

# ***Drupella*: Coral Predator Thresholds for Ningaloo Reef**

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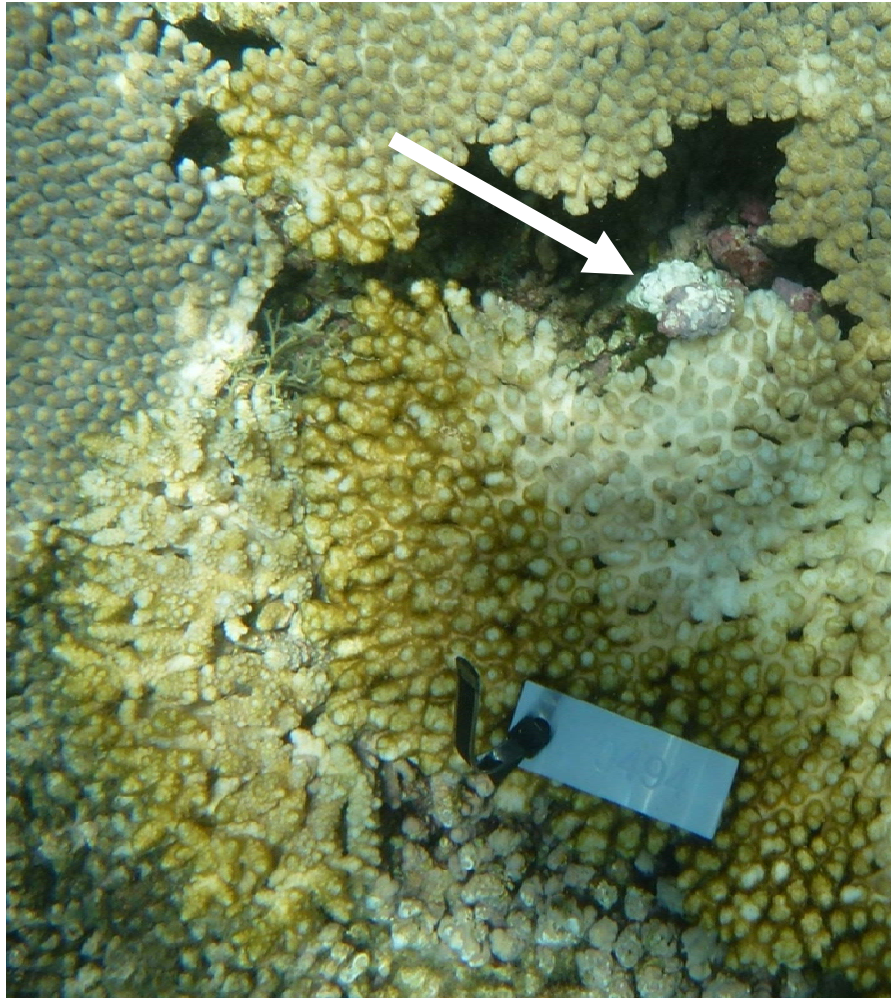
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# *Drupella*: A Coral Predator



- Marine gastropod  
Phylum – Mollusca  
Class – Gastropoda  
Family – Murcidae  
Genus – *Drupella* (Thiele 1925)
- Widespread in shallow waters of the Indo-Pacific
- Prey almost exclusively on living coral tissues (Turner 1994)
- Feed day and night on coral at Ningaloo Reef (Forde 1992)
- Feed at interface between live and dead corallites; attraction to damaged coral (Forde 1992)
- Strong preference for acroporids (Turner 1994)





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# Importance: Potential Outbreaks



- Outbreaks associated with death of coral
  - 1982: *D. fragum* in Japan  
densities up to  $5.12/m^2$   
(Moyer et al. 1982; Fujioka & Yamazato 1983)
  - 1987: *D. cornus* in Ningaloo  
densities up to  $19.4/m^2$   
high coral mortality  
75% reduction in coral cover  
(Ayling & Ayling 1987, Turner 1994)
  - mid 1990: *D. cornus* in Red Sea  
densities up to  $12.24/m^2$   
killed most coral colonies on reef  
(Shafir 2008, Antonius & Reigl 1997, Moghrabi 1997; Loya & gur 1996)
- Corals build basic structure of reef  
providing habitat for reef organisms





