COTS COMMS

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Welcome and Adieu

The merger of media conglomerates is not an unusual event these days and the economic rationalisation that exists in private enterprise equally pervades public service. Issue #11 of COTS COMMS will be incorporated as a part of the next edition of Reef Research and that arrangement will continue as long as the functional need exists. So to new readers of COTS COMMS - Welcome. To "old" readers - Adieu.

Current COTS

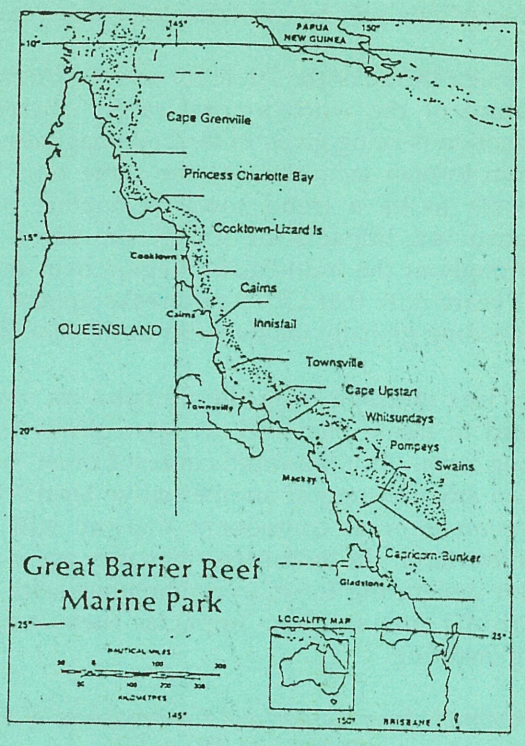
Since the May COTS COMMS, the Australian Institute of Marine Science (AIMS) survey team has visited reefs off Townsville and the Whitsundays. Two reefs surveyed off Townsville (John Brewer and Helix) epitomise the patchiness of recovery of reefs affected by COTS in the mid-1980s. While John Brewer Reef had a noticeable increase in live coral cover since it was surveyed two years ago, Helix Reef showed no appreciable chance in median live or dead coral cover categories since last year.

Eight reefs were surveyed in the Whitsunday region. The outbreak recorded at Hardy Reef last year has declined and there has been no significant change in coral cover. COTS were also observed along the southern flank of Bait Reef suggesting that numbers may have increased on this reef despite ongoing control measures by operators and Q.DEH staff.

User reports of COTS sightings continue to trickle in with large numbers reported on reefs in the Far North Section (Sherrard and Chapman Reefs) and in the Swains.

The big picture of COTS on the Great Barrier Reef "Broadscale surveys of crown-of-thorns starfish and corals along the Great Barrier Reef: 1982-1992" by AIMS has just been received by GBRMPA. The Synthesis Report summarises the results of 412 reefs surveyed between October 1982 and June 1992 using the manta tow technique. Key results are:

- About 28% (116) of all reefs surveyed have been affected by outbreaks of starfish in the last 12 years. An estimate for the percentage of reefs, within the whole GBR that have been affected by outbreaks is 17% $\pm$ 4%. This figure is similar to that for the previous year.
- The estimated percentage of reefs with active outbreaks rose from 9.7% in 1985/86 to 15.6% in 1988/89. By the end of 1991/92 the figure had declined to 8.5%.
- Despite the slight increase (ca. 3.3%) in the proportion of surveyed reefs with outbreaks over the last year the data show continued evidence of a slow decline in the activity of the starfish within the GBR. Over the last 3 years the estimated proportion of reefs with outbreaking populations of starfish has been between 5% and 9%.



- Changes in the proportion of reefs (surveyed) affected by outbreaks over the last 7 years show no consistent trend with between 27% and 42% of reefs having either active outbreaks or recovering from recent outbreaks.

