Predator-Prey Interactions in Coral Reef Fish:
The Implications of Predation Risk on the Behavior and Growth of Prey

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Abstract

Sublethal or nonlethal predator-prey interactions (predation risk) can influence prey species' behaviours and food web dynamics across a wide-range of ecological communities and diverse taxa. In this thesis, I explore the potential for predation risk to influence the behaviour and growth of marine animals. Local predation risk fluctuates greatly in space and time and anti-predator behaviour is expected to be selected over evolutionary times to optimise prey fitness. Flexibility in behavioural responses to predation risk is likely to be an evolutionary adaptation that mitigates the trade-offs between the costs of physical and chemical defences against predators and maximising growth and reproduction. In high-risk situations during the life of an animal, anti-predator behaviour maximising survival may reduce net energy intake by an individual and potentially its reproductive fitness relative to net energy intake and fitness in low risk situations. I identify major determinants of, and common prey responses to, predation risk in marine environments. I argue that nonlethal predator-prey interactions influence the behaviour of marine species and, because of the high phenotypic plasticity characteristic of these animals, are likely to affect life-history traits such as growth and size-at-maturity. These effects may be especially significant in speciose communities, such as coral reefs, where the number of nonlethal interactions is high.

I examine the anti-predator behaviour of juveniles and adults of a number of species of site-attached coral reef fishes. In order to test for a change in behaviour due to predation risk, I exposed these fishes to a caged Serranid predator, *Cephalopholis cyanostigma*, in laboratory aquaria. Seeking and associating with refuge was the most common antipredator response in diurnal species of the prey fish, *P. moluccensis* and *P. amboinensis*. Conversely, two nocturnal prey species (*Apogon fragilis* and

Cheilodipterus quinquelineatus) moved away from their refuge in the presence of the reef piscivore, presumably to avoid attacks from potential ambush predators. Both size-classes of the four species of prey examined reduced their foraging significantly in the presence of a predator. Vigilance, however, was primarily a role assumed by adults and not juveniles. Such differing ontogenetic behaviour and the associated selected advantages may help explain the persistence of mixed size-class groups, a common feature in social groups of coral reef fish planktivores. Moreover, anti-predator behaviour of individual coral reef fish may depend on the ecology of that species and the specific foraging of its ontogenetic stage.

I then examined, more closely, predator-induced modifications in foraging behaviour of a common tropical fish, *Pomacentrus moluccensis*, in groups of different size and at different ontogenetic stages on coral reefs in the Great Barrier Reef. Different group sizes of *P. moluccensis* were exposed to a potential predator or non-predator and changes in foraging behaviour of juveniles and adults were observed. In the presence of a predator, foraging effort, estimated by the number of bites taken and foraging distance away from shelter, was reduced whilst the presence of a non-predator caused an increase in foraging distance of *P. moluccensis*. In the presence of a predator, adults exhibited greater reduction in foraging than juveniles. Juveniles continued foraging even in the presence of predators which may help explain maintenance of high growth rates in young coral reef fishes. In contrast, reduced foraging in adults might reflect an emphasis on survival. Prey fish in large groups exposed to a predator displayed less reduction in foraging effort compared to fish in smaller groups. This was consistent with observational surveys that show a reduction in per capita vigilance with an increase in prey group size. Therefore, aggregating in coral reef fishes, a common phenomenon,

may serve to dilute predation risk and increase individual foraging effort in social groups of pomacentrids. These results suggest that nonlethal predator-prey interactions may have an important effect on food ingestion rates and therefore energy uptake of coral reef fish. These effects were mediated by prey group size and ontogeny.

Finally, I investigated the effects of non-fatal interactions on prey morphology and growth, and explored how intraspecifc density may influence these effects. Using experimental manipulations of group sizes of *Pomacentrus moluccensis*, and a system of artificial coral reefs and cages at Lizard Island on the Great Barrier Reef (GBR), I tested the prediction that predation risk would reduce foraging and growth in this species while grouping would dilute this risk and ameliorate some of these negative effects. Results indicated that the risk of predation affected the behaviour and reduced the growth rate of the prey and that these effects were most pronounced in small prey group sizes. Observational data collected from natural reefs in the immediate vicinity suggested that a reduction in per capita vigilance with increase in group size may explain the diminished individual costs of predation risk recorded in large groups. These results suggest that predators may significantly reduce the growth of a prey individual at low prey group size, but will have a smaller effect at higher prey group sizes due to a reduction in per capita vigilance. This suggests that social groups in coral reef fish systems may have evolved, in part, to optimise the trade-offs between survival and growth. Suppression of growth due to predation risk may affect population dynamics of adult coral reef fish by regulating the rate of individuals reaching reproductive maturity and/or by increasing the probability of size-selective mortality on juveniles.

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