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# Aim: Determine *Drupella* Thresholds for Ningaloo Reef



- **Step 1:** Determine *Drupella* feeding rates on *Acropora spicifera*
  - Obtain consumption rate from colonies with active *Drupella* feeding:  
 $\text{cm}^2 / \text{average individual} / \text{day}$
- **Step 2:** Determine *Acropora spicifera* growth rates
  - Obtain growth rate from healthy coral colonies:  
 $\text{cm}^2 / \text{day}$
- **Step 3:** Determine *Drupella* thresholds for Ningaloo Reef
  - Combine *Drupella* feeding rates with coral growth rates
  - Obtain maximum sustainable density of *Drupella* (i.e. maintain net coral growth)



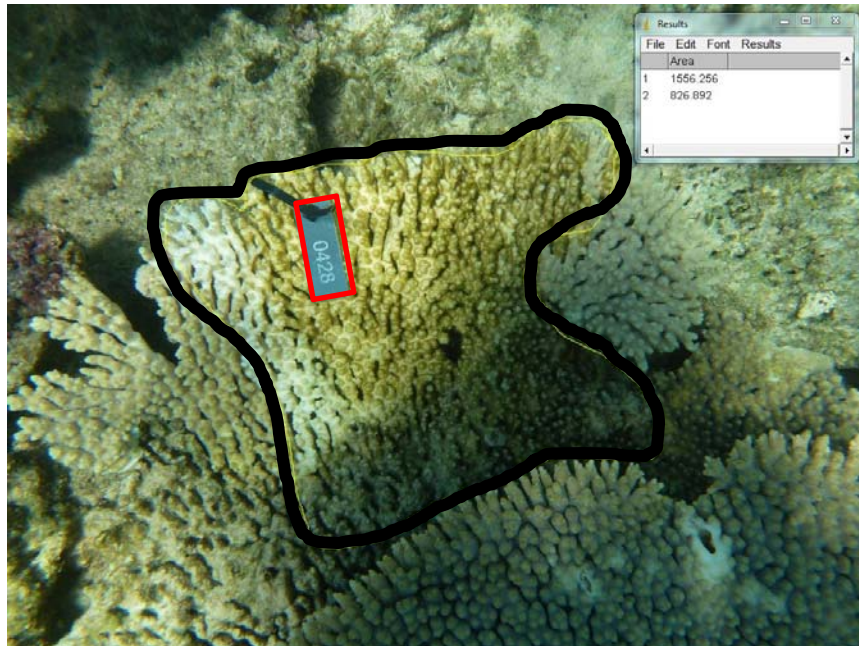


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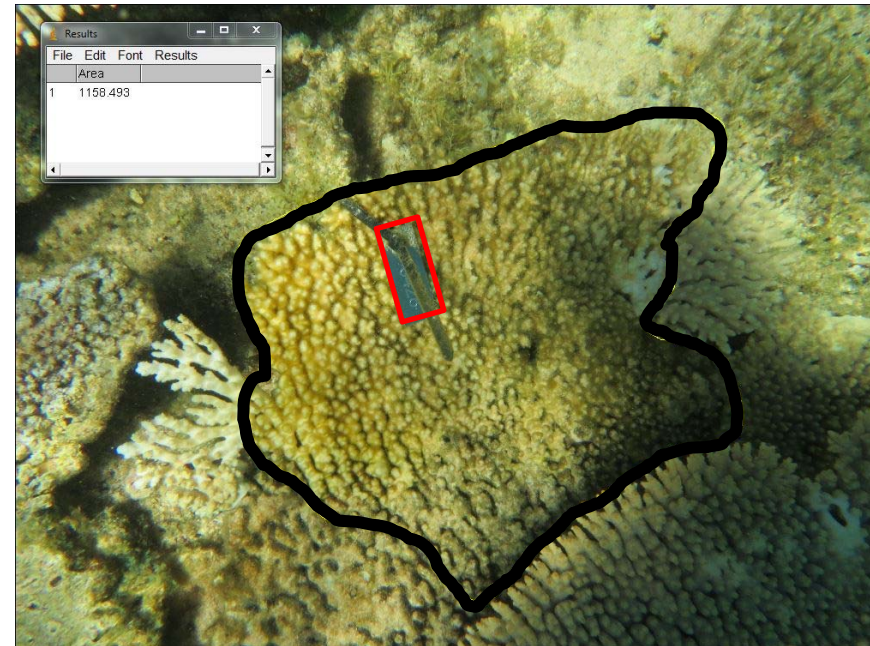
# Methods: *Drupella* Feeding Rates



