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FINAL REPORT:

USE OF ROTENONE AT HERON ISLAND

GBRMPA PERMIT NO. G93/550

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1. Introduction

Permit no. G93/550, allowing the use of rotenone at Heron Island, was required as part of a PhD project examining the effect of habitat structure, reef connectivity and scale on the dynamics of fish communities on coral reefs. Most of the current literature embraces the concept of recruitment limitation as the main structuring force in coral reef fish communities. Recruitment limitation has been suggested as an explanation for the high degree of spatial and temporal variation identified in the fish assemblages of patch reefs. However, conclusions regarding the dynamics of patch-reef assemblages cannot necessarily be extrapolated to apply to fish communities of contiguous reef. For this reason, the current project is aimed at examining the relative importance of stochastic and deterministic processes in the structuring of fish assemblages on habitat patches varying in size and connectivity. Rotenone sampling was required for two main reasons:

(i) To examine the recolonisation of sections of reef that had been denuded of fish. How does size and connectivity of the habitat patch affect colonisation rates and community resilience, *i.e.*, how closely does the recolonised community resemble to community present prior to rotenone sampling?

(ii) To sample populations of a damselfish, *Pomacentrus moluccensis*, from habitat patches varying in size and connectivity. How to the populations from different sites vary with regards to age structure (which may reflect recruitment history)? Is there any difference in growth rate among sites varying in size and connectivity.

The use of rotenone was chosen as the most logistically desirable method for achieving the above goals, *i.e.*, denuding sections of reef of all fish, and sampling populations for age structure with minimal bias towards large or small individuals. Rotenone has been used for similar purposes by other researchers, although usually for sampling lagoonal patch-reefs only. Some problems did arise through the use of rotenone on the reef slope. These problems are discussed later in the report along with recommendations on the use of rotenone for collecting fish in the future.

2. Locations of Sites:

In November and December 1993, fish communities were sampled using the icthyocide rotenone on the northern reef slope of Heron Island (Figure 1). At this location (referred to as Second Bay) the reef slope is fragmented, ranging in connectivity from sections of contiguous reef to isolated outcrops of coral known as patch-reefs. Sample sites were selected on the basis on size and connectivity, and included 3 sections of contiguous reef and 9 patch-reefs (Table 1).