- A total of 10 reefs were recorded to have outbreaks during the 1991/92 fiscal period. Four of these were found on reefs in the Swain Complex.
- There is some evidence to suggest that the GBR system is beginning to recover from outbreaks. Live coral cover has increased slightly (ca. 4%) over the last year to about 27%. On the other hand, dead coral cover has continued to decline and is now at about 3%.

COTS in Focus

Some major international and local events relevant to COTS have transpired since the last issue of COTS COMMS. The 7th International Coral Reef Symposium in Guam (22-26 June 1992) devoted a session to COTS research. A workshop on research dealing with the causes and consequences of COTS was held in Townsville earlier that month. Both sessions demonstrated the significant advances in our understanding of the COTS phenomenon and the major contribution made by Australian researchers. Abstracts of papers presented at the Townsville workshop are reproduced here for those unable to attend. The proceedings will be available later this year.

A major theme of the 7th ICRS was the precarious nature of the world's coral reefs. Increasing attention is being given to direct damage resulting from human activities. At the same time there seems to be a trend towards neglect of the enormous impacts of COTS on coral reefs throughout the Indo-Pacific Region over the last 30 years now that COTS outbreaks appear to be subsiding globally (as they did in the late 1970s).

A clear message from the Symposium was the need to think, plan and act strategically for the long term. In the overall context of reef "health" (can anyone suggest an alternative term?) COTS are an integral component that we still don't understand. In their own right they are a major reef structuring force, in combination with other chronic or sudden impacts they may be devastating.

Abstracts from Causes and Consequences of COTS Outbreaks Workshop

ASSESSMENT OF THE ROLE OF DISSOLVED ORGANIC MATTER AND BACTERIA IN THE NUTRITION OF CROWN-OF-THORNS STARFISH LARVAE.
T. Ayukai and O. Hoegh-Guldberg

Whether resource limitation is important in crown-of-thorns starfish (COTS) larvae has been a matter of controversy. Lucas has suggested that the concentration of phytoplankton in GBR waters is usually too low for COTS larvae to achieve the normal growth and development. In contrast, *in situ* rearing of COTS larvae has shown no evidence of starvation under low phytoplankton conditions common in GBR waters.

Both Lucas and Olson have suggested the possibility that COTS larvae derive their nutrition from resources other than phytoplankton: i.e. dissolved organic matter (DOM) and bacteria. The study of utilization of these two resources by COTS larvae appears to hold the key to compromise the discrepancy between their results. Free-living bacteria are too small to be utilized by COTS larvae. On the other hand, COTS larvae were able to take up dissolved free amino acids (DFAA) that seemingly represent a large proportion of biologically utilizable DOM in seawater. The carbon budget model developed suggests that, even if the contribution of DFAA is taken into account, the starvation of COTS larvae is likely to occur quite commonly in GBR waters.

The feeding rate of zooplankton is generally determined by measuring the change in particle concentration during incubations. This method, however, is time-consuming and not sensitive enough to detect small changes. In this study, the feeding rate of COTS larvae was determined by measuring the accumulation of heat-killed, fluorescence labelled cells (FLC) in the gut of individual larvae after short incubation (< 15 min).

Five different types of FLC were prepared: ie. 2 species of phytoplankton (*Phaeodactylum tricornutum* and *Dunaliella tertiolecta*), 2 species of coccoid cyanobacteria (unidentified and ACMM326, the culture collection of the Sir George Fisher Centre, JCU) and natural bacteria. Free-living bacteria (< 0.8 um) were too small to be ingested by COTS larvae, although utilization of colony-forming and particle-attached bacteria remained to be investigated. COTS larvae were able to utilize cyanobacteria (1 - 2 um). The clearance rates on cyanobacteria, however, were more than one order of magnitude lower than those on larger algae (5 um in equivalent spherical diameter).