Colony 428 - Dead Tissue Time 1: 827cm<sup>2</sup>



Colony 428 - Dead Tissue Time 2: 1158cm<sup>2</sup>



Count *Drupella* at Time 2: 3 x 25mm, 10 x 30mm, 5 x 35mm

Tag (8cm x 3cm) acts as a scale bar to standardize area by pixels

Method error ( $\pm 12\%$ ); average difference between 2 observers calculating areas





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# Results: *Drupella* Feeding Rates



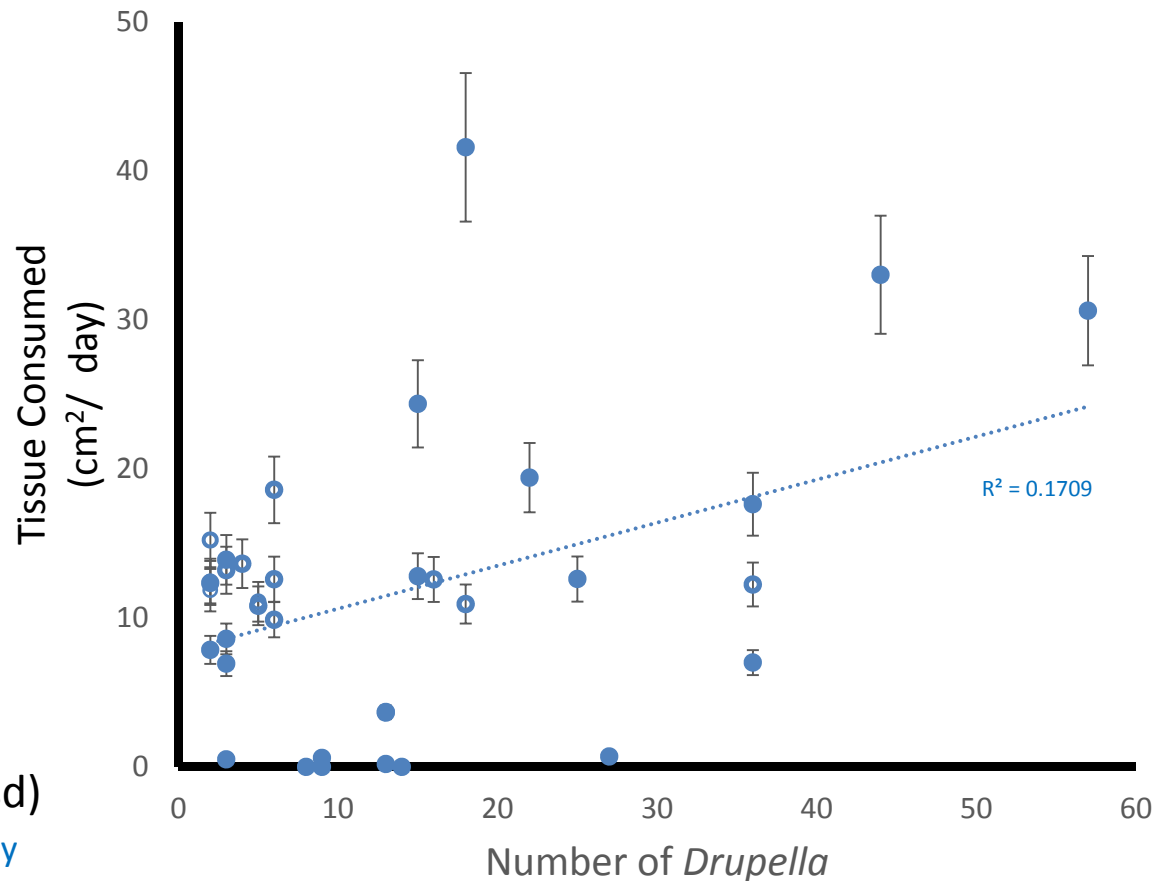
- $n = 36$ 
  - 10 days in Oct/Nov 2014 (n=21 colonies) ●
  - 10 days in March 2016 (n=15 colonies) ○

