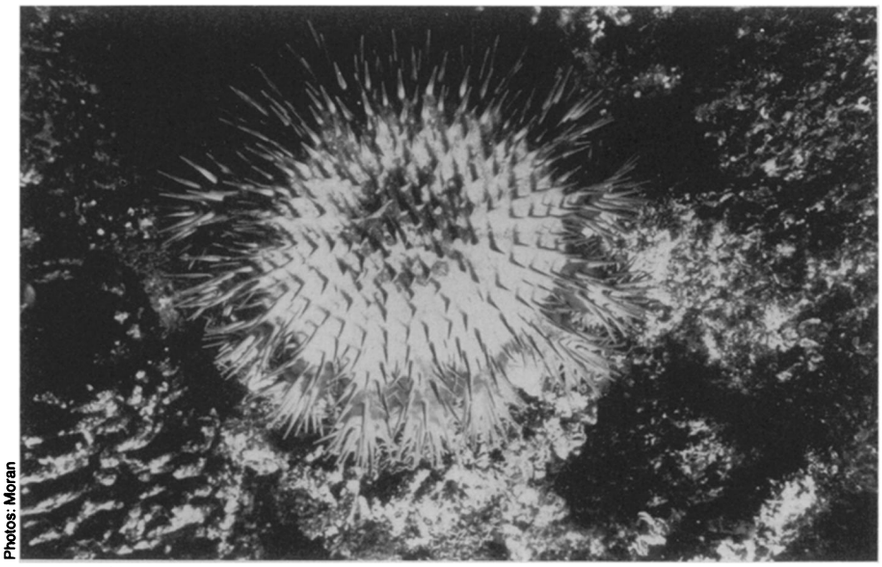
In Pursuit of the Hit-and-Run Starfish

By SUSAN WALTON



Photos: Moran

A. planci's *toxic spines grow to 5 cm in length and protect it from predation.*

In 1982, biologist Peter Moran paid a visit to the John Brewer Reef — one of many that make up the Great Barrier Reef off the Pacific coast of Australia. He was studying coral recovery, and wanted to see how well John Brewer had recouped from an infestation by the coral-eating crown-of-thorns starfish some 12 years earlier. The survey showed that 35 percent of the area he studied on the 7-kilometer reef was covered with live corals — a level that indicated near-total recovery in numbers, if not in diversity. But when he returned several months later, he found that crown of thorns had paid a second visit. With only 2 percent of the area covered, the reef was nearly devoid of live corals.

The recent outbreak on John Brewer — and on 17 of 21 other reefs in the region that were surveyed this year — illustrates the modus operandi of the starfish *Acanthaster planci,* better known as crown of thorns. First reported in large numbers in 1957 in the Ryukyu Islands between Japan and Taiwan, the crown of thorns has an unsettling hit-and-run style. They attach themselves to reefs, consume most of the live coral, and depart. "They seem to arrive from nowhere and then disappear," says Moran, a postdoctoral fellow at the Australian Institute of Marine Science (AIMS) in Townsville, Queensland, who has been studying the starfish for two years. "They go as quickly as they come."

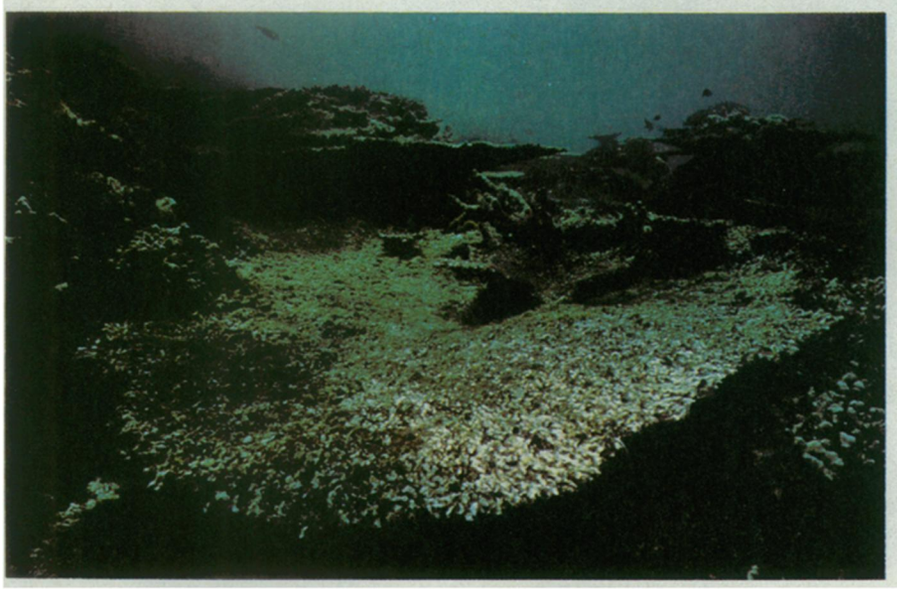
That the large aggregations also seemed to arrive from nowhere in 1957, several hundred years after the animals were first noted in small numbers, has prompted equal amounts of speculation and controversy about why the outbreaks occur. The theories can be divided into two basic categories: that the outbreaks are human induced, and that they are natural phenomena whose patterns have not yet been perceived. According to Moran, none of the explanations has been proved, in part because the starfish are difficult to study. Spread all over the Indo-Pacific, they are unpredictable and hard to tag.

