POPULATIONS, BEHAVIOUR AND EFFECTS OF *DRUPELLA CORNUS* ON THE NINGALOO REEF, WESTERN AUSTRALIA.

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INTRODUCTION

Whelks of the genus *Drupella* are relatively common inhabitants of coral reefs throughout the Indo-Pacific. In Western Australia, *Drupella cornus* have been collected from coral reefs ranging from the Abrolhos Islands north to Broome (Museum of Western Australian collections), and are expected to occur on the less surveyed northern reefs. The earliest reported findings of *Drupella cornus* from the Ningaloo Reef region are those of Museum collections from Pt Quobba, just south of the reef, in 1960.

My initial observations of *Drupella* aggregations were made at Coral Bay in October 1985. Digitate corals were observed with up to 90 adult *Drupella* feeding on, or clustered around the colonies. Further observations in March 1986 found that those colonies initially under predation had been totally killed. Subsequent observations made by A. M. and A. L. Ayling in April 1987 of *Drupella* populations between Coral Bay and Osprey Bay, a distance of some 140 km, indicated the scope of the phenomena.

POPULATIONS

Initial intensive investigations of *Drupella* biology commenced at Osprey Bay, a site proposed as a sanctuary zone within the Marine Park, and where previous research into fish populations and hydrology had already been undertaken. A series of eight 50m transects were laid on the back reef, perpendicular to the reef, and coral community structure recorded by line intersection. The area 25cm either side of the line was searched for *Drupella* . Since the hydrographic studies of the previous 12 months, the reef's coral communities had obviously degenerated, and live coral was generally less than 5% of the substrate, while live *Drupella* were scarce. On the one transect where dead shells were collected, 50 were found while only 1 live *Drupella* was recorded. Further studies therefore concentrated on regional assessments, and on specific studies centred at Coral Bay, where both *Drupella* and coral were still plentiful.

REGIONAL ASSESSMENTS

A major regional survey of *Drupella* populations and reef community structure was undertaken in conjunction with CALM studies in February 1989. Transects 20m long and 0.5m wide were used, a search area of $10m^2$. A total of 34 transects were undertaken between Coral Bay and Neds Camp on the Ningaloo Reef, and a further 6 were done on Bundegi Reef, in Exmouth Gulf.

The Ningaloo sites generally showed significant signs of *Drupella* damage, as indicated by the amount of standing dead *Acropora*, their preferred host, on the