- Mean size of *Drupella* ( $\pm$ sd)
  - $34 \pm 3$ mm (n=789 individuals)

- Consumption Rate =

$$\frac{\text{Tissue consumed}_i \text{ (cm}^2\text{)} / 10 \text{ days}}{\# \text{ of } Drupella_i * \text{Average Length}_i \text{ (mm)}} \\ \text{Mean Length all } Drupella \text{ (mm)}$$

- Mean consumption rate ( $\pm$ sd)
  - $1.9 \pm 2.2$ cm<sup>2</sup> / 34mm individual / day





# Results: *Drupella* Feeding Rate Comparisons

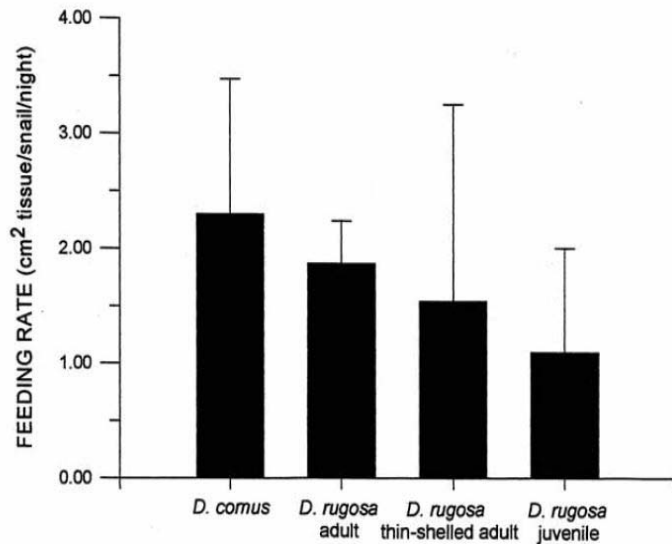


Figure 19. Mean feeding rates of each *Drupella* type, over all trials, as shown in Table 5. Vertical bars are 95 per cent confidence intervals.

- Mean consumption rate:
  - this study :  $1.9 \pm 2.2 \text{ cm}^2 / 34 \text{ mm individual} / \text{day}$
  - previous aquaria study :  $1.8 \text{ cm}^2 / \text{snail} / \text{night}$  ; 28-35mm for *D.cornus* (Cumming 2009)

