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Research Note

Seasonal population dynamics of the monogeneans *Quadriacanthus kobinensis* parasitising *Clarias fuscus* in Pearl River, China

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Summary

This paper describes the population dynamics of *Quadriacanthus kobinensis* on the gills of *Clarias fuscus* following a field investigation from June 2012 to May 2013 in Pearl River, China. The results showed that in *Q. kobinensis* prevalence was highest (70.13 %) in the summer and Mean intensity reached a peak in the autumn. The maximum number of *Q. kobinensis* in a fish was 474. The maximum abundance occurred during summer (25.8) and the minimum values during spring. *Q. kobinensis* exhibited an aggregated distribution in all seasons. The highest prevalence was in hosts of 28 cm<L and the infection intensity was also the highest in this group. In terms of infection intensity, host of 28 cm<L differed significantly from those of 24<L≤26 cm, but no significant differences existed in other body length groups.
Keywords: population dynamics; Monogenea; *Quadriacanthus kobinensis*; *Clarias fuscus*; Pearl River; China

Introduction

Catfish of the family Clariidae are widespread in freshwaters of tropical and subtropical Africa and Asia (Na-Nakorn & Brumment, 2009). Economically important catfish species *Clarias fuscus* (Siluriformes: Clariidae) is a much valued species for consumption in many countries, especially in South China, where it is frequently consumed. The fish species occurs across South China due to its ease of spawning, tolerance of low dissolved oxygen and high stocking density and it is regarded as the most edible catfish species (Qin *et al.*,1998; Zheng *et al*.,1988). Despite its merits for aquaculture, it harbours a number of deadly pathogens, including viruses, bacteria and parasites. Monogeneans are common pathogens which occur naturally in an open culture systems (Bakke *et al*., 2002). Monogenea are hermaphroditic ectoparasites of aquatic vertebrates, predominantly fish where they can be found on the skin and gills (Euzet & Combes, 1998). There is an equilibrium between host and parasite and monogenean parasites cause few obvious problems in nature. However, these parasites can reach very significant prevalence in captivity, such that the number of affected fish and the parasite load per host are both increased, which makes the disease evident and severe (Thoney & Hargis, 1991). *C. fuscus* is abundant in the Pearl River, China (Lu ,1990) and frequented by *Quadriacanthus kobinensis* on the gills. The occurrence of monogenean parasites have previously been shown to exhibited significant seasonal variations and peak period (high prevalence and intensity) is the most harmful period (Xia & Wang, 1997). Research on infection dynamics of *C. fuscus* in the Pearl River is necessary to determine intervention measures to reduce severe losses in farming conditions. The results presented here stems from a survey on seasonality of *Q. kobinensis* in *C. fuscus* under natural conditions in the Pearl River.

Table 1. Infection indices of *Q. kobinensis* in *Clarias fuscus* during different seasons in Pearl River, China

mean water temp. (°C)	No. of fish sampled	Length of fish (Mean ± SE) (cm)	Prevalence (%)	No. of parasites	Mean Intensity (SE) Max	Abundance (SE)
Spring 19.8	91	22.1 ± 0.3 13.0 – 30.0	62.64	661	11.6 (2.1) 69	7.3 (1.4)
Summer 30.7	77	23.2 ± 0.4 15.1 – 31.9	70.13	1984	36.7 (7.7) 221	25.8 (5.7)
Autumn 24.4	92	22.9 ± 0.5 13.7 – 32.5	53.26	2115	43.2 (11.7) 474	23.0 (6.6)
Winter 15.6	81	22.3 ± 0.3 14.6 – 29.8	60.49	1281	26.1 (5.9) 265	15.8 (3.8)

Materials and Methods

Experimental design and host collection

In the Pearl River basin, spring lasts from March to May, summer from June to August, autumn from September to November, and winter from December to February of the following year. Fish samples were collected monthly from June 2012 to May 2013 with gill nets in the lower reaches of the Pearl River between latitudes and longitudes 23°02'N, 23°04'N and 113°18'E, 113°24'E. Up to 30 fish were collected and transferred live to the laboratory. The fish were measured and weighed; they ranged from 2 to 34 cm in total length and,1 – 470 g in weight. The river water surface temperature were measured daily.