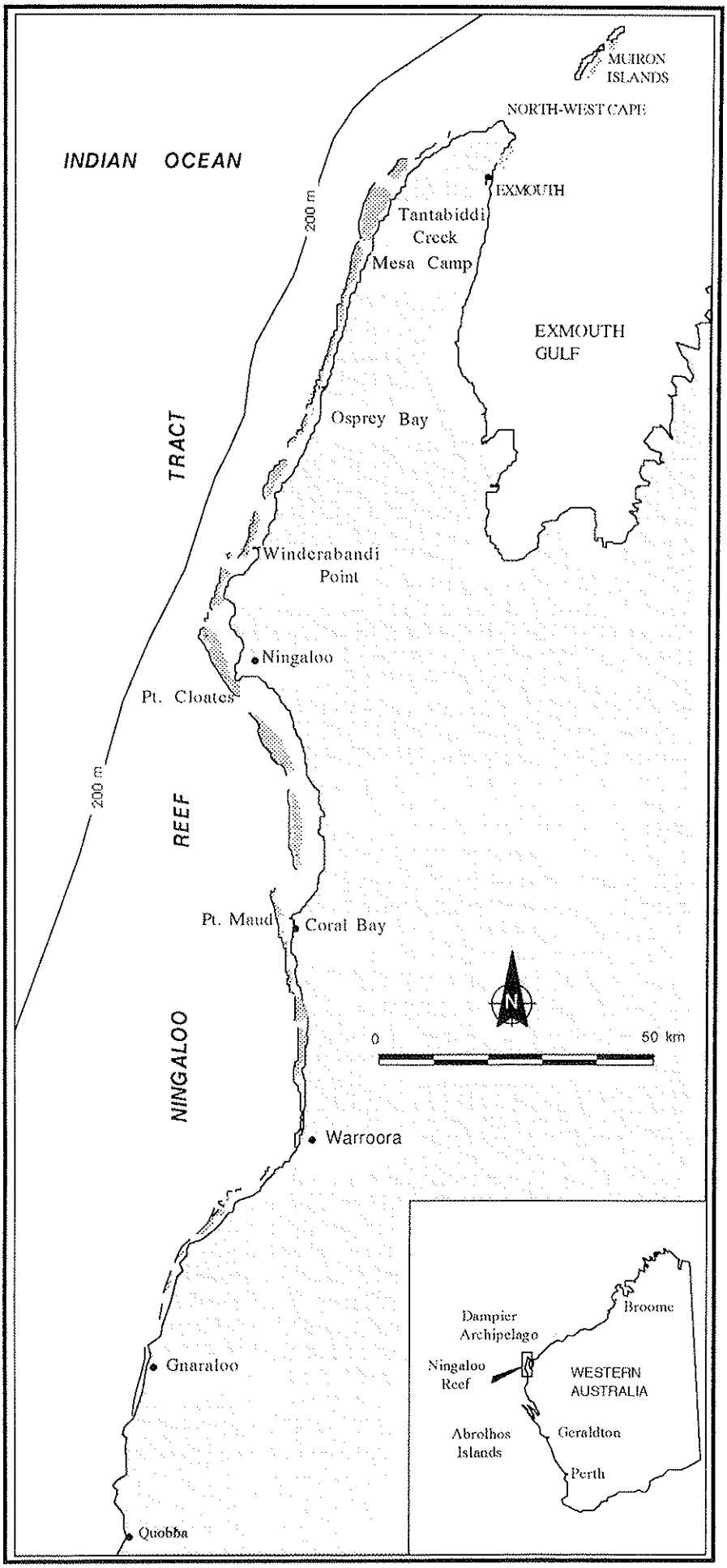

Figure 1. The Ningaloo Reef Tract of Western Australia

backreef. Dead standing *Acropora* accounted for up to 91% of the reef cover at some sites.

Earlier observations made by myself and A. M. and A. L. Ayling (1987) had indicated that the northern section of Ningaloo Reef had been most affected by *Drupella* with evidence of a southerly spread of abundant *Drupella* populations. For the broad scale of assessment of the backreef, the 17 sites surveyed south of Winderabandi Point to Coral Bay and the 17 transects north to Neds Camp were grouped and compared with the Bundegi Reef data.

The mean *Drupella* densities from the northern and Bundegi Reef areas were low, being 2.6 and 2.9 *Drupella* m^{-2} respectively, while in the south the mean was 6.7 *Drupella* m^{-2}. Live coral cover was, however, very high at Bundegi averaging 76%, and considerably higher in the south, at about 35%, than to the north where the mean was less than 15%. When *Drupella* numbers were compared to live coral cover, both Ningaloo backreef densities were about 18 *Drupella* m^{-2} live coral, while the Bundegi Reef densities were about 3.3 *Drupella* m^{-2} live coral.

Population densities throughout the study area ranged from 0 to 24 *Drupella* m^{-2}, a figure comparable to the maximum densities of 20 *Drupella* m^{-2} encountered by Fujioka and Yamazato (1983) at Okinawa, Japan.

Due to adverse weather conditions, only limited access could be gained to the forereef during the regional survey. However, during the course of research, observations of that habitat have been made. *Drupella* have been found in various abundances at all forereef sites examined, which supported coral, to a depth of 20m.

One aspect of the regional study was that recruits or juveniles were not located from Bundegi Reef and only low numbers were found on the Ningaloo Reef. Other research, in part aimed at locating juveniles, has also failed to find juveniles at Bundegi, while large numbers have been located from Ningaloo Reef areas.