Date	Species	Type	Prey species	# Snails	# Nights	cm <sup>2</sup> tissue/snail/night
Aug 1994	<i>D. rugosa</i>	adult	<i>A. nasuta</i>	5	7	2.11, 2.31
	<i>D. rugosa</i>	adult	<i>A. valida</i>	5	7	3.83, 1.94
	<i>D. rugosa</i>	adult	<i>S. pistillata</i>	5	7	2.11, 2.41
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	5	7	1.76, 1.89
	<i>D. rugosa</i>	thin-shelled adult	<i>A. microphthalma</i>	5	7	1.73, 0.77
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	15	7	1.31, 1.28
Feb 1994	<i>D. rugosa</i>	thin-shelled adult	<i>A. microphthalma</i>	10	17	2.11
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	10	17	2.09
	<i>D. rugosa</i>	adult	<i>A. elseyi</i>	10	3	3.03, 2.27
	<i>D. rugosa</i>	juvenile	<i>A. microphthalma</i>	10	7	1.44, 0.91
Oct 1993	<i>D. cornus</i>	adult	<i>A. microphthalma</i>	10	7	3.36, 2.24, 1.79
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	10	7	1.59, 1.79, 2.13
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	64	3	2.18
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	81	7	1.48
	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	20	14	1.04
Mar 1993	<i>D. rugosa</i>	adult	<i>A. microphthalma</i>	20	14	1.04
	<i>D. cornus</i>	adult	<i>A. microphthalma</i>	15	14	1.81
Feb 1992	<i>D. rugosa</i>	adult	<i>A. loripes</i>	5	8	2.88, 3.92, 0, 0, 1.02
	<i>D. rugosa</i>	juvenile	<i>A. loripes</i>	5	8	0.375, 1.65
	<i>D. rugosa</i>	adult	<i>A. formosa</i>	10	4	0.775, 1.375



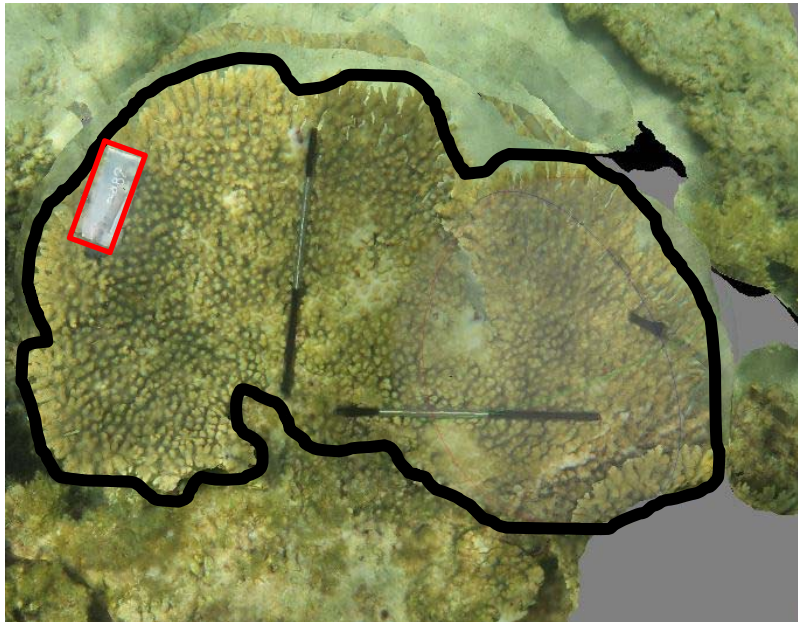


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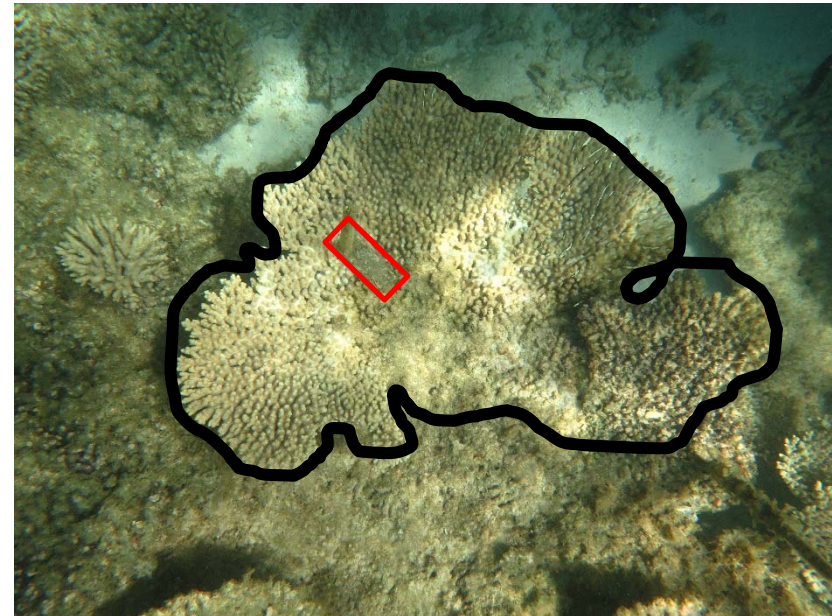
# Methods: Coral Growth



