SUMMARY OF *DRUPELLA* WORKSHOP

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INTRODUCTION

Barry Wilson presented a challenge by asking, Is research necessary? His enthusiastic affirmative answer was an appeal to establish for *Drupella cornus* at Ningaloo Marine Park what were the range, frequency and amplitude of events associated with this coral-eating gastropod. Furthermore, he warned us about speculations and suggested that we approach three sets of questions. First, what is happening now to *Drupella cornus* and the corals at Ningaloo Marine Park, will the reef regrow, and will it have the same species of corals? Second, will the the dramatic increase in abundance of *Drupella cornus* happen again and if so how often? Finally, can we prevent future outbreaks of *Drupella cornus,* and if so, should we? The rest of the papers and discussions did not answer the questions but went some way to providing some of the information to show the way ahead. This account is our attempt to summarize what the workshop revealed about *Drupella cornus*; the names in parentheses refer to the authors of presentations at the workshop.

TAXONOMY

The taxonomic status of *Drupella cornus* is not straightforward, but Wilson is convinced that there are only two species of coral-eating muricid in the genus *Drupella* involved in the outbreaks damaging corals in Australia: *Drupella cornus*, involved in the damage to Ningaloo Marine Park (Wilson, Forde, Osborne), and *Drupella rugosa,* which is most abundant on Queensland reefs (Ayling). Furthermore, the genetical analyses (Johnson, Holborn and Black) indicated that there was only one species involved in the outbreak population at Ningaloo Marine Park.

THE OUTBREAKS

Drupella cornus have long been known to occur in Western Australia as far south as the Abrolhos Islands, but what is new is their great abundance in some local areas (Wilson). At Ningaloo Marine Park, the back reef is the habitat where these snails have been destroying the coral. The history of this outbreak of *Drupella cornus* at Ningaloo Marine Park seems to be as follows (Osborne). There was no record of massive aggregations of snails in the records of expediditons by the W.A. Museum in 1976 to 1980. First reports were from Coral Bay in 1982 and by 1985 "infestation" was a term used about the snails. Surveys in 1987 (Ayling and Ayling 1987), 1989 (CALM) and 1991 (Osborne) have revealed an abundance of *Drupella cornus* all along Ningaloo Marine Park, with densities in 1991 highest in the south at Pelican Point and Coral Bay, in the centre at Lefroy Bay and in the north at Tantabiddi. Furthermore, the occurrence of abundant *Drupella cornus* seems to be spreading.

Large numbers of recruits in digitate corals, but no adults, were observed at the Muiron Islands in April 1991 (Forde) and could be interpreted to be the beginning of a new outbreak. At even greater diatances from Ningaloo, increases in abundance of *Drupella* have been observed in permanent quadrats between Serrurier Island and Mermaid Sound (Hilliard). Although some of the quadrats were established before *Drupella cornus* was recognized as a pest, others were set up more recently, and for all quadrats in recent years special attention has been made to recording the snail and the kind of damage it produces. At the Lowendahl Islands there has been a steady increase in the number of sites where *Drupella cornus* occurs, in their abundance at each site and in the amount of damaged coral at the site (30% decrease in coral in 6 months) (Hilliard).

In northern Queensland, damage by *Drupella* is now also recognized as being widespread (Ayling). A survey of almost 100 reefs, revealed a gradient in the proportion of the coral colonies being grazed from 26% at 14° to <1% at 20°S. Although both species of *Drupella* occurred at these sites, *D. rugosa* was the most abundant (Ayling), a pattern also found at Lizard Island (Cumming) where 8 to 10% of the acroporans and pocilloporans were infested with snails.

LIFE HISTORY OF *DRUPELLA CORNUS* AT NINGALOO REEF

An amalgamation of several studies provides a reasonably clear picture of the life history of *Drupella cornus* at Ningaloo Marine Park. Histological examination of gonads of snails revealed that animals could be ripe and spent at various times of the year but there is no information appropriate to determine the length of the reproductive cycle (Nardi). However, so far female snails have laid eggs encased in capsules in the laboratory only in July to October (Turner) and egg capsules have been found in the field at this time as well (Turner). Captive females can produce up to 115 capsules containing between 300 to 1400 eggs. Free-living veliger larvae with 1.5 whorls in the protochonch hatch from the capsules after about 30 days and, in the laboratory, spend 2 days swimming actively at the surface before descending to the bottom of the containers where they feed and live without metamorphosing for at least one month (Turner). The smallest recruits found in the field have 4 whorls in the protochonch; based on laboratory growth rates they would take about 2 to 3 months after hatching to grow that large (Turner).

Although the length of larval life remains unknown, these observations indicate that there is the potential for substantial connections among populations provided by the dispersal of planktonic larvae. An electrophoretic study of enzyme variation at 10 polymorphic loci provided an indirect approach to understanding dispersal where direct study of larvae and recruitment were impossible (Johnson, Holborn and Black). The genetic similarities among adult populations of *Drupella cornus* are consistent with extensive gene flow. There is no evidence of different genetic groups related to habitat, stage of infestation, or geography over more than 1100 km. Extensive dispersal appears to be the norm for this snail. However, this does not necessarily mean that there is no local recruitment associated with the outbreak at Ninagloo Marine Park. Consistent with the possibility of such local recruitment is the finding of greater genetic subdivision among outbreak populations than among non-outbreak populations (Johnson, Holborn and Black). There is also fine-scale heterogeneity of recruits, but that is not evidence for subdivision of populations. Instead, it indicates that the process of recruitment is patchy, and very likely involves settlement of aggregated groups of larvae (Johnson, Holborn and Black).

Very small recruits appear in the field in Feburary (Turner). The smallest recruits occur in digitate acroporans where they remain and feed on the coral until they reach about 20mm long (Forde). Corals with these recruits are evident because of the feeding damage made by the snails. Snails larger than 20mm tend to move to the base of the coral and to the rubble beneath and they remain cryptic until they reach 25mm in length, when presumably they join aggregations of adults snails larger than 25mm (Forde). As judged by the size distributions of snails in coral heads at different times of the year, the best estimate of the size at 1 year of age is about 10 to 15mm long (Turner).

Estimates of size-at-age derived from a fit to a Gompertz growth equation from marked snails recaptured after 6 months predicted that a 10 mm snail should grow to an asympototic size of about 37 mm at Coral Bay in about 5 to 6 years (6 to 7 years of age) (Black and Johnson). The modal size of adults at that site is 35mm. The smallest snails with histologically recognizable sexual organs were about 21mm long (Nardi) and therefore probably in their second year of life. Sexually mature snails, with ripe gonads, are at least 25mm long (Nardi), and therefore at least 3 years of age (Black & Johnson).

In the absence of estimates of annual mortality rates, the period of population turnover cannot be determined. Nevertheless, the major destruction of coral in a local outbreak occurs within the span of a single generation of *Drupella cornus*, and the large outbeak populations probably represent few cohorts. The history of the outbreak at Ningaloo Reef and the apparent expansion in the north (Forde, Hilliard) suggest a ripple effect of recruitment from high density populations. The most important question about the biology of these populations appears to be, what determines the success of particular cohorts of recruits?