The possible carbon intake of COTS larvae from phytoplankton was estimated based on the feeding kinetics measured and the reported values for the phytoplankton concentration in

reef waters. The values estimated ranged between 1.07 - 1.66 ngC ind^{-1} h^{-1} for bipinnaria larvae and between 1.16 - 3.52 ngC ind^{-1} h^{-1} for brachiolaria larvae. The estimated % contribution of phytoplankton to the metabolic requirements of COTS larvae ranged between 46.7 -72.5 % for bipinnaria larvae and between 14.6 - 44.3 % for brachiolaria larvae.

SEASONAL CHANGES IN FERTILITY AND FECUNDITY IN *ACANTHASTER PLANCI*.
R.C. Babcock & C.N. Mundy

Changes in fecundity, measured as gonad index, and fertility, measured as fertilisation rate, were monitored over the recorded spawning season of *A .planci* at Davies Reef on the central Great Barrier Reef from 1990 - 1992. This starfish has been observed spawning in the field from December to February on the GBR, with most observations being made in January. In contrast, both gonad index and fertility peak early in the season, declining to low levels by late January. These observations indicate that the majority of successful reproductive events will take place early in the spawning season, before the onset of the monsoonal wet season. The timing of spawning may need to be considered in evaluating the importance of terrestrial run-off as a possible causal factor in outbreaks on the GBR.

ARE THE HYDRODYNAMICS GUILTY OF CAUSING OR STIMULATING OUTBREAKS OF CROWN-OF-THORNS STARFISH ON THE GREAT BARRIER REEF ?
Kerry Black

Are there causal links between the outbreaks of starfish and the GBR hydrodynamics ? The evidence suggests that hydrodynamics are certainly implicated. Secondary outbreaks appear to be a consequence of larval recruitment from other sources. An initial outbreak seeds the reefs "nearby" causing subsequent outbreaks some 2 - 4 years later. The larval excursion is determined by (i) the current strength during the pelagic phase, (ii) the interaction of the continental shelf coastal currents with the reef-scale circulation, and (iii) the location along and across the shelf of the source of larvae. A 25 - year time series of actual currents in the central GBR confirms that the observed distribution and migration of outbreaks may be simply a response to inter-reef larval exchange, carried by a reversing low frequency current from a reef saturated with spawning adults. However, cyclical behaviour in the outbreaks may yet prove to be related to other ocean-scale factors, eg. longshore oscillations in the point of attachment of the East Australian current. Even, *El Nino* events may play a role.

The cause of initial outbreaks may be far more complex. Do the adult numbers simply build up until a threshold in fertilised larval numbers is exceeded and an outbreak results ? Do hydrodynamics interact to create zones of relatively high recruitment on and around reefs ? Black and Moran have found a link in the latter case. These same zones may also maintain low level populations of adults until a drop in the coastal current strength during the spawning season causes many larvae to be retained, and local recruitment increases dramatically. Several successive years of low currents may be needed to create an "outbreak".

Small-scale tests over distances of metres have clearly shown that the larvae are passive, ie. their swimming speeds and buoyancies are negated by the action of random vertical turbulence in natural currents. Measured negative buoyancies are unlikely to bring larvae to the sea bed. They may, however, help them to attach once they get close.

The paper takes a broad view of cause and effect at a number of physical scales. Much of what we've learned implicates the hydrodynamics. This is hardly surprising as passive larvae undoubtedly find themselves at the whim of the currents. This paper seeks to define the important whims.

THE HISTORY, CURRENT STATUS AND FUTURE POSSIBILITIES OF CONTROLLING CROWN-OF-THORNS STARFISH.
William Gladstone

GBRMPA is planning for the next series of outbreaks of crown-of-thorns starfish by developing a Contingency Plan. An important part of the Contingency Plan is devoted to the feasibility of widespread, primary controls aimed at preventing the southwards spread of outbreaks. This option is being examined in anticipation of demands for such action, given the history of the phenomenon in Australia, the much greater public usage of reefs and the possible disruption of the coral recovery process since the last outbreak. In this talk I will review the history of GBRMPA's policy on controls, the results of past and present controls and reasons for their success or failure. The arguments likely to be raised for widespread controls (including the

causes of outbreaks, recovery since last outbreak, usage of reefs) will be discussed. The feasibility of widespread controls will be examined in terms of costs, possible effectiveness, side effects and alternatives.

