleidus* Jain, 1952 (55 spp.). All seven genera are members of the family *Ancylo-discoididae* (Lim *et al.*, 2001). Of the seven monogenean genera found in this study, *Thaparocleidus* had the highest species diversity (55 species or 66% of the total monogeneans obtained) and were found on 28 fish species of 16 genera from five families (*Bagridae*, *Pangasiidae*, *Schilbeidae*, *Siluridae* and *Sisoridae*). *Cornudiscoides* was next with 13 species (17%), and restricted to the family *Bagridae* (*Hemibagrus* and *Mystus*). This is followed by *Bychowkyella* with eight species (10%) found on *Clariidae*, *Heteropneustidae* and *Sisoridae*; *Bifurcophaptor* with two species (2%) restricted to the *Bagridae* (*Hemibagrus*); *Quadriacanthus* with two species (2%) from the *Clariidae*; *Hamatopeduncularia* with two species found only on the freshwater *Ariidae*; and *Mizelleus* with one species on the *Siluridae* (Tables 1 and 2).

Table 2. Host distribution patterns of monogenean species.

Monogenean gener	No. of monogenean species on host						Total
	On 1 host	On 2 hosts	On 3 hosts	On 4 hosts	On 5 hosts	On 6 hosts	
<i>Bifurcohaptor</i>	2	-	-	-	-	-	2
<i>Bychowskyella</i>	6	1	1*	-	-	-	8
<i>Cornudiscooides</i>	8	5	-	-	-	-	13
<i>Hamatopeduncularia</i>	1	1	-	-	-	-	2
<i>Mizelleus</i>	1	-	-	-	-	-	1
<i>Quadriacanthus</i>	-	1	-	1**	-	-	2
<i>Thaparocleidus</i>	45	8	1	-	-	1***	55
Total no. of species	63	16	2	1	0	1	83
Percentage (%)	76	19	3	1	0	1	100

Remarks: **Bychowskyella tchangi*, ***Quadriacanthus kobiensis*, *** *Thaparocleidus caecus*

DISCUSSION

Diversity of monogeneans on siluriform fish

Different host families. The bagrids had the greatest monogenean species diversity with 30 species from *Bifurcohaptor* (2 spp.), *Cornudiscooides* (13 spp.) and *Thaparocleidus* (15 spp.). The pangasiids and silurids were next with 19 monogenean species each and most were from *Thaparocleidus*. Only a species of *Mizelleus* was present on *Wallago attu* (*Siluridae*).

The clariids possessed nine monogenean species from two genera, *Quadriacanthus* (2 spp.) and *Bychowskyella* (7 spp.). Only one species of *Bychowskyella* was found on the heteropneustid. Sisoriids, on the other hand, had two species from two monogenean genera, *Bychowskyella* (1 sp.) and *Thaparocleidus* (1 sp.). The freshwater *Ariidae*, represented by *Hemipimelodus*, had only one monogenean genus, *Hamatopeduncularia* with two species. The monogenean diversity within the host family was correlated to the diversity of the host families. The number of species or monogenean species diversity for each fish family depended on the diversity of the fish host species in the family concerned. The *Bagridae*, for example, with 12 host species, had the highest diversity in monogenean species (30 spp.), while *Pangasiidae* and *Siluridae* with ten and nine host species, respectively, had 19 monogenean species each.

Different host genera and species. The bagrid *Hemibagrus nemurus* had the highest number of monogenean species with eight species from three genera, namely: *Thaparocleidus* (3 spp.), *Cornudiscooides* (3 spp.) and *Bifurcohaptor* (2 spp.) (Table 3). The diversity of species per host varied from one to six in the pangasiids, *Thaparocleidus* species was found on *P. bocourti*, while six *Thaparocleidus* species were collected from *P. larnaudii*.

