The Role of the threespot damselfish, *Stegastes planifrons*, in Contemporary Caribbean Reef Ecology

Submitted by Ellen Husain, to the University of Exeter as a thesis for the degree of *Doctor of Philosophy* in Biological Sciences, September 2011.

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other university.

Signed: ....

Abstract

Caribbean reef ecosystems have undergone major ecological changes in the last 30 – 40 years, with the result that ecological systems once dominated by structurally complex *Acropora cervicornis* and *Montastraea annularis* corals now consist mainly of flattened carbonate substrates with macroalgal overgrowth. A need for greater understanding of coral reef ecosystems is imperative if we are to attempt to conserve them. The threespot damselfish, *Stegastes planifrons,* is herbivorous damselfish species ubiquitous to Caribbean reefs, where it has been termed a keystone species. Aggressive in nature, *S. planifrons* defends territories of around 70 cm in diameter from other roving herbivorous fish and urchins, in apparent effort to maintain the algal resources therein for its own use. The predilection of *Stegastes planifrons* for basing its territories on the now Critically Endangered staghorn coral, *Acropora cervicornis,* and the Endangered boulder coral *Montastraea annularis* is well known, however the likely ecological implications of this fact have not been investigated. Using a combination of experimental and observational methodologies we examine the ecological implications of coral microhabitat choice and use by *S. planifrons*. We also assess the magnitude of the direct and indirect effects of *S. planifrons'* territorial behaviour on macroalgal dynamics both within and outside of territory confines, at the reef-wide level.

We find that coral microhabitat is a more important determinant of algal community structure than damselfish presence, and that this can be explained by a previously unrecognised effect of coral microhabitat on the grazing behaviour of roving herbivorous fishes - on which *S. planifrons'* territorial behaviour has little effect. In a modification of the space availability hypothesis of Williams et al (2001) we suggest that *Acropora cervicornis* acts as a grazing fish „exclusion zone", and we further hypothesise that the existence of large stands of this coral prior to the Caribbean „phase shift" may have acted to concentrate the grazing pressure of excluded roving fish onto the remaining areas of the reef. We further hypothesise that the loss of such „exclusion zones" and accompanied effective dilution of grazing pressure may have been on a scale large enough to have been a significant underlying factor in the proliferation of macroalgae seen on modern day Caribbean reefs.

In the absence of demonstrable direct or indirect effects on benthic algal communities we question the continued keystone status of *S. planifrons,* particularly since the status 6 was originally based on interference behaviour involving the important grazing urchin *Diadema antillarum,* which is now functionally absent from Caribbean reefs. Implications of the context-dependant nature of keystone status are also discussed. We find that the effect of *S. planifrons* on coral community may be more important than its effects on benthic algal community. In examining the factors involved in habitat coral choice we establish a significant preference for 100% live coral substrate over substrates with a supply of algal food. Territory selection was followed by a high rate of coral biting – a behaviour which has previously been shown to result in coral tissue death and the fast establishment of algal turf communities on which S. planifrons likes to feed (Kaufman 1977). We also demonstrate a novel and significant association between *S. planifrons* presence and disease incidence its primary habitat coral, the Critically Endangered staghorn coral *Acropora cervicornis*, and a significant correlation between areas of fish biting and the later onset of disease. Changes to the overall role of damselfish on today's Caribbean reefs are discussed in light of these insights.

Acknowledgements

I choose to remember the moon shadows. The jumping iguanas. The day of the dragonflies. The poor small, exhausted birds, and the hawk that killed them. The fish eagle. The day of the jellyfish. The Island crocodile. The silversides and the groupers; the giant salp; the garden eels. The celestial night dive.
The dead sailors, and the one that swam ashore.
The most incredible whale sharks and their beady eyes; the enormous glowing whirl of cuberra snapper.
One Barrel Rum and coconut water. Rice and beans. Escabeche.
..And of course, the midnight parrotfish.

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Despite one false start, two hurricane evacuations, one death threat, WCS's enforced evacuation, and the distractions of work at the BBC, this thesis is now finished. Well, after all that, it really had to be.

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