GROWTH RATES OF *DRUPELLA CORNUS*

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BACKGROUND

The outbreak of *Drupella cornus* at Ningaloo Reef highlighted our ignorance of basic aspects of the population structure and dynamics of this species. As pointed out by Moran (1986) about the studies of the outbreaks of the crown-of-thorns starfish, field data on growth, mortality and longevity are critically important aspects which reveal the temporal scale of events in these populations; so far, these kinds of data exist neither for the crown-of-thorns starfish nor for *Drupella cornus*. In combination, rates of growth and of mortality give an indication of turnover in the population and therefore an understanding of how rapidly numbers might change.

As far as we can tell, there is no way of directly estimating the age of individual *Drupella cornus*. Like other gastropods, some *Drupella cornus* have growth check marks in the shells but they do not form a regular pattern which could be interpreted, nor is the interval of time between successive marks known. Therefore, we examined the rate of growth of individually marked *Drupella cornus* during a six-month interval during spring and summer at two sites on the backreef, one at Coral Bay where the snails were in an early stage of causing damage and the other at Yardie Creek where the snails had been damaging the corals for some time. Our aims were to determine how variable growth rates were within and between sites and to estimate the relationship between size and age.

MARKING AND MEASURING

Our methods were simple and consisted of capturing, marking, and releasing individual *Drupella cornus* in August 1990, and recapturing them in February 1991 after 6 months. We were unable to randomly sample the population of snails because of the cryptic behaviour of the recruits and juveniles and their use of different microhabitats than the adults. Therefore, our samples of marked snails consisted of recruits and small juveniles removed from individual coral heads and adults collected from aggregations feeding on corals. We marked about 1500 snails (Table 1) using a 4-cornered file to make a deep groove in the heavy shells from the point where the outer lip inserted on the body whorl to the tip of the spire. As the snail grew, the lip advanced along the body whorl past the filed groove. We recaptured about one quarter of the snails at Coral Bay but only about one fifth at Yardie Creek (Table 1). On the recaptured snails, we measured the total length from tip of the spire to the notch of the anterior siphonal canal. The initial length of the snail when it was marked was measured from the tip of the spire to the initial location of the notch of the siphonal canal as judged from the position of the filed groove. This position was often very conspicuous because of a growth check mark associated with the filed groove. Table 2 shows that the presence of check marks was not confined to our marked snails and that the proportions of marked and unmarked snails that failed to grow were similar; we interpret this to indicate that our handling, marking and deployment of snails in the field did not drastically affect their growth.

