Pomphorhynchus heronensis and restricted movement of *Lutjanus carponotatus* on the Great Barrier Reef

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Abstract

Samples of *Lutjanus carponotatus* (Lutjanidae) from reef flat (shallow) and reef slope (deep) sites around Heron and Wistari reefs on the southern Great Barrier Reef were examined for *Pomphorhynchus heronensis* (Acanthocephala). Individual fish from the reef slope had 0–9 (2.6) worms as compared with 1–122 (39.6) worms for individuals from the reef flat ($P < 0.0001$). Other variables (year, season, size of fish) made little contribution to the variation. Reef flat and reef slope sites were separated by as little as 300 m. These results imply both that the fish have very limited local movement and that transmission of the parasite is concentrated locally.

Introduction

Parasites of fish have often been used as indicators of the distribution of their hosts (Lester *et al.*, 1985, 1988; Leaman & Kabata, 1987; MacKenzie, 1990, 1993). Most such studies have been over large areas and have aimed at identifying stocks or large-scale movements of the fish. Historically, little has been published on the use of parasites to indicate the movement or distribution of fish in restricted areas. More recently Adlard & Lester (1994) found that the ectoparasitic isopod *Anilocra pomacentri* indicated site attachment of a pomacentrid fish, *Chromis nitida*, at Heron Island on the Great Barrier Reef. Grutter (1998), also on the Great Barrier Reef, found that a *Benedenia* species (Monogenea) parasitic on the skin of a labrid, *Hemigymnus melapterus*, has a significantly greater prevalence on the reef flat than the reef slope. In French Polynesia, Rigby *et al.* (1997) found richer helminth communities in samples of a serranid, *Epinephelus merra*, from the barrier reef than in those from fringing reefs. The paucity of such studies until recently may reflect the lack of expectation that parasite composition and abundance will vary over short distances; both parasites and hosts might be expected to mix within a single ecosystem so that distribution of parasites would be broadly uniform. It is well-established, however, that many species of fishes demonstrate strong site-attachment whereby, following

recruitment, the fish moves only short distances in a home range (e.g. Choat & Bellwood, 1985; Thresher, 1985; Victor, 1987; Barrett, 1995). If fish combine site-attachment with flexibility in the selection of microhabitat then there is the opportunity for differences in parasite assemblages over small distances. Differences might result from either the differential action of ocean currents in dispersing infective stages or because of the presence or absence of intermediate hosts at different sites.

Here we report a heterogeneous distribution of the acanthocephalan *Pomphorhynchus heronensis* Pichelin, 1997 in the coral reef fish *Lutjanus carponotatus* over small distances.

Materials and methods

Lutjanus carponotatus is a conspicuous and diurnally active carnivore found on coral reefs from depths of less than a metre to 80 m. We examined 66 specimens of *L. carponotatus* from Heron and Wistari reefs on the southern Great Barrier Reef. Fish were collected principally by line fishing but a few specimens were speared. Samples were collected on seven occasions in either summer or winter between 1992 and 1997. Specimens came from three reef slope sites (8–15 m depth) from around the Heron and Wistari reefs and from one site on the Heron Reef flat (1–2 m depth) (see fig. 1). Each specimen was killed, measured (caudal fork length – LCF), and the entire gastrointestinal tract examined for parasites. This report considers only the acanthocephalan

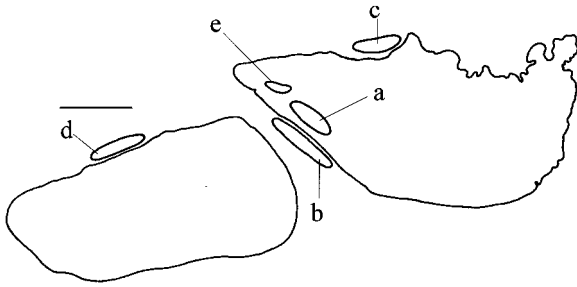* Fax: 61 7 3365 1588
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Fig. 1. Collecting sites on and around Heron and Wistari Reefs. a, Heron Reef Flat; b, Heron Channel; c, North Heron; d, North Wistari; e, Heron Island. Scale bar = 2 km.

Fig. 2. *Pomphorhynchus heronensis* in *Lutjanus carponotatus* at Heron Island. All fish. □, fish from reef flat; ♦, fish from reef slope.

Pomphorhynchus heronensis which is restricted to the rectum and occasionally the posterior end of the intestine. The adult parasite is easily and reliably counted because it is large (6–14 mm long) and permanently attached to the gut of the host (Pichelin, 1997).

