RECYCLING

ON THE REEF

:: DR RICHARD C MURPHY

HAVE YOU EVER WONDERED WHAT HAPPENS TO FISH POOP? I DIDN'T THINK SO, BUT YOU SHOULD HAVE. CONSIDER ALL THE RESIDENTS OF THE CORAL CITY WHO EAT TONS AND TONS OF FOOD AND PROCESS IT EACH DAY. WHERE DOES ALL THAT STUFF GO AND HOW DOES THE CORAL CITY AVOID POLLUTING ITSELF OUT OF EXISTENCE. WE HUMANS CERTAINLY COULD USE SOME GUIDANCE, AS OUR WATER IS BECOMING MORE AND MORE CONTAMINATED AND OUR LAND FILLS ARE REACHING CAPACITY. LETS DIG A BIT DEEPER INTO THE FASCINATING SUBJECT OF WASTE ON THE REEF.

In the coral city there is no waste. The byproduct of every organism is a resource for another. Remember our last article about the power plants of the reef where algae living inside corals use waste as fertilizer? This internal recycling of nutrients between corals and algae insures that fertilizer is not lost to the outside and that algal productivity remains high. This recycling takes place completely within the coral polyp.

In the context of the larger ecosystem, there is a sanitation department composed of workers such as sea cucumbers and worms, who forage over the reef cleaning up, ingesting, and reusing anything left over.

Efficient use and recycling by the sanitation engineers are important because many reefs thrive in the midst of vast aquatic deserts of the open sea. In this "biological desert," it is the nutrients that are in short supply rather than water in terrestrial deserts. In most tropical seas nutrients are in such short supply that productivity is comparable to that of the Sahara Desert! Nutrients or fertilizer are essential for algae to thrive and serve as food for the rest of the ecosystem. Where there are no nutrients there is no food produced; thus, nutrients limit the amount of work algae can do. In spite of nutrient limitations, coral reefs exist as highly productive oases in these deserts thanks to the sanitation engineers and their role as recyclers. In fact, recycling helps coral reefs sustain rates of productivity as high as rain forests.

Parrotfish: The Lawnmowers of the Reef

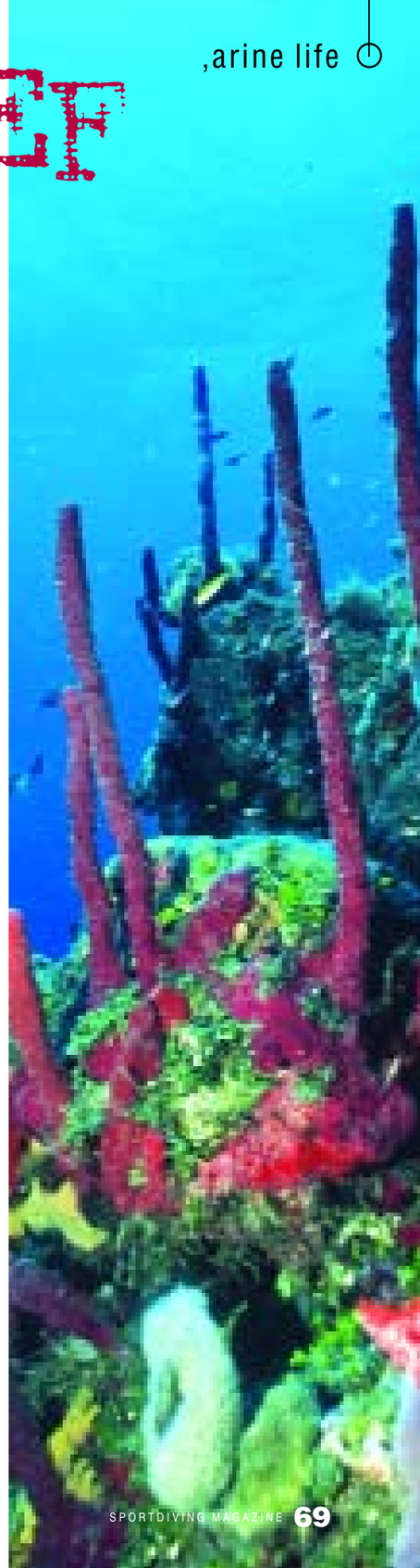
Consider again the parrotfish that serve as lawnmowers by keeping algae from dominating the surface of the reef. Have any of you who are divers ever noticed that as a scared parrotfish darts off it may leave a cloud of smoke behind? Well, you just scared the poop out of it, but in the case of parrotfish the defecated material is special. In the process of their grazing on algae or corals, the parrotfish may break off pieces of the calcium carbonate.