LONG TERM RESPONSE OF HERBIVOROUS FISH TO CROWN-OF-THORNS OUTBREAKS.
Tony Hart

This project involves a comparative study of three crown-of-thorns impacted (Grub, Yankee, Dip) and three non-impacted (Centipede, Coil, Bowl) reefs in the Townsville section of the GBR. The specific objectives are to compare: 1) substrate characteristics; 2) density, biomass, and size-structure of selected herbivorous fish species; 3) growth rates; 4) body condition; 5) feeding ecology; 6) size at age, and 7) age at maturity of two species, between impacted and non-impacted reefs. The two species are *Scarus frenatus* (Pisces: Scaridae), and *Acanthurus nigrofuscus* (Pisces: Acanthuridae). Significant differences for both mean live coral cover (14% and 50% at impacted and non-impacted reefs respectively) and mean turf algal cover (52% and 18% at impacted and non-impacted reefs respectively) were found during June 1991 and January 1992. However, no significant differences were found for densities, biomass, feeding rates or body condition. This is largely due to very distinct between reef and cross-shelf patterns for all variates which are confounding the impacted/non-impacted comparison. The study concludes that examining densities of these herbivorous fish is of limited value when trying to detect effects of crown-of-thorns perturbations to the reef substrate. This conclusion is supported by the conflicting results cited in the literature to date. Research will now focus on establishing growth rates, size at age, age at maturity, feeding ecology, and changes in body condition over time, in an attempt to detect a variate which will be more useful in detecting effects of COTS outbreaks.

THE ROLE OF DISSOLVED ORGANIC MATTER (DOM) IN THE NUTRITION OF EMBRYOS AND LARVAE OF *ACANTHASTER PLANCI*.
Ove Hoegh-Guldberg

Dissolved organic matter (DOM) is a ubiquitous and plentiful resource in marine environments. Recent work on temperate and polar larvae has highlighted the potential role of DOM in the energy requirements of larval echinoderms. As part of a broader study aiming to define the nutritional biology of the planktotrophic larvae of *Acanthaster planci*, I examined the role of two important forms of DOM, alanine (neutral amino acid) and glucose (monosaccharide), in the energy requirements of *A. planci* during larval development. Glucose was transported by bipinnaria and brachiolaria, but was characterized by a single low affinity (K_t: 55 - 119 μM) transport system. When compared to the metabolic requirements of larval *A. planci* (measured using indirect calorimetry), transported glucose appears to be relatively unimportant in the diet of larval *A. planci* (contributing less than 3% of total metabolic requirements at substrate concentrations of 5 μM glucose). Data for alanine, however, present a clearly different situation. Alanine transport was characterized by a biphasic system with the combined features of high binding affinity (K_t: 2-3 μM) and high transport capacity (J_{in}^{max}: 400 - 500 pmol $ind^{-1}h^{-1}$). Maximal transport rates for alanine of *A. planci* bipinnaria were approximately 5-6 times higher than those of bipinnaria of similar mass cultured from related temperate starfish. This huge increase in the transport capacity for alanine of larval *A. planci* is unaccounted for by the effect of temperature on rate processes, and suggests that larval *A. planci* have 3 times the number of transport sites for alanine as do temperate relatives. Comparison of alanine transport to larval energy requirements reveals that larval *A. planci* can compensate for the requirements of maintenance and growth at alanine concentrations of approximately 2 μM. These data are discussed in the context of the nutritional biology of larval *A. planci* and preliminary data on the concentration of amino acids in the water column and boundary layers of the Great Barrier Reef.