Graphs and descriptive and analytical statistics on the distribution of *P. heronensis* were generated in Excel 7.0 for Windows and Minitab Release 11 for Windows. Differences in the distribution of *P. heronensis* were examined by Student's *t*-test of mean intensity between reef slope (grouped) and reef flat sites. The relationship between intensity and LCF was examined using linear regression. Intensity data were also classified into four groups and the variation therein examined by chi-squared (χ^2) analysis for all sites separately. Classified data were also used to examine the relationship between intensity and depth of collection (pooled sites), season of collection, year of collection, and LCF. The intensity classifications were 0, 1–10, 11–50 and $\geqslant 51$ individuals. The relationship between depth and season of collection was examined by χ^2 analysis. The effect of year of collection on intensity was examined using oneway ANOVA.
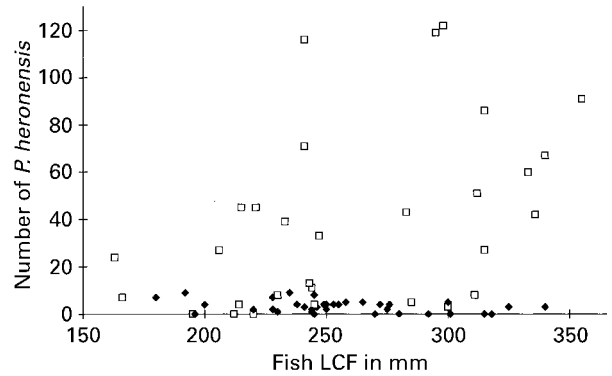
Results

Site

Prevalence and intensity of infection showed considerable variation between the reef flat and the three reef slope sites (table 1, fig. 2). The range of intensities of infection for fish from the reef flat was evidenced by a variance two orders of magnitude larger than that of any other site and a mean of 39.6, which was about 10 times greater than the site with the next highest mean intensity (North Heron, 4 worms per fish). Because the three reef slope sites were not significantly different (Student's *t*-test $P = 0.391$, North Heron was not included due to its small sample size of 2) these were pooled for comparison with the reef flat site. The intensity differences between the reef flat (shallow) and the other three reef slope (deep) sites pooled was significant at $P < 0.0001$ (Student's two-tailed *t* value = 5.47). Of the 30 fish from the reef flat, none was uninfected, compared with 33% of fish free from infection in the pooled reef slope sample. In the χ^2 analysis of classified intensity data, the difference between reef slope

Table 1. *Pomphorhynchus heronensis* in *Lutjanus carponotatus* at Heron Island (data by site).

	N	LCF range (mean)	Parasites range (mean)	No. with 0	Prevalence %
Reef slope					
North Wistari	11	195–280 (237)	0–5 (1.8)	5	54.5
Heron Channel	23	228–325 (269)	0–9 (2.9)	7	69.6
North Heron	2	285–340 (313)	3–5 (4)	0	100
Pooled reef slope	36	195–340 (262)	0–9 (2.6)	12	66.7
Reef flat	30	163–355 (256)	1–122 (39.6)	0	100
Totals	66	163–355 (259)	0–122 (19.4)	12	81.8

LCF, caudal fork length.

Table 2. *Pomphorhynchus heronensis* in *Lutjanus carponotatus* at Heron Island (data by season).

Site	Season	N	LCF	Worms
Reef flat	Summer (Jan)	6	233–312 (262)	33–122 (72)
	Winter (Jul/Aug)	24	163–355 (254)	1–119 (31.5)
Reef slope	Summer (Jan)	19	228–340 (273)	0–9 (3.4)
	Winter (Jul/Aug)	17	195–301 (249)	0–5 (1.8)

LCF, caudal fork length.

Table 3. *Pomphorhynchus heronensis* in *Lutjanus carponotatus* at Heron Island (data by year).

Habitat	Year	N	LCF	Worms
Reef flat	1994	8	163–355 (243)	7–91 (44)
	1995	16	192–336 (260)	1–119 (25)
	1997	6	233–312 (262)	33–122 (72)
Reef slope	1992	2	318- 325 (322)	0–3 (1.5)
	1994	17	195–340 (272)	0–9 (2.6)
	1995	3	212–255 (233)	0–4 (2)
	1996	5	228–315 (252)	0–8 (3)
	1997	1	258	5

LCF, caudal fork length.

(pooled) and reef flat was significant at $P < 0.0001$ ($\chi^2 = 36.4$) whereas the difference between individual sites was also highly significant ($P < 0.0001$, North Heron was excluded because of the small sample size of 2).