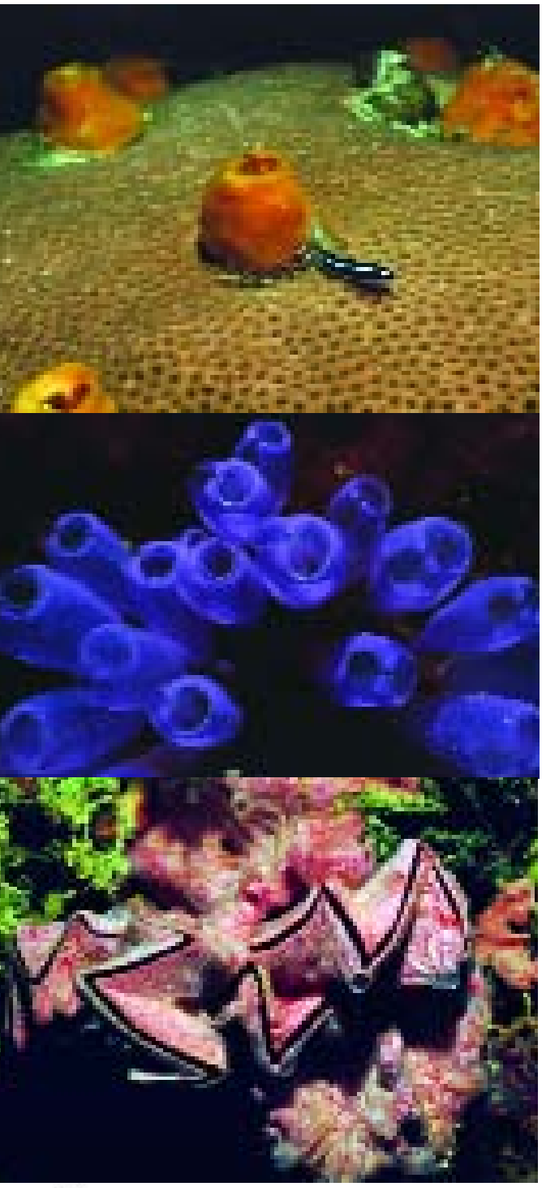
Ground up in the throat by molar-like pharyngeal teeth, this calcium carbonate is pulverized so that the organic matter can be digested. The inedible material then passes through the gut and is released as sand. In fact, a single two-foot parrotfish can produce a few hundred pounds of sand in one year. So, as you stroll along a pristine beach with "clean" white sand beneath your feet, remember where some of it came from and who to thank for it.

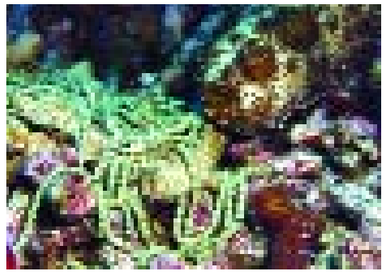
Landfill Put to Use

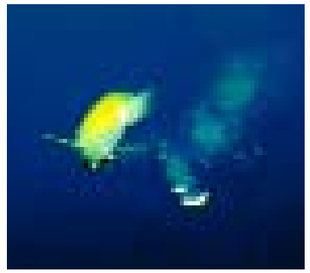
Storms often convert living coral colonies into rubble and you might think that this could undermine the structural integrity of the coral city. In fact, the remnants of the coral buildings destroyed by natural events become the bricks of reef construction, filling spaces in the reef and often becoming cemented together to form a solid reef. In fact, coral and shell fragments and the remains of calcareous algae, such as the green-segmented Halimeda sp., can become solidified into reefs much stronger than those composed of coral skeletons alone. Geological profiles of some ancient reefs show that such cemented debris makes up a large part of the reef 's foundation, as seen in large calcareous structures such as Eniwetok Atoll.