CONSEQUENCES OF OUTBREAKS: RELATIONSHIPS BETWEEN SPATIAL SCALES OF OUTBREAKS AND TEMPORAL SCALES OF RECOVERY.
Craig Johnson & Ann Preece

Spatial models indicate that recovery of coral cover after damage events depends on large-scale system level properties as well as biological ones. *Monte Carlo* studies showed that the relationship between recovery rate and spatial extent of damage depends on the effective connectivity of the system, which affects availability of larvae for recruitment, and relative magnitudes of larval retention (self-seeding), coral longevity and survivorship of recent pre-damage recruits. Recovery rates (1) may be highly dependent or largely independent of the spatial scale of damage depending on

values of these parameters, and (2) may vary with the intensity of damage per reef. At high reef densities coral recovery rates are sensitive to survival of recent pre-damage recruits if coral longevity is short (30 years), but the degree of self-seeding is relatively unimportant. In contrast, if the density of reefs is low, and there is no self-seeding, coral does not recover at all but either stabilises at reduced coral cover or declines, depending on its average longevity. If reef density is low and there is some larval retention (13% cover over 7 days), then recovery depends largely on survival of pre-damage recruits and coral longevity is less important.

MEASUREMENT OF MORTALITY RATES OF *ACANTHASTER PLANCI.*
John Keesing

Our lack of understanding of the role predators play in influencing population dynamics of *A. planci* and uncertainty about whether variability in predation pressure could influence outbreaks has stimulated research into mortality rates of *A. planci* in the field. The purpose of this talk is to summarise results obtained in the 30 months the project has been underway and to discuss the application of these results to *A. planci* population dynamics.

Field experiments to date have shown that mortality rates of *A. planci* are high (ca. 5 % / day) in the first one or two months following settlement reducing to about 1 % / day at three months of age and stabilising to about 0.5 % / day thereafter. These are preliminary estimates and at this stage more information is needed on how these rates may vary dependent on habitat type and starfish density. Nevertheless some predictions about settlement rates required to initiate outbreaks can be made and the likely importance of predators as a regulating influence on populations can be inferred.

A MANAGEMENT APPROACH TO THE COTS QUESTION.
G. Kelleher

Scientists and managers often view issues from different perspectives. Scientists as a group have traditionally wished to learn more about an issue for the sake of learning, for the sake of testing a hypothesis, for the sake of furthering their careers or for a combination of these reasons. While managers are also curiosity driven, they are usually required to focus their curiosity on those aspects of matters which are vital to the solution of management problems.

From the manager's perspective, the fundamental question to be answered about the COTS phenomenon is whether it has been grossly affected by human activity. On the basis of the answer to that question, the manager will determine his response, particularly whether to interfere in the "natural" system or to refrain from interference. A summary of the logic of this position is as follows:

* we do not understand completely the Great Barrier Reef as a system;
* what we value as the Great Barrier Reef has developed as a result of natural processes which have acted in ways that we do not fully understand;
* recurrent crown-of-thorns starfish infestations may have been one of the natural processes that have structured our existing Great Barrier Reef ;
* we do not know what effect human interference with a crown-of-thorns starfish infestation will have on the Great Barrier Reef system in the medium and long terms;
* therefore, until we know either

    a. that an infestation is likely to have unacceptable immediate effects on the Great Barrier Reef or;
    b. that human interference on a massive scale in a crown-of-thorns starfish infestation will not have adverse effects on the Great Barrier Reef as a system,

then we should refrain from interfering in a major way with that infestation.