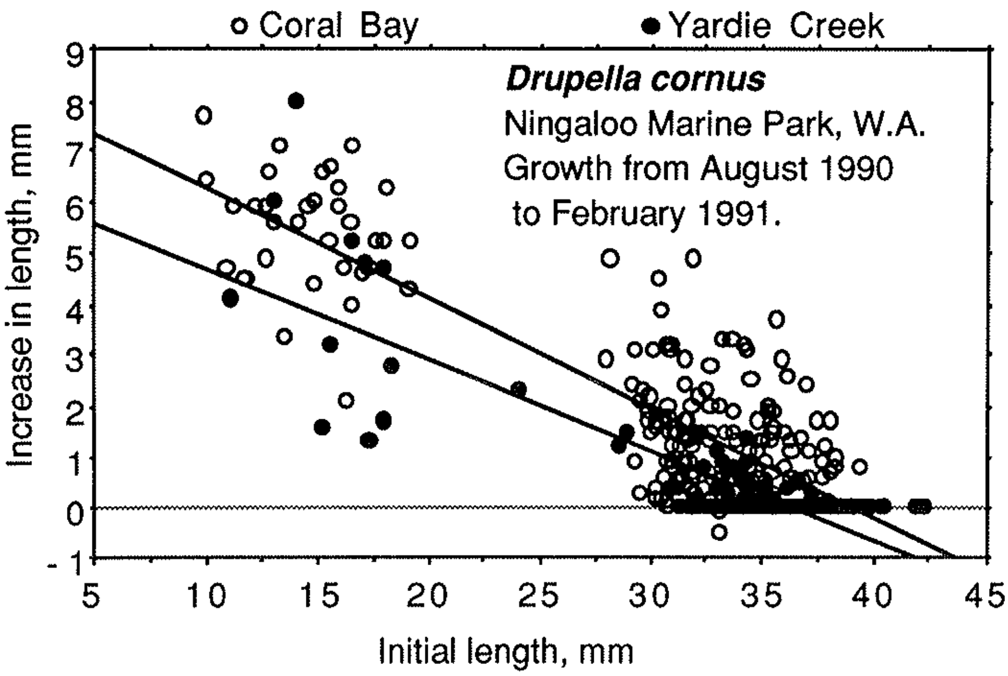

FIGURE 1. Relationship between increase in length (Y in in mm) (final length - initial length) and initial length (in mm) for *Drupella cornus* from Coral Bay ($Y = 8.4 - 0.22X$; $n = 205$; $r^2 = 0.70$) and from Yardie Creek ($Y = 6.5 - 0.18X$; $n = 114$; $r^2 = 0.73$).

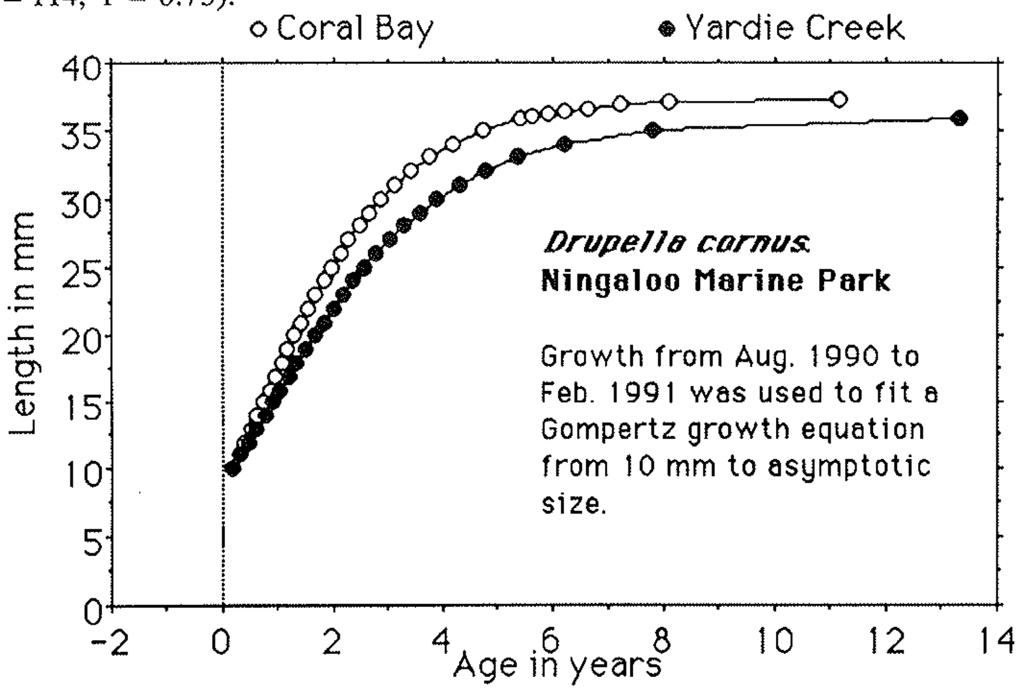

FIGURE 2. Gompertz growth equation ($S = S_{\infty} \exp[-\exp -b(t+t_0)]$) for *Drupella cornus*. Asymptotic sizes were 37.2 and 35.8 mm and b were -0.337 and -0.267 for Coral Bay and Yardie Creek respectively. Years are actually one half the number of 6-month time increments.