Colony 482 - Live Tissue Time 1: 827cm<sup>2</sup>



Colony 482 - Live Tissue Time 2: 1158cm<sup>2</sup>



Tag (8cm x 3cm) acts as a scale bar to standardize area by pixels  
Method error ( $\pm 10\%$ ); average difference between 2 observers calculating areas







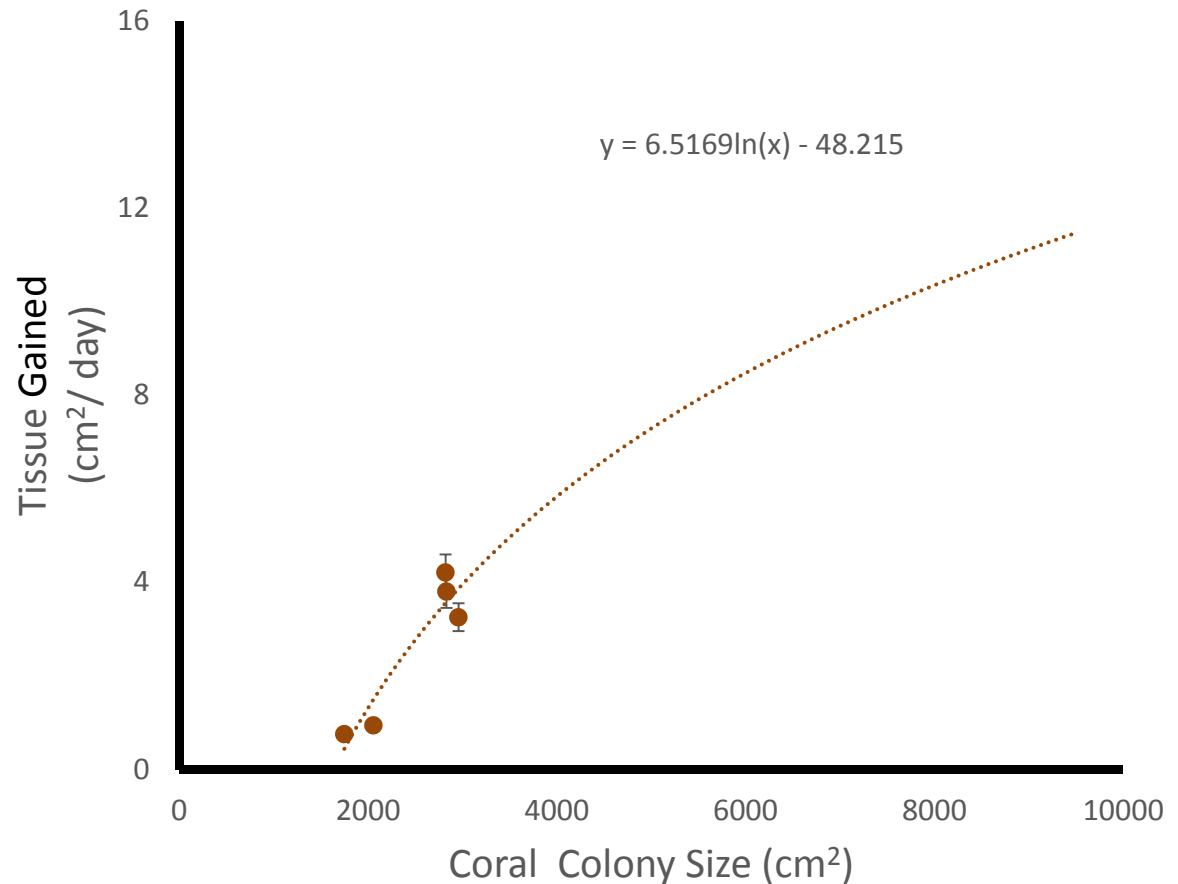
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# Results: Coral Growth