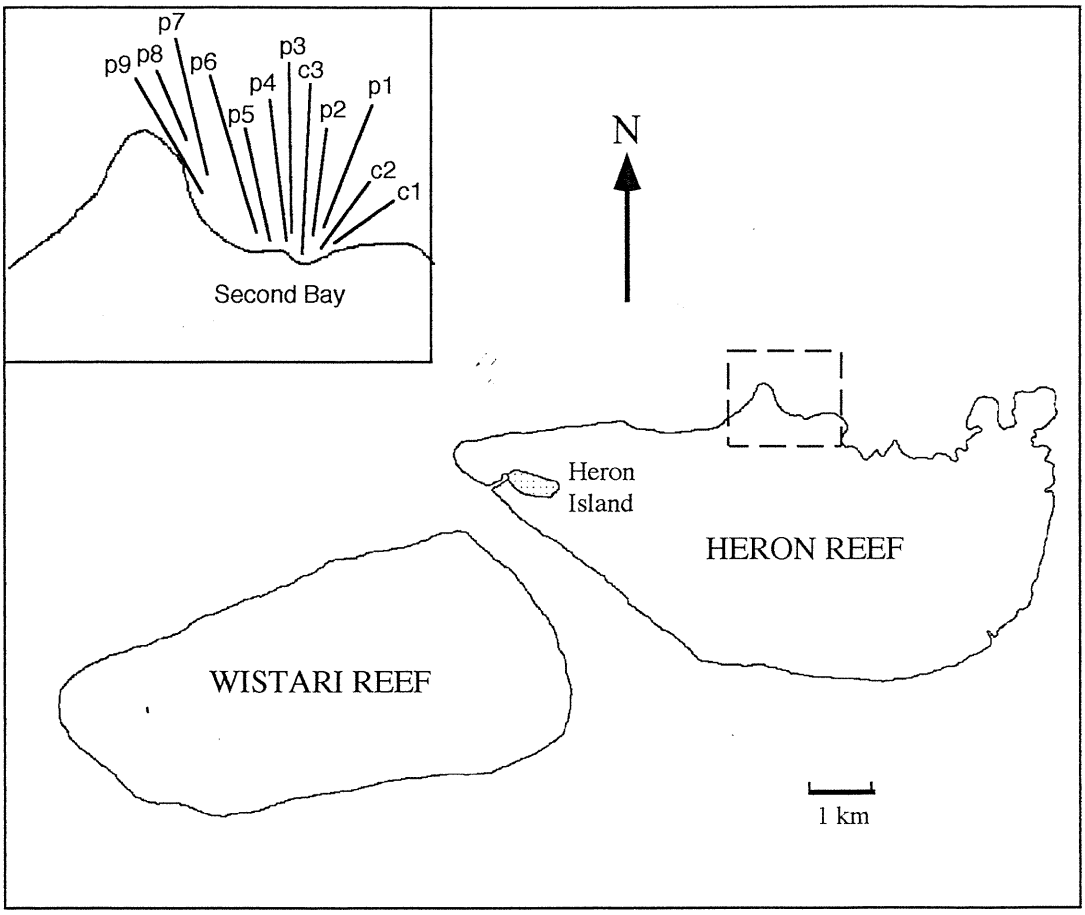

Figure 1: Locations of sampling sites at Heron Island

Table 1: Sizes of sites sampled with rotenone

Site	Type	Area (m^2)
c1	contiguous	36.0
c2	contiguous	36.0
c3	contiguous	36.0
p1	patch	21.9
p2	patch	7.1
p3	patch	13.5
p4	patch	20.0
p5	patch	26.5
p6	patch	16.0
p7	patch	21.0
p8	patch	17.5
p9	patch	19.0

3. Methodology

On the advice of Peter Doherty at the Australian Institute of Marine Science, rotenone was used at a ratio of approximately 1 kg of dry rotenone for every 100 m^2 of reef. Powdered rotenone was mixed with seawater (*c.* 150 $g.L^{-1}$) with the aid of a small amount of detergent, and the mixture placed in sealed plastic bags which could be punctured underwater and squeezed to distribute the solution over the site in a controlled manner. Initial trials with rotenone on patch reefs proved relatively ineffective. At the concentration used, rotenone takes approximately 10-15 minutes to affect fish. Unfortunately, even on extremely calm days, a very slight surge is enough disperse the rotenone before at affects fish. Previous researchers probably experienced fewer problems sampling lagoonal patch reefs, as these are entirely protected from oceanic swell at low tide.

To increase the effectiveness of rotenone in Second Bay, each site was covered by a large sheet of plastic, underneath which, rotenone was applied. After 15 minutes the plastic was removed and dead fish were collected. In the laboratory, fish were identified and preserved in 10% formalin, except for *P. moluccensis* which was preserved in alcohol to protect otolith microstructure.

For effective sampling, a large number of divers were required to manoeuvre the plastic into position, and to collect dead fish before they float away or are eaten. All sampling was conducted within 2 hours of the daylight low tide on calm days (<10 knots wind,< 0.5 m swell), to minimise problems associated with water currents.

4. Species and Number of Fish Collected:

A total of 967 individual fish were collected from Second Bay from the 12 sampling occasions (Table 2). Most fish were identified to species and placed in the Heron Island Research Station Museum.

Table 2: Fish collected during rotenone sampling at Heron Island

Family	Species	no. individuals
Apogonidae (cardinalfish)		215
Muraenidae (moray eels)		4
Holocentridae (soldierfish)		6
Acanthuridae (surgeonfish)		
	Ctenochaetus binotatus	2

Family	Species	no. individuals
Chaetodontidae (butterflyfish)		
	Chaetodon aureofasciatus	1
	Chaetodon rainfordi	1
Labridae (wrasses)		
	Cirrhilabrus punctatus	50
	Coris schroederi	4
	Halichoeres margaritaceus	2
	Halichoeres melanurus	18
	Labrichthys unilineatus	2
	Labroides dimidiatus	1
	Labropsis australis	1
	Labrichthys unilineatus	1
	Pseudocheilinus hexataenis	3
	Macropharyngodon choati	5
	Pseudolabrus guentheri	7
	Stehojulis bandanensis	2
	Thalassoma lunare	10
Ostraciidae (boxfish)		
	Ostracion cubicus	1
Plesiopidae (longfins)		
	Plesiops coeruleolineatus	34
Pomacanthidae (angelfishes)		
	Centropyge bispinosus	1
	Centropyge tibicen	2
	Centropyge vroliki	1
Pomacentridae (damselfish)		
	Amblygliphidodon curacao	22
	Chomis nitida	52
	Chromis ternatensis	3
	Chysiptera flavipinnis	1
	Chysiptera rollandi	29
	Dascyllus reticulatus	17
	Neoglyphidodon melas	1
	Plectroglyphidodon lacrymatus	3
	Pomacentrus amboinensis	35