But with the outbreak now under way, Moran and others hope to use a new method to track the animals, thereby providing new information for those who must manage the reef. The questions are of more than academic interest to Australia and other nations in the Indo-Pacific. Knowing why the outbreaks occur is a critical factor in deciding how to deal with them — whether to try to control them or their apparent cause, or to accept them as part of the natural order. Japan, for example, has removed about 10 million starfish over the last decade, at a huge cost. Yet subsequent studies have shown the animals tend to leave without human intervention as their food supply becomes depleted.

A. planci was first described by Rumphius in 1705, and subsequently classified by Linnaeus. Until 1957, it was seen only in small numbers. The starfish are multicolored with between nine and 23 arms. Adults are covered with spines of 4 to 5 centimeters in length. The spines are toxic; stings are described as "quite painful" and can cause swelling and vomiting in humans. The starfish are generally found in lagoons and deeper water on exposed reef fronts, and avoid shallow or exposed locations. Individual starfish have been observed to move about 20 meters per hour on the barrier reef. Biologists presume that the aggregations move from reef to reef, but Moran notes that there is a "complete absence" of data on the animals' movement in deep water.

Laboratory studies — the main source of information about *A. planci* — show that the starfish grow to 35 centimeters in captivity. In the wild, however, investigators have seen starfish of 60 centimeters. They have a life span of about eight years in tanks, and of unknown duration in the wild. James Lucas, a biologist at James Cook University in Townsville, has identified a six-stage life cycle: larval; settlement and metamorphosis; juvenile; large coral-feeding juvenile; adult; and senile adult. Reproduction occurs mainly during the adult stage. A reef is declared infested, by AIMS standards, if more than 20 animals are picked up in a 20-minute tow; the infestations may be localized to one part of the reef.

Neither field observations nor tank studies have revealed much about why the



A. planci *outbreaks start at a few isolated spots (above left), as evidenced by localized patches of dead, white remains of coral that has recently been eaten. The starfish are voracious eaters and can quickly devour huge areas of reef, as happened at John Brewer Reef (left). Close-up (above) shows* A. planci *on dead table coral with adjacent green stag coral that will soon be eaten as the animal moves along the reef.*

outbreaks occur, but there has been no shortage of theories. One theory — among the most widely publicized — holds that chemical pollutants have reduced the numbers of *A. planci* larval predators, thus dramatically increasing the starfish's survival rate. Another suggests that outbreaks are caused by dredging, which clears large areas and allows larvae to settle and grow. A third theory postulates that harvesting of giant tritons, which prey on juvenile and adult starfish, has permitted the large outbreaks.

But according to Moran, there are anomalies in the data that render all these theories unsatisfactory. Some of the outbreaks have occurred in remote areas where humans have had little or no impact. The decline of giant tritons has been gradual, while the outbreaks of starfish have been stable and have happened in places where the triton population has been stable. Moreover, studies have shown that the *Charonia tritonis* has a modest appetite for crown of thorns, consuming only one per week and passing them up entirely if other, presumably tastier, species are available.

The theory that outbreaks are natural phenomena is based on reports of earlier sightings and on fossil remains of starfish in sediments. But neither record provides solid evidence of large outbreaks — only, as was already known, signs that some starfish were around. One pattern that does hold for outbreaks in Micronesia links the starfish aggregations with an increase in runoff. About three years after very heavy rains, outbreaks have occurred. The runoff causes plankton blooms, which support more larvae. But so far, this pattern has not been apparent on the Great Barrier Reef.

"There's no direct, scientific evidence for any of the theories," Moran says. "There's so much we need to know about the problem." For example, he points out, investigators have never seen an outbreak of juveniles, so there is a large blank spot in the data on starfish behavior over time.

"What we're thinking now is that perhaps they settle in deep water, 30 to 40 meters," Moran says. "The outbreaks may be moving up from the deep water at the base of the reef. Maybe they've settled as larvae in a certain area, 30 to 40 meters off the reef."

Precise tracking of such moves would help to answer some of these questions. But previous efforts have been frustrated by the animals' uncanny ability to resist tracing. If you put a tag on the arm, the starfish removes the arm and grows a new one; dyes fade quickly, and clipped spines regenerate. Now, working with animals in the lab, Moran is using a 14-gauge syringe to implant specimens with microinjectable radio transponders. The transponders, which emit signals revealing their location, are staying with the starfish — a significant improvement over past tagging efforts.

Moran and other biologists at AIMS will also continue to study reef recovery. The studies conducted thus far suggest that most reefs in the midshelf region achieve the pre-outbreak level of coral cover within 15 years. But, as is true of recovery following the destruction of a rain forest, the regrowth may not have the same diversity of species. "What we've found," says Moran, "is that it looks like it will take many more years for the community structure to recover, if in fact it ever does." □

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