A CROWN-OF-THORNS STARFISH CONTINGENCY PLAN.
B. Lassig, W. Gladstone, P. Moran & U. Engelhardt

Two crown-of-thorns starfish outbreak episodes have occurred on the Great Barrier Reef (GBR) during the last 30 years. On both occasions a lack of vital information on the causes, process and pattern of outbreaks contributed to delays in funding that meant it was too late to instigate concerted research efforts to study the causes of primary outbreaks. A review of the Great Barrier Reef Marine Park Authority's crown-of-thorns starfish research program recognised this problem and recommended the establishment of emergency funding and a contingency plan for research to be initiated should future primary outbreaks occur. In the event of another outbreak,

increasing use of the GBR for tourism and recreation is likely to result in demands from users for widespread control efforts. Such demands have characterised both previous outbreaks. Expansion of control efforts beyond attempting to protect sites of particular value to tourism or science would be contrary to current Authority policy which is based on a precautionary management principle not to interfere with what may be a natural phenomenon, together with the extremely high cost and futility of current control techniques. Another outbreak may occur at any time in the future from later this decade into the next century (or beyond). Continued research before the next outbreak may establish anthropogenic influences on outbreaks and/or long-term adverse ecosystem effects of outbreaks (both making widespread controls more desirable) and/or ascertain more efficient and effective control techniques (making widespread controls more feasible). Under such conditions, the benefits of control action may outweigh the associated financial and ecological costs. The Contingency Plan thus takes into account control as well as research options. An effective plan of action in the event of a future outbreak on the GBR hinges on the early detection of outbreaks and the availability of funds. On-going monitoring, with particular emphasis on the suspected source area between Cairns and Cooktown is vital.

ARE CROWN-OF-THORNS POPULATIONS CHAOTIC? WOULD IT MATTER IF THEY WERE ?

Hamish McCallum

The statement that outbreaks of crown-of-thorns starfish are unpredictable, at least in the Northern Section of the Great Barrier Reef, is uncontroversial. This unpredictability may be simply a result of random variation, externally generated by stochastic larval settlement, or it may be generated by the intrinsic dynamics of the interaction between corals, starfish and predators. The suggestion that the population dynamics of the starfish may be intrinsically chaotic has been made a number of times. The life history of the starfish has features that contain the "seeds of chaos": a very high reproductive potential per generation, coupled with over-exploitation of a slowly recovering resource. However, whether the life-history parameters of *Acanthaster* will actually generate chaotic dynamics has not been demonstrated clearly. A model will be presented to address this question.

This paper also explores some of the consequences which would follow if outbreaks were generated by intrinsic dynamics, rather than external variability, and discusses their implications for management, particularly with respect to predation on juvenile starfish.

ACANTHASTER FEEDING ON CORALS: THE CONSEQUENCES FOR BIOEROSION.

B.M. Musso

The secondary consequences of COT outbreaks have rarely been investigated. The present work is concerned with the effects of outbreaks on the process of biological degradation of the reef framework. On reefs that have experienced severe outbreaks, the overall reworking of calcium carbonate by biological agents is expected to be greater than on reefs with high live coral cover. To establish whether the rates of bioerosion per unit area are enhanced on a reef in outbreak condition, and what are the causes and effects of degradation of standing coral skeletons, two research programs have been undertaken. An experimental program consists of simulating COT predation by killing *in situ* coral colonies in restricted areas on the reef crest. Three species of *Acropora*, usually highly preyed upon by *Acanthaster*, have been used. To date, results show that *Acropora hyacinthus* undergoes rapid skeletal degradation by external destructive agents, while skeletons of *A. gemmifera* and *A. cuneata* remain for longer periods exposed to the action of excavating organisms. The surveying program, which involves both COT-affected and unaffected reefs, consists of sampling dead substrates occurring on large *Porites* bommies. These substrates have the advantage of allowing to establish the death time of the coral, and therefore to estimate rates of bioerosion relative to periods of over 30 years. Preliminary results show that the method is a powerful tool for establishing both large scale and disturbance-induced variations in the process of internal bioerosion.

IN SITU REARING OF COTS LARVAE.