Multispecies monogenean community on the fish hosts

Fish species usually possess more than one monogenean species. The co-existing species could be congeneric species (species belonging to the same genus) or sympatric species (different monogenean species, genera or families, which share the same host species) (Lim, 1987). In this study 29 (66%) of the 44 examined host species possessed more than one monogenean species, while 11 species (25%) were infected with only one monogenean species (Table 3). Many Thai freshwater catfish (12 host species or 28%) had two co-existing congeners, while 18% had three co-existing species. Of the 83 monogenean species obtained, 78 species (94%) could be found together with other monogenean species, whilst five fish species were found to be infected with only a single monogenean species each: *Glyptothorax major* with a *Bychowskyella*; *Batasio tengara* with a *Thaparocleidus*; *Leiocassis siamensis* with a *Thaparocleidus*; *Silurichthys* sp. with a *Thaparocleidus*; and *Bagarius bagarius* with *Thaparocleidus*, respectively.

Monogenean-host distribution patterns: specificity

Host specificity is the direct result of co-evolution with a particular host (Brooks, 1986, 1989; Lim, 1987; Rohde, 1993). Host specificity can be narrow or wide depending on the monogenean species concerned. Several hypotheses have been founded to explain wide host specificity. Wide host specificity could be due to the ability of the host to change the parasites (Leong and Holmes, 1981; Lim, 1987). Among the seven monogenean genera found in this study, *Cornudiscooides* and *Hamatopeduncularia* were specific to particular host genera and families: *Cornudiscooides* was restricted to *Hemibagrus* or *Mystus* (*Bagridae*), while *Hamatopeduncularia* was found only on the ariids. *Hamatopeduncularia* and *Chauhanellus* (*Ancyrocephalinae*) and *Neocalceostoma* and *Neocalceostomoides* (*Neocalceostomatidae*) have been recorded from marine ariids only (Lim, 1998).

Bychowskyella and *Thaparocleidus* could be found on a wide variety of fish families, whilst the other five monogenean genera (i.e., *Bifurcohaptor*, *Cornudiscooides*, *Mizelleus*, *Quadriacanthus* and *Hamatopeduncularia*) have a limited host range. *Bychowskyella* is present on the *Bagridae*, *Clariidae*, *Heteropneustidae*, *Schilbeidae*, *Siluridae* and *Sisoridae*; while *Thaparocleidus* is found on *Bagridae*, *Pangasiidae*, *Schilbeidae*, *Siluridae* and *Sisoridae* and on non-siluriform *Notopteridae* (Lim, 1996); *Quadriacanthus* is restricted to *Clariidae* in the Oriental region, but it occurs on the *Clariidae* as well as the *Bagridae* and *Cichlidae* in Africa (Paperna, 1969; 1979). However, there are some monogenean genera which are restricted to a particular catfish host species. For example, *Mizelleus* is thus far only found on the *Wallago attu* (*Siluridae*) of India and Thailand (Lim and Lerssutthichawal, 1996).

This study shows that the majority of monogenean species (63 species or 76%) are restricted to one host, while 16 species (19%) have two hosts (Table 2). Only four species (5%) have more than two hosts, e.g., *Quadriacanthus kobeensis* on four *Clarias* species; *Bychowskyella tchangii* on two *Clarias* species and on *Heteropneustes fossilis* (*Heteropneustidae*). *Thaparocleidus caecus* is the most common species and could be found on six pangasiid host species belonging to four genera, i.e., *Helicophagus waandersii*, *Pangasianodon hypophthalmus*, *Pangasius conchophilus*, *P. krempfi*, *P. larnaudii* and *Pteropangasius pleurotaenia* (Tables 1 and 2).

The fish species from different families in the same region could be infected with the same monogenean species, for example *C. batrachus* (Clariidae) and *H. fossilis* (Heteropneustidae) share the same *Bychowskyella* species (*B. tchangi*). This study confirms the specificity of the majority of monogeneans. This is especially true for the monogeneans of the bagrids where there are no common monogenean species, unlike the pangasiids which have several common monogeneans.

Table 3. Monogenean distribution pattern on different hosts.