HABITATS

One aspect of *Drupella* biology crucial to studies on the Ningaloo Reef and not addressed within the literature, was the habitat selection of the recruit and juvenile stages of the whelk. The adults, although often cryptic, are usually located by the feeding scars they leave. On the Ningaloo Reef they are found individually, in small groups or in aggregations of up to 300 individuals. Feeding scars are most often found on corals of the genera *Acropora* and *Montipora* with less common occurrences on *Porites* and *Galaxea* and very rarely on members of the family Faviidae. These are the same coral genera preferred by *Drupella* on the coral reefs of Okinawa (Fujioka and Yamazato, 1983). Recruits also feed upon corals and were also located by feeding scars. These were distinctive, in that only a small number of branches were freshly scarred, while dead branches from earlier predation showed distinct weathering zonation over a small area, indicating a very slow rate of predation. Recruits ranged in total length from 2.2mm to about 22mm, and were almost exclusively found on digitate *Acropora* species. Whelks of this class size and of 28 to 40mm were generally found, but intermediate sized whelks were rare. One aim of the research done in 1990 was locating the missing size class between the sedentary juveniles and the large adults. These were again located by

distinctive feeding scars. Corals were found with scarring similar to that made by recruits, but with low or non-existent recruit populations. Searching of adjacent reef recesses and under rubble located aggregations of clean-shelled *Drupella*, ranging from about 20 to 30mm. *Drupella cornus* life strategy appears therefore, to involve a planktonic veliger stage (S. Turner, pers. comm.), followed by selective settlement in digitate corals where they live until outgrowth of the inter-branch space. They then form external aggregations still feeding upon the host coral before becoming free ranging adults.

BEHAVIOUR

Experiments were conducted to appraise the social and feeding behaviours of adult *Drupella*. All the members of a feeding aggregation were collected and sexed to determine whether sexual bias was responsible for observed aggregations. Of the 197 individuals collected, 99 were female and 98 male. Other aggregations were collected, marked with enamel paint and placed on digitate corals, both undamaged and under predation, while pre-existing *Drupella* were removed. The marked *Drupella* failed to attack the pristine corals, but did feed on the damaged corals. Over 5 days the number of tagged *Drupella* on each of 6 heads under predation varied, and un-tagged whelks were also found.

The accidental breaking of another adjacent digitate coral resulted in massed *Drupella* on the broken piece the following morning, indicating an attraction to freshly damaged *Acropora*. Subsequently a damage experiment was undertaken on observed preferred and non-preferred coral species. Groups of 5 differently marked *Drupella* were placed 10, 20, 50 and 100cm from 6 pieces of broken *Acropora*. Two further groups of similarly marked snails were placed at the same distance from undamaged colonies as controls. Over 92% of the snails placed 10cm from the broken corals were found the following morning clustered upon them, while the numbers tailed off to about 12% of the animals placed 100cm from the broken corals. One such coral was found with 37 untagged *Drupella* clustered over it the next morning, which must have come from more than 1m away. The controls were untouched.

A complimentary experiment on non-preferred coral species was undertaken synchronously. Twenty-five marked snails were placed adjacent to 10 undamaged Faviid corals and to 10 corals of the same species damaged by a hammer and chisel. The following morning there were neither *Drupella* affixed to the corals nor were feeding scars apparent. The majority of the snails had not moved from their release site.

Further movement studies were undertaken on feeding aggregations. Whole aggregations of between 150 and 200 individuals were collected, painted and placed under a dead tabular *Acropora*, a live tabular *Acropora* under predation, and a live undamaged *Acropora*. Any pre-existing *Drupella* were removed. Overnight the majority of the tagged snails were within 30cm of the release point. Only at the undamaged coral was there any considerable movement, with 5 marked snails located on a broken piece of coral, with 32 unmarked *Drupella*, 2.1m from the release point. Over 7 days there was slow dispersion from all 3 groups. The coral under predation had a dynamic population of *Drupella* with increasingly unmarked numbers appearing, and tagged members found on other predated corals. Inspection of the 3 release points, 3 months later found the partially eaten coral completely killed and the undamaged coral still undamaged. Twenty-seven marked

Drupella were found still alive under the dead coral, apparently not having moved over the period.