Ken Okaji

The *in situ* larval rearing equipment developed by Olson was modified with a series of in-line filters (100 um, 1, 0.2 and Activated Charcoal Filter-ACF) to determine what parameters are most important for the nutrition and survival of *A. planci* larvae. The result of the trial showed that a higher proportion of larvae were ready to settle in 100 um filtered seawater (100 FSW), while a slightly lower proportion were ready to settle in 1 and 0.2 FSW. The larvae reared in ACF

water did not develop beyond early brachiolaria stage. This seemed to suggest that adequate nutrients were available in natural seawater to support larval development. However, assessment of water quality inside the plastic larval chamber revealed that chlorophyll *a* levels of 100, 1 and 0.2 FSW were significantly higher than natural. This indicates that seawater inside the chambers was possibly more nutritious than natural seawater. The elevated chlorophyll *a* level may be due to algal fouling on the wall of the chambers and/or filter system. Environmental parameters, as an index of food availability, needs to be assessed when seeking to relate feeding and nutrition in the study of *A. planci* larvae.

SCIENTIFIC VISUALISATION AND THE LARGE SCALE POPULATION DYNAMICS OF *ACANTHASTER PLANCI.*

James Scandol

Scientific visualisation uses computer generated images with human vision to communicate computer generated data. This approach has been applied to the *Acanthaster* phenomenon on the Great Barrier Reef (GBR). *CotSim* is a population model which enables users to interact with the complex dynamics of simulated *Acanthaster* populations in a multi reef environment. *CotSim* is based upon a size classified density dependent matrix model of *Acanthaster* integrated with a multi species coral model. Larval dispersal is simulated using models of water transport at the time of *Acanthaster* spawning. Users of *CotSim* can modify parameters or starfish densities to note the models response. They can compare space/time distributions of starfish based on different initial populations, or simply be entertained by the stochastic network which distributes *Acanthaster* larvae. *CotSim* uses a unique method of displaying space/time population states on the GBR. Communication of the dynamic processes involved in large scale *Acanthaster* populations is a major objective of this model. It is hoped that the enhanced user/computer interaction will provide improved conceptualisation of large scale population dynamics on the GBR. *CotSim* also aims to facilitate acceptance of the *Acanthaster* larval dispersal simulations.

NATURAL HISTORY OF *ACANTHASTER PLANCI* (L.) ON THE GBR.

Richard Stump

Validation of the spine pigment band method of age determination for *Acanthaster planci* (L.) has been obtained in 3 out of 6 pigment band groups (n = 12) representing years 3+ to 6+. Time series population samples showed a significant positive linear trend in mean arm spine ossicle and pedicel length over 38 months. Pigment band frequency distributions showed that 3 consecutive years of large-scale recruitment occurred between 1984-1986. Assuming the validity of using pigment bands to age other populations putative longevity was 12 years from Lady Musgrave Island. There was no significant difference in slope or elevation of regressions using spine ossicle length and pigment band count for Davies Reef, Hook Island and Lady Musgrave Island despite significant differences in mean population diameter.

Mean body diameter oscillated seasonally due to gametogenesis prior to spawning and decreased significantly throughout the study. Fecundity also decreased significantly with age in both sexes. Individuals which matured prior to the outbreak had significantly larger mean body diameter than the cohorts which developed under outbreak conditions. Von Bertalanffy growth curves were used to describe pre- and post-outbreak groups. Maximum body size is reached soon after maturity so that absolute age cannot be determined from size in adults although longevity may be correlated with size. Modal classes in size frequency distributions appear to represent relative age groupings under conditions when successive recruitment involves increasing population density.

Life history characteristics may vary between semelparous and iteroparous strategies according to the influence of population density prior to maturity. In order to understand the processes involved in the development of outbreaks further studies are needed to describe the characteristics of low density populations. Future field projects should incorporate mark/recapture exercises for validation of the method for age determination in each population.