Parasite examination

The gills were excised immediately after fish killed by severing the spinal cord anterior to the dorsal fin and examined for gill parasites using a dissection microscope in separate Petri dishes containing water from the tap. The epithelium surface of the gill filaments were scraped with a needle and the scrapings were collected in a beaker filled with water. The contents was then stirred, allowed to settle and the supernatant decanted. This procedure was repeated until a clear suspension was obtained Sediments were examined with a dissection microscope for parasites For identification purposes, monogeneans were fixed on a slide either with a drop of Malmberg solution (ammonium picrate glycerine) or glycerine jelly. The water surface temperature were measured daily. The host fishes were divided into six size groups based on their body length (L), L≤20 cm, 20< L ≤22 cm, 22< L ≤24 cm, 24< L ≤26 cm, 26< L ≤28 cm and L > 28 cm to determine whether a correlation existed between fish length and the infection levels.

Statistical analyses

Prevalence, intensity, mean intensity and abundance of parasites were calculated as defined by Margolis *et al*. (1982). The significance test for seasonal changes in abundance, mean intensity, mean length of parasites and mean length of fish was carried out using one-way ANOVA (Bryman & Duncan, 1997). Statistics for each season of *Q. kobinensis* includes variance-mean ratio S^2/X, parameter of negative binomial distribution *K*, average degree of congestion *M**, and diffusivity index $I\delta$. T-test was used to detect the significance of different host size classes in the infecting effect of *Q. kobinensis* on the hosts. All statistical analyses were executed using SPSS 17.0 (SPSS Inc., Chicago, Illinois) at a significance level of 0.05.

Results

Seasonal variations in populations of Q. kobinensis

A total of 6041 specimens of *Q. kobinensis* were collected from 341 individuals of *C. fuscus* between June 2012 and May 2013 (Table 1). The prevalence, intensity and other parameters related to *Q. kobinensis* infection are shown in Table 1. Prevalence values were above 50 % in all seasons and show a indistinct seasonal trend. Prevalence values were above 50 % in all seasons and show a indistinct seasonal trend. Prevalence value was highest

Table 2. The seasonal fluctuation of aggregation indices of *Q. kobinensis* in host

	Infection intensity	S^2	S^2/X	K	M^*	$I\delta$
Spring	0 – 69	189.69	26.13	0.29	32.39	4.42
Summer	0 – 221	2512.97	97.52	0.27	122.29	4.70
Autumn	0 – 474	3999.04	173.95	0.13	195.94	8.45
Winter	0 – 265	1192.03	75.40	0.21	90.21	5.65

Table 3. The seasonal frequency distribution indices of *Q. kobinensis* in host

No. of *Q. kobinensis*	Frequency indices			
	Spring	Summer	Autumn	Winter
0	38.71	29.87	46.74	39.51
1 – 4	31.18	27.27	19.57	14.81
5 – 8	7.53	6.49	4.35	8.64
9 – 12	3.23	6.49	4.35	3.70
13 – 16	6.45	3.90	3.26	6.17
17 – 20	3.23	1.30	1.09	4.94
>20	9.68	24.68	20.65	22.22

(70.13 %) in the summer and lowest (53.26 %) in autumn. Mean intensity reached a peak in autumn (43.2) and its lowest level in spring (11.6), it somewhat increased in summer, but then decreased in winter. The maximum number of *Q. kobinensis* was 474 whereas the maximum values for abundance were recorded during summer (25.8) and the minimum values occurred during spring (7.3) .

Aggregation Index of Q. kobinensis in host

The diffusion index ($I\oint$) means crowding degree (M^*) and variance-to-mean ratio (S^2/X) were greater than 1,and the results showed that *Q. kobinensis* was in aggregated distribution in each season. Values for the negative binomial parameter (K) differ among seasons and showed different aggregation intensities. The population distribution pattern of *Q. kobinensis* in *C. fuscus* is shown in Table 2. Table 3 shows that most hosts across all seasons is only infected by a small number of *Q. kobinensis*. In contrast, a small number of host were infected by large amounts of *Q. kobinensis.*

Significance test of infection intensity among the different host body length groups of Q. kobinensis

The highest prevalence occurred in 28 cm<L fish ,and infection intensity was also the highest in this size class. Results of the significance test for infection intensity is provided in table. 4. In terms of infection intensities between size classes, hosts of 28 cm < L differed significantly from 24<L≤26 cm,but no significant differences existed between the other groups.