Fish host families	No. of host species									Total fish species examined
	No. of monogenean species on each host species									
	0	1	2	3	4	5	6	7	8	
Ariidae	-	-	1	-	-	-	-	-	-	1
Bagridae	2	3	3	1	1	-	-	1	1	12
Clariidae	-	3	1	3	-	-	-	-	-	7
Heteropneustidae	-	1	-	-	-	-	-	-	-	1
Pangasiidae	1	1	2	2	2	-	2	-	-	10
Schilbeidae	-	-	1	-	-	-	-	-	-	1
Siluridae	-	1	4	2	2	-	-	-	-	9
Sisoridae	1	2	-	-	-	-	-	-	-	3
Total	4	11	12	8	5	0	2	1	1	44
Percentage (%)	9	25	28	18	11	0	5	2	2	100

Expected diversity of species on siluriformes of Thailand

The diversity in a community is an indication of stability. The greater the diversity the more stable the community. The diversity of a community of organisms is composed of two components, namely: (a) the number of species present in the community (species-richness of the community (i.e., the number of species present in the community)); and (b) the relative abundance of the species (or evenness or equitability) (Lim, 1998; Solomon, 1979). In this study, relative abundance data is not available since it was not possible to sample the same number of host species, therefore, only one component of the diversity (the species-richness) could be considered.

The 83 dactylogyridean species obtained in the present study are not representative of the expected diversity on freshwater siluriform fishes of Thailand, since these species were collected from only 40 of the 44 host species investigated and there are 98 species of freshwater catfish in Thailand. The expected number of monogenean species on catfish in Thailand could be estimated by considering the number of monogenean species per host species and the number of freshwater siluriforms (Table 4).

Table 4. Diversity of monogeneans on freshwater catfish of Thailand

Fish families	No. of fish species recorded	No. of fish species examined	No. of fish species infected	No. of monogenean species collected	Average No. of monogenean species per host
Amblycipitidae*	1	0	-	-	-
Akysiidae*	5	0	-	-	-
Ariidae	4	1	1	1	1
Bagridae	25	12	10	30	3(1-8)
Chacidae*	1	0	-	-	-
Clariidae	7	7**	7	9	2(1-4)
Heteropneustidae	1	1	1	1***	1
Pangasiidae	12	10	9	19	4(1-6)
Schilbeidae	5	1	1	2	2
Siluridae	23	9	9	19	3(1-4)
Sisoridae	14	3	2	2	1(1-1)
Total 11 families	98	44	40	83	2-3

Remarks: * not examined; ** with two non-indigenous species; *** have same monogenean species as *Clarias* spp.

Estimation of diversity

By multiplying the average number of monogenean species per fish host species by the number of host species, the expected diversity on Thai freshwater catfish is estimated to be 196 and 294 species based on the assumed presence of two monogenean species per host species and three monogenean species per host species, respectively. This means that the present 83 species represent only 33% to 50% of the probable monogenean diversity on catfish, and that there are about 113 to 211 species (or 50% to 67%) yet to be described. If empty niches are considered and assuming that the present observation reflects what is in nature, then 9% of the siluriforms will be without monogeneans. This means nine species of siluriforms (9% of 98 species) will be without monogeneans while 89 siluriforms will be expected to possess two or three monogenean species per host species giving an estimated expected diversity of 178 or 267 monogenean species, respectively (Table 4). These figures can only be confirmed or refuted when all the catfish species of Thailand have been sampled.

CONCLUSION

This study contributes to basic knowledge of the parasite fauna on the siluriform fishes in Thailand. The main objective of this study has been achieved, given the limitations encountered even though the present collection only represent at best 30% to 50% of the monogeneans expected to be available on the Thai freshwater siluriforms. A complete documentation of the monogeneans on the other freshwater siluriforms not investigated in this study should be considered in future studies. As a transition zone, Thailand may encounter greater generic diversity than presently observed. About 76% of the monogenean species

on the Thai siluriforms are host-specific. This concurs with the observation of Bychowsky (1957) that about 74% of the known monogenean species occur on a single host species and 84% on a single host genus. On the other hand, about 24% of the monogeneans on the 40 catfish species infect more than one host species which are usually related at least at generic if not at family level.

The absence of monogeneans from the four host species could be due to non-conducive macro-environmental factors (Lim, 1987). Another probable reason is based on the observed over-disperse distribution patterns (negative binomial distribution) of monogeneans on a host population (Lim, 1987) which implies that within a given host population there are a few individuals without parasites as well as few with many parasites. Thus in the case of the four species where individual fish sampled did not contain any monogeneans, monogeneans may possibly have been found if more fishes had been examined.

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