SEASONAL VARIATION IN THE EFFECTS OF PARTIAL PREDATION ON ADULT *ACANTHASTER PLANCI.*

Hugh Sweatman and Ian R Butler

It has been suggested that excessive fishing may increase the frequency of outbreaks of *A. planci* by reducing predation, but records of such predation are rare. Many starfish show evidence of having lost arms so some attacks by some predators must not be lethal. Few fishes would be able to eat any but very small starfish whole and the only fully documented case of predation on *A. planci* by a

commercially exploited reef fish from the GBR, a lethrinid had only four arms of an adult starfish in its stomach. We aimed to look at how much damage might be lethal to an adult crown-of-thorns starfish.

In May 1991, groups of starfishes had 0, 2, 4, or 8 arms cut off or were cut in half across the oral disc. A total of 100 animals were held in a cage on the reef for 15 days, in which time only three animals, each from a different treatment group, were lost.

A similar experiment in December 1991 also included starfish that had been starved for 6 weeks to see how poor nutrition influenced the results. This time animals had 0, 4, or 8 arms cut off, or had half or two thirds of their bodies removed. The mortality of all groups was much higher in a similar period. Both increased damage and starvation led to higher mortality, but the mortality of unstarved individuals that were only handled but had no arms removed was >45%.

The timing of the second experiment coincided with spawning, so the animals may have been physiologically stressed. The water temperature was also higher, which might favour pathogens. The cages in the summer experiment also may have favoured pathogens because the animals were more crowded than in the earlier experiment. However the animals that were starved for six weeks before the experiment were handled similarly and were held in similar cages but suffered much lower mortality over a longer period.

From the point of view of predation, the probability of rapid mortality after a given amount of damage varies seasonally, but is higher when the animals have well developed gonads which is likely to make them more nutritious prey. Management programs to control local starfish populations by cutting starfish into pieces also seem more likely to be effective at that time of year. The sensitive period may be brief.

SOME PERSPECTIVES ON THE *ACANTHASTER* PHENOMENON.

Leon Zann

Although outbreaks of *Acanthaster planci* have occurred in many, widely separated coral reefs of the Indo-Pacific over the past 30 years, research on the phenomenon and its causes has almost exclusively centred on the Great Barrier Reef. However, because of the GBR's physical, ecological and oceanographic complexity, the low level and subtle nature of anthropogenic effects, and the low number of outbreak events (ie two), correlative studies on possible causes have not been possible.

This study takes a wider view of the phenomenon by examining the recent history of *A. planci* in other parts of the Indo-Pacific, particularly in the geographically isolated groups in the South Pacific. Outbreak episodes in isolated groups are more likely to be independent, primary events. The groups investigated are smaller in size, less complex oceanographically, and anthropogenic effects are more extreme, ranging from minimal to very severe. The number of 'independent' outbreak events examined also provides some statistical 'pseudo-replication' for correlative studies.

Outbreak histories were reconstructed from oral hist published and unpublished reports, and dedicated stud Fiji, Western Samoa, Vanuatu, Cook Islands, Kir Tuvalu, and from published and unpublished repor Tokelau, New Caledonia, French Polynesia, Niue, Sol Islands, in Papua New Guinea in the South Pacific, a Johnson Island, Hawaii, the Marianas, Carollines and in the Northern Pacific. The timing of the onset of outl episodes was established where possible, and recruit times were estimated (by backdating these 2 years). A recruitment of juveniles was directly monitored in the Reef in Fiji since 1977. The outbreak histories in the study groups and subgroups were related to characteristics (geomorphology (low/high isla geography, and extent of anthropogenic impacts (eg c populations, development, fisheries, agriculture, run-off pollution)).

COTS COMMS is edited by Brian Lassig with assistance from Udo Engelhardt. Views expressed are not necessarily those of the Great Barrier Reef Marine Park Authority.

Contact for Comments, Questions & Contributions:

Dr Brian Lassig
Great Barrier Reef Marine Park Authority
PO Box 1379
Townsville
QUEENSLAND AUSTRALIA 4810

Telephone (077) 81 8811
Facsimile (077) 72 6093