Discussion

Monogeneans prefer fishes, amphibians, reptiles and mammalians has host (Pan *et. al.*, 1990), and occur especially on gills of fishes. Monogenea has a high degree of host specificity (Whittington 1998). A total of 4 monogenean species, *Clariotrema austrofujianensis*, *Clariotrema meridionalis, Q. kobinensis* and *Gyrodactylus fusci* have previously been reported on the gills of *C. fuscus* in natural systems in China (Zhang ,1984). However, only *Q. kobinensis* and *G. fusci* were found on the gills of *C. fuscus* in our investigation, the result confirms that of Lim (1998) in Southeast Asia. We haven't calculated the statistical parameters for *G. fusci* because *Q. kobinensis* was absolutely predominant .There were only 93 specimens of *G. fusci* collected and it was far less than the number of *Q. kobinensis* .The seasonal population dynamics of a monogenean is related to complex environmental parameters especially water temperature (Chubb,1977) as e.g., MO (1992) found *Gyrodactylus salaris* through most of the year except 2-3 months when temperature had fallen to almost 0 °C; Jansen & Bakke (1993) found the infra populations of *G. salaris* increased markedly on all salmon parr with the spring rise in water temperature and lower temperatures in winter affect the population growth of the parasite negatively; Yang *et. al*. (2006) found infection levels of *Pseudorhabdosynochus coioidesis* and *Pseudorhabdosynochus serrani* were low during summer and prevalence and mean intensity were high in autumn and early winter. Water temperature reached peak in summer (30.7 °C) and decreased in winter (15.6 °C) in our investigation. In present study , prevalence was high in summer (70.13 %) and low in autumn (53.26 %); abundance was also high in summer (25.8) but low in spring (7.3); mean intensity was high in autumn (43.2) and low in spring (11.6). The seasonal population dynamics of *Q. kobinensis* in *C. fuscus* over four seasons showed that mean abundance, mean intensity and prevalence did not differ significantly which were due to relatively warm water (15.6 – 30.7 °C) . The result shows that there was no clear effect of temperature on the probability of being infected corroborating the finding of Hendrichsen *et. al.* (2015) which given the lower water temperature (mean 5.4 °C). Perhaps another reason of irregular seasonal population dynamics of *Q. kobinensis* was the relatively stable population structure of hosts (the seasonal population dynamics of *C. fuscus* will be published later) which means new hosts immigrate or previous hosts emigrate or die, in the mean time new parasites enter the hosts or previous parasites emigrate or die. (Lv. *et. al.*, 2000). The distribution of *Q. kobinensis* in a host over the year shows an aggregated distribution, and the degree of aggregation varied little. The seasonal fluctuation of aggregation indices of *Q. kobinensis* in host showed that the majority of hosts were not infected and a large numberof *Q. kobinensis* parasited a small amount of hosts, so *K* is lower, and the population density of parasites is higher. The aggregated distribution minimize the effect of parasite on host populations and may be related to the fact that parasitization makes the host weak and thus more susceptible to other parasites (Li & Wang, 2002). The observed frequency distribution indices in this study showed that *Q. kobinensis* was found to be infected during the sampling months of whole year, and their infection levels were relatively low during Autumn. Both experimental and theoretical studies indicate that host body length positively correlate with mean intensity , prevalence , number of parasites and abundance. Khidr (1990) found prevalence and intensity of *E. cichlidarum* increase significantly with increasing host size. Tombi & Bilong Bilong (2004) also recorded a positive correlation between parasitic infections and host size and attributed this to increasing gill surface area and water flow through the gill chamber. Madanire-Moyo *et al*. (2011) also reported that prevalence values increased with increasing host size. However, there is no correlation between host body length and the mean intensity and prevalence in our study. The relationship between *Q. kobinensis* and the hosts *C. fuscus*in the Pearl River basin needs further research.

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