- $n = 8$ 
  - Photographed 4/11/2014
  - Rephotographed 8/3/2016
- Mean size of coral displaying growth ( $n=5$ )
  - $2483 \pm 243 \text{ cm}^2$
- Some corals showed no growth or tissue loss ( $n=3$ )
  - $-3.7 \pm 3.9 \text{ cm}^2 / \text{day}$
- Maximum growth at 100% cover ( $1\text{m}^2=10,000\text{cm}^2$ )
  - $11.8 \text{ cm}^2 / \text{day}$

More colonies needed; 15 currently tagged for analysis



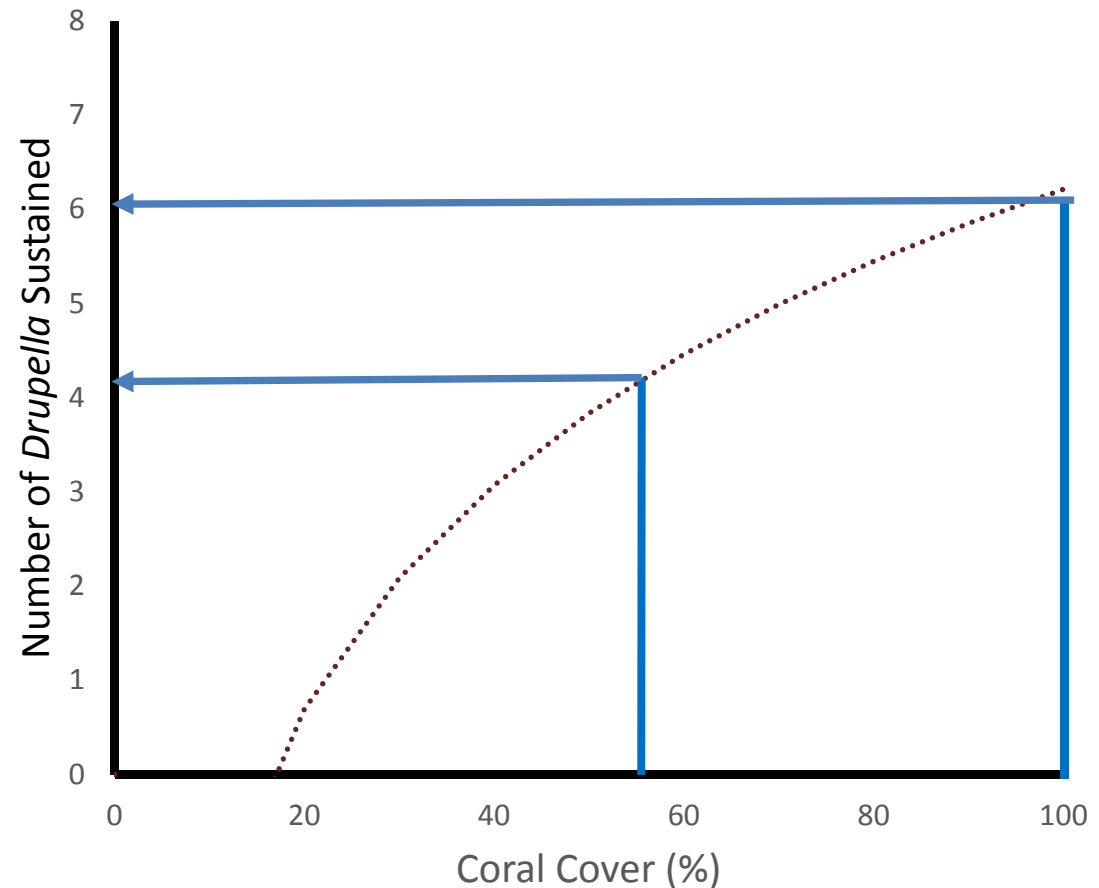


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# Goal: *Drupella* Thresholds