Family	Species	no. individuals
Pomcentridae (cont)		
	Pomacentrus brachialis	22
	Pomacentrus coelestis	33
	Pomacentrus melanchir	48
	Pomacentrus moluccensis	273
	Pomacentrus wardi:	24
Pseudchromidae (dottybacks)		
	Cypho purpurascens	6
	Ogibyina novaehollandiae	3
	Pseudochromis paranox	5
Scaridae (parrotfish)		
	Scarus sordidus	1
Serranidae (cods)		
	Cephalopholis boenak	7
	Epinephelus merra:	1
Tetraodontidae (puffers)		
	Canthigaster valentini	7

5. Effects on Invertebrate Fauna

Rotenone poisoning did not appear to have a strong effect on the invertebrate fauna, although dead shrimps were observed following poisoning on a few occasions. Crabs, nudibranchs, and gastropod molluscs were observed to move and feed in a normal manner immediately following rotenone poisoning. Corals appeared unstressed by the application of rotenone, although colonies touching the overlying plastic would sometimes produce abnormal quantities of mucous as a response to rubbing. Each site has been visited a number times in the 9 months following sampling and no coral deaths have been observed.

6. Other Comments Regarding the Use of Rotenone

6.1 Potential for Accidental Poisoning:

The potential for uncontrolled poisoning of fish on the reef slope resulting from an accidental spillage of rotenone is minimal. Even a minor surge is enough to disperse rotenone before is takes affect, unless the poison is artificially confined. During

sampling, all fish were collected within the perimeter of the site (enclosed by plastic); no deaths were observed on nearby habitat patches.

6.2 Collection of Fish

While rotenone poisoning of patches allows the sampling of fish populations without bias towards individuals on the basis of size, there are a number of problems associated with the method on large well-connected areas of reef. Because the site had to be covered by a large sheet of plastic, larger vagile fish species, such as large wrasses, scarids, acanthurids, and seranids, were frightened away from the site prior to sampling. During sampling, a large number of fish were thought to have died in holes and crevices where they were unable to be recovered. Under the initial influence of rotenone many individuals were observed to swim erratically in a downward direction which tended to drive them into crevices and coral interstices. Following death, the gill opercula opened widely which often caused difficulty in removing fish from tight holes in the substrate. A large number of fish were also eaten by mobile predators, such as cods and wrasses, before they could be collected. Overall, catch rates were much lower than was hoped; clearly, rotenone poisoning is not an appropriate method for validating visual surveys on contiguous reef. It is likely that catch rates would be improved when sampling lagoonal patch reefs that do not require covering to prevent dispersal of the poison.

7. Conclusion

Despite the problems outlined above, the main goals of the project were achieved. I would have liked to have sampled more sites, but constraints on the use of rotenone prevented this (e.g., waiting for calm days, coordinating the large number of assistants). Initial results from the project are extremely interesting. Since the sampling period, I have conducted visual surveys of the denuded sites every 3 months. It appears the rate of recolonisation is strongly related to the connectivity of the patch. More surveying is required before an estimate of community resilience can be obtained, and for this reason I request that the permit be extended to allow visual surveying throughout 1995 (no more rotenoning is required - see enclosed permit application)

Analysis of otolith microstructure suggests that the growth rate of *Pomacentrus moluccensis* is dependent on the size and connectivity of the habitat patch. The completed analysis will be presented in a Graduate Diploma thesis by Michael Porrit (under the supervision of Craig Johnson, Zoology Department, University of Queensland) and in a paper by Ault, Porrit, and Johnson (*in prep.*). My thesis will be completed by October 1995; reprints of all papers arising from the research will be forwarded to GBRMPA as soon as they are available.