Aggregations of *Drupella cornus* are, therefore dynamic assemblies apparently attracted to mucous or other secretions from damaged *Acropora*. These secretions from the polyps adjacent to the freshly eaten coral probably provide the stimulus to continue feeding along a front when *Drupella* usually shelter during the day.

A further behavioural mode which has been observed on the backreefs of Ningaloo Reef are of *Drupella* feeding on corals other than the preferred species and in exposed feeding positions during the day. These coral have included *Fungia* sp., *Goniastrea* sp., *Platygyra* sp., *Echinopora* sp., and *Stylophora* sp.. On these occasions *Drupella* are very obvious feeding both day and night contrary to reports from other locations. This behaviour has resulted in the extremely low live coral cover found between Neds Camp and Osprey Bay.

EFFECTS

Drupella have had obvious and widespread effects upon the backreef communities on Ningaloo Reef. The northern third of the reef has had most of the *Acropora* species killed. The change in feeding mode from the preferred host species to almost all scleractinian corals is contrary to the hypothesis of Moyer et al. (1982) that the "weeding out" of fast-growing species provides space and enhances coral diversity. Some of the *Acropora hyacinthus* colonies eaten have exceeded 3m diameter and *Porites* of up to 1m diameter have been found dead, presumably from *Drupella* predation. Extrapolating from Simpson's (1988) studies of coral growth rates at the Dampier Archipelago, these corals would be in the order of 20 and 35 years old respectively.

The complete predation of all such tabular corals in some areas of the reef indicates that this phenomenon has not occurred in these areas over at least the last 20 years. The commencement of the out-break of *Drupella* on the Ningaloo Reef was not observed, and indications of recovery of the northern areas are now becoming apparent (K. Nardi, pers comm., 1989; K. Holborn, pers comm., 1991). However, evidence of secondary outbreaks have been found on other areas of the northern backreef. Digitate *Acropora* species appear to be among early reef colonisers, and also provide habitats for recruiting *Drupella*.

Large sections of the forereef of the Ningaloo Reef are presently without live or dead standing coral cover, while other similar areas have luxuriant coral cover. An earlier *Drupella* phenomenon could have caused these bare areas, as *Acanthaster planci* have been postulated as causing the bare substrates of Sailfish Reef in the Dampier Archipelago (Simpson and Grey, 1989).

Finally, whereas Bundegi Reef supports a population of very large adults with no juvenile aggregations, the Muiron Islands appear to support large numbers of juveniles and low numbers of adults. Cursory observations in April 1991 of the protected reefs of the Muiron Islands revealed large numbers of coral heads "infected" with *Drupella* recruits. One such coral head collected contained 120 recruits. This may be the beginning of an outbreak similar to that which has occurred on the Ningaloo Reef.

REFERENCES

Ayling A. M. and A. L. Ayling. 1987. Ningaloo Marine Park: Preliminary fish density assessment and habitat survey. Unpub. report for the Department of Conservation and Land Management, Western Australia.

Fujioka Y. and K Yamazato. 1983. Host selection of some Okinawan coral associated gastropods belonging to the genera *Drupella, Coralliophila* and *Quoyula. Galaxea*, 2: 59-73.

Moyer J. T., W. K. Emerson and M. Ross. 1982. Massive destruction of scleractinian corals by the muricid gastropod, *Drupella* in Japan and the Philippines. *The Nautilus* 96, 69-82.

Simpson C. J. 1987. Ecology of scleractinian corals in the Dampier Archipelago, Western Australia. Environmental Protection Authority, Perth. Technical Series No 23. 238pp.

Simpson C. J. and K. A. Grey. 1989. Survey of Crown-of-thorns starfish and coral communities in the Dampier Archipelago, Western Australia. Environmental Protection Authority, Perth. Technical Series No 25. 24pp.