GROWTH RATES

Figure 1 is a simple summary of the growth of 205 recaptured snails from Coral Bay and 114 from Yardie Creek; smaller snails increased in length more than larger ones, with size explaining about 70% of the variability in growth; snails larger than 40 mm failed to grow at all; and snails at Coral Bay grew faster than ones at Yardie Creek.

GROWTH CURVE

We used the methods outlined in Kaufmann (1981) to determine which of several growth curves best described our data on *Drupella cornus*; by a small margin our data fitted a Gompertz equation ($S = S_{\infty} \exp[-\exp -b(t+t_0)]$) best. The estimates of the asymptotic lengths (S_{∞}) were 37.2 mm at Coral Bay and 35.8 mm at Yardie Creek and the estimates of b were -0.337 and -0.267 respectively. We used these parameters to derive the size-at-age curves shown in Figure 2 for a snail starting at 10 mm long, the smallest initial size of snail that we recaptured. However, in order to present the ages in years we assumed that the growth rates from August to February were the same as from February to August and the ages in years are actually one half the number of 6 month intervals. If growth over summer to winter is slower than from autumn to summer, these ages will be underestimates. Figure 2 shows that snails would take almost 6 years to grow from 10 mm to their asymptotic size.

Our information about the early life of *Drupella cornus* is fragmentary and comes from the work of others. Dr. Stephanie Turner (pers. comm.) suggested that from egg to 15 mm snail might take about 1 year. Michael Forde (pers. comm.) observed 5 snails grow from 10 to 15 mm in 2 months in summer. Once the time taken to grow to 10 mm is known, the curves of Figure 2 can be shifted right along the x-axis by the appropriate amount.

SURVIVORSHIP

We released marked snails on semi-isolated coral bommies and searched these and the immediate surroundings intensively to recapture marked snails. However, *Drupella cornus* can and do move about (Michael Forde pers. comm.), so it is unclear to what extent our rates of recapture (Table 1) reflect mortality or mortality plus emigration. If our 25% recovery of marked snails after 6 months were indicative of actual rates of survival, 1000 snails would be reduced to 1 in 2.5 years. This is a minimal estimate and seems excessively low in the light of our observations of apparently low abundance of recruits and juveniles, continued abundance of adult snails, and relatively low rate of growth We were unable to use information from changes in size frequency distributions to estimate rates of mortality because of our inability to obtain random samples of the population.

CONCLUSIONS

In 6 months, 10 mm long*Drupella cornus* can increase in size by 5 to 6 mm but 30 mm long snails increase by only 1 to 2 mm; variability of rates of growth are associated with differences among individuals, initial length and sites. Based on a fit to a growth curve, *Drupella cornus* at Ningaloo Marine Park would take about 5 to 6 years to reach the mean size of adult snail. Our information about rates of mortality are insufficient for an accurate estimate turnover time in these populations. Nevertheless, based on modal sizes of adults, which cause conspicuous damage to the reef, the individuals causing the most damage are about 5 or 6 years old, with an expedted further life of an additional 2 years.

ACKNOWLEDGEMENTS

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TABLE 1. Individually marked and recaptured *Drupella cornus* at two sites in Ningaloo Marine Park.

	Coral Bay early infestation		Yardie Creek established infestation	
	Marked in August	Recovered in February	Marked in August	Recovered in February
Adults				
numbers	~614	175	479	102
percentage		~29		21
Juveniles:				
numbers	326	69	113	13
percentage		21		12
Total:				
numbers	~940	244	592	115
percentage		~26		19

TABLE 2. Indication of lack of handling and marking effect on *Drupella cornus* at Coral Bay as judged by incidence of check marks associated with marking snails.

	Numbers of: Marked snails		Unmarked snails	
	Check mark	No check mark	Check mark	No check mark
Recent growth	85	29	21	5
No recent growth	0	22	0	37

Comparison of the two 2 x 2 contingency tables (Pielou 1974):

$$\chi^2 = 3.3, 1 \text{ df}, p = 0.07$$