- Growth curve used to determined number of *Drupella* sustained
- Tissue gained cm<sup>2</sup>/day  
Consumption rate cm<sup>2</sup>/snail/day  
(1.9 ± 2.2cm<sup>2</sup> / 34mm individual / day)
- 100% coral cover could sustain 6.2 average sized *Drupella* / m<sup>2</sup>
- Coral cover at Mandu for 2015 (min, mean, max)  
Lagoon (0, 14%, 46%)  
Reef Flat (0, 15%, 55%)
- 55% coral cover could sustain 4.2 average sized *Drupella* / m<sup>2</sup>





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# Continued Progress

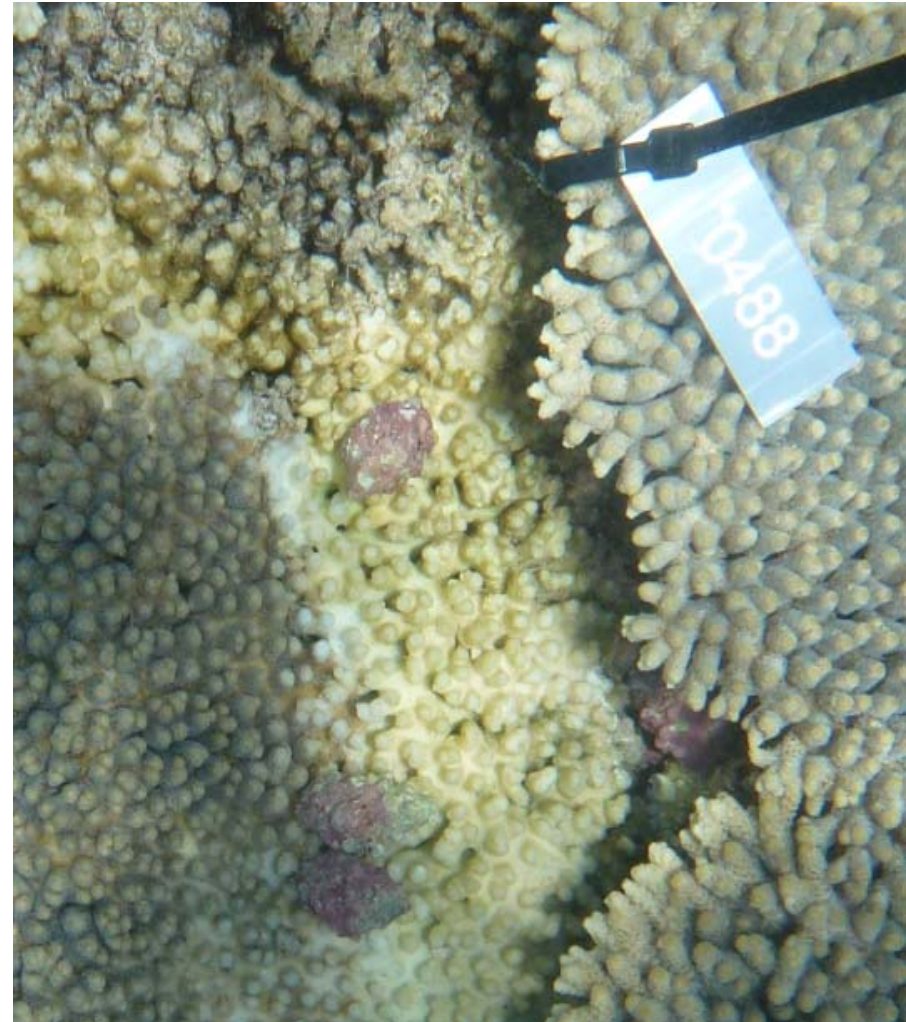


Mean *Drupella* consumption rates  
=  $1.9 \pm 2.2$  cm<sup>2</sup>/ average individual / day  
\*explore our data for average *Drupella*  
densities and compare to other studies

Specific *Acropora* growth rates

\*more growth data required

\*incorporate data from 15 currently  
tagged colonies





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# Acknowledgements



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