Season

Classified intensity data showed no significant deviation from a random distribution ($\chi^2 = 2.13$, $P = 0.546$) between seasons (table 2). Within sites, however, there were differences in mean intensity as measured by two-sample *t*-test. For the reef flat site, the difference between winter and summer was not significant ($P = 0.86$), whereas for the reef slope sites, summer intensities of infection were significantly higher ($P = 0.049$) (table 2). This significant but not particularly strong relationship probably resulted from a statistically-significant bias ($P = 0.006$) between season and depth of collection; by χ^2 analysis, these factors deviated from random in their expected distribution (more *L. carponotatus* having been collected from the reef flat during winter).

Year

There was a significant effect of year of collection in the reef flat site (ANOVA F = 4.42, $P = 0.022$) but not in the reef slope sites (F = 0.43, $P = 0.76$) (table 3). This was due to a significantly higher intensity in the 1997 sample than in the 1995 ($t = -2.66$, $P = 0.032$). No other combination of years had significantly different mean intensities.

Host size

There was no significant difference in the sizes of the fish from within each site and season sample (Student's *t*-test $P = 0.59$ and $P = 0.11$, respectively). Although the correlation coefficient was low ($r^2 = 0.07$) due to a large number of large, uninfected fish from reef slope sites, the regression of infection intensity on LCF showed a positive relationship significant at $P = 0.018$ (F = 5.88). This relationship was also apparent when LCF values were grouped into three classes ($\leqslant 250$ mm, 251–300 mm, $\geqslant 301$ mm) and compared with the classified intensity data ($\chi^2 = 12.6$, $P = 0.045$).

Discussion

Our analyses demonstrate a clear correlation between intensity of infection with *Pomphorhynchus heronensis* and

the water depth from which the fish were collected. The relationship was highly significant and not confounded by the other relationships found. The strength of this result implies that individuals of *Lutjanus carponotatus* do not feed at both reef flat and reef slope sites. Our reef flat and reef slope sites were as little as 300 m apart, which suggests that movement of *L. carponotatus* may be very limited indeed. This result is informative in the context of the variation in mobility that has been reported for other lutjanids. The most detailed available information is that of Sheaves (1993) who reported tagging studies of *Lutjanus russelli* in north Queensland. He found that this fish was usually recaptured within 40 m of the site at which it was released. In contrast, Hobson (1965) suggested that nocturnally-feeding lutjanids showed wider movements and typically moved between day resting sites and night feeding sites. *Lutjanus carponotatus* is predominantly a diurnal feeder; perhaps it can be predicted that most diurnally-feeding lutjanids will prove to be strongly site-attached.

The corollary to the evident site-attachment of the hosts is that transmission of *P. heronensis* must be highly localized. An explanation for the concentration of this acanthocephalan must lie in an understanding of the life-cycle. Whereas the monogenean that Grutter (1998) reported as being concentrated on the reef flat has a direct life-cycle, all acanthocephalans have indirect life-cycles. The life-cycle of *P. heronensis* is unknown, but those of other species of *Pomphorhynchus* all involve cystacanths in amphipods (e.g. Gleason, 1989; Dezfuli *et al.*, 1991; Semenas *et al.*, 1992). Amphipods are abundant, although poorly known (Bruce, 1993), on the Great Barrier Reef and it seems reasonable to predict that they act as inter-mediate hosts to *P. heronensis*. It may well be, therefore, that the localization of transmission relates to localization of populations of suitable amphipods. Equally, however, there could be a physical explanation in that the smaller volumes of water on the reef flat lead to a greater concentration of eggs and heavier infection of the intermediate hosts there. Barger & Nickol (1998) showed that the form of the egg of acanthocephalans of the genera *Leptorhynchoides* and *Pomphorhynchus* influenced their settlement pattern and led to different patterns of infection in the amphipod hosts which they shared.

These results, taken together with those of Adlard & Lester (1994), Rigby *et al.* (1997) and Grutter (1998) have a broad implication for the study of parasites of coral reef fishes; sampling must be carried out at a range of spatial scales, even within a system as small as a single coral reef, if the diversity of communities of parasites is to be recorded reliably. If useful conclusions are to be drawn about parasite community structure and function within these systems, then sampling must be more intensive still. These studies also raise questions about the biology of helminths of coral reef fishes in general. Are parasites concentrated because the intermediate hosts are concentrated? Do the restricted water volumes on the reef flat influence the success of parasites? Are there differential advantages for hosts in selecting sites in response to parasite load? Indeed, can parasite-mediated site selection affect other community structuring processes in such space-limited systems? Answers to such questions will

require first a great deal more data on variation in parasite populations across the full array of spatial scales, to determine whether the distribution identified here for *P. heronensis* is anomalous or indeed characteristic of helminths of coral reef fishes.

Acknowledgements

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