Were we humans to embrace such a strategy we would reduce landfill problems substantially by reusing our building wastes for new construction. To a limited degree, we are beginning to do this with building materials such as used bricks, tiles made from used light bulbs, cinder blocks using waste material as aggregates, wood substitute materials made with reused plastic bags and sawdust, straw bale construction, and houses made of used tires. (Even the Romans used hollow columns filled with detritus instead of solid marble.)









Sanitation Engineers

Have you divers ever marveled at what appears to be a beautiful chain of beige pearls draped over a coral head or wondered about those nice sausage-shaped structures on a sandy bottom and thought about what they might be? Well yes, they are, as you might have guessed, the fecal castings from one of the reef 's sanitation engineers. Many sea cucumbers crawl along the bottom, ingesting huge quantities of sand. From this sediment they extract detritus, which is waste organic matter such as feces, parts of dead organisms, and mucus. In this process they perform an important ecological function. By making use of what could be considered waste products, they increase the ecological efficiency of the entire ecosystem by more fully utilizing its food resources. They also "clean up" the reef by releasing, back to the reef, sediment cleaner than it was before it passed through their digestive tracts.

Purifiers

Just as the sanitation engineers clean the sediments, so do the water purifiers clean the water. Sponges, clams, and sea squirts filter sea water through their bodies, extracting food (including plankton, organic particles and even dissolved organic matter), and returning to the reef ecosystem water that is cleaner than when it arrived. By filtering the water for their own benefit they also contribute to the reef 's health and vitality. Organic matter and drifting organisms that would otherwise be carried away by currents are kept within the reef ecosystem by these filter-feeders. Many water purifiers live in the rubble and in hidden spaces deep within the reef. Through their feeding currents, they ventilate the reef by bringing in oxygen and keeping the reef 's recesses from becoming stagnant. This helps bacteria digest the last bits of organic matter and facilitates the return of their nutrient byproducts to the surface for algae to use as fertilizer for producing more food.

The amount of work done by these purifiers is incredible. Some sponges, for example, can remove as much as 99 percent of the bacteria from the water they filter, and some can filter their own volume of water in less than 30 seconds. Imagine a hypothetical reef .6 miles long (1,000 meters) and 330 feet wide (100 meters) wide at a depth of 33 feet (10 meters). Now imagine a population of sponges, within this area, consisting of one-half liter of tissue per square meter, which is not unreasonable considering that some sponges are over one meter in diameter and more than a meter tall. This imaginary population of sponges could filter 38 million gallons of water every day, and the entire volume of water above the reef four times each day! Not bad for a solar-powered, air- and water-conditioning system that repairs and replaces itself – for free!

Lest we get too warm and fuzzy about poop eaters, they are not really altruistic, though, from their point of view they are doing work to stay alive and reproduce. Yet at a larger community level they are performing important functions that benefit the entire ecosystem. As with most of the reef 's residents, they are doing multiple jobs at once: one selfish and another with benefits beyond self.

Lessons from the reef

Our modern human cities don't fare well in terms of efficiency and recycling, and for now efficient recycling is not high on our priority list, at least in most countries—although it is a topic of major concern and a high priority in a few countries on our planet.

Ours is still a throw-away mentality. But on planet Earth you cannot really throw anything away; it is just put somewhere else. We do not yet realize, as a generally shared commitment, that this approach is inappropriate. Our sanitation departments are dedicated more to protecting people from disease and getting rid of garbage and burying or dumping personal wastes and chemicals into landfills or into the sea.

As we continue to consume and deplete more and more resources, we will no longer be able to afford the luxury of wasting nutrients contained in our domestic waste. Soon we shall be faced with the question of how to reuse waste to fertilize and irrigate green belts and farmland, to improve crop productivity, and to find better ways to reduce costs by eliminating the problems of where to put waste. As on the coral reefs, in the future we are likely to be designing communities where recycling and food production are integrated into "edible landscaping." In these more enlightened communities their slogan may be "Garbage is good!"

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