

# QUEEN AMONG MOLLUSCS

The Hop, Hop, Hopping Conch

by Edwin S. Iversen



HERE ARE SOME NOW!"

It was late at night, pitch black, as we drifted in our small skiff over a shallow tidal flat in the Bahamas' Berry Islands. On the sand bottom the beams of our flashlights found a few conch smaller than two inches, but not as many as we had hoped for. "The tide is dropping fast, we'd better not get this boat hung up," said the Bahamian biologist observer in our group.

Our search for conch born that year and the possibility of stranding our boat were not the only things on our minds. Our apprehension stemmed also from the many reports of drug traffic in this area: furtive landings by boat and plane, Coast Guard surveillance and busts, deals gone sour amidst wild shooting. We fervently hoped that if anyone came our way we would have time to explain convincingly what we were doing there in the middle of the night, in a skiff, with flashlights.

We were looking for a community of young-of-the-year queen conch, *Strombus gigas*, to try and determine what sort of habitat favored the growth of these molluscs from drifting larvae to bottom-bound juveniles. Conch stocks are declining as they are harvested for their meat and their shells, and I was principal investigator in a study of the feasibility of aquaculture of the species, supported by the Wallace Groves Aquaculture Foundation. If and when large numbers of hatchery-born conchs became available, we would want to know what sort of area to plant them in to encourage their survival.

The queen conch is very much at home in these Bahamian islands, located about 120 miles southeast of Miami. It is one of the largest and loveliest of the marine snails, growing to a length of about twelve inches and a weight of about seven pounds. Its shell is beautiful, its meat delicious: lovely to look at, delightful to eat, to paraphrase a 1930s song. To be lovely to look at is one thing, but to be delightful to eat as well can spell disaster; add to these charms the allure of the seas which the queen conch calls home, the warm, clear, and shallow turquoise waters that make it so easy to see and capture, and it is little wonder these creatures are being decimated.

The intent of our project was to reverse the decline of this cheap, nutritious, and available food source for the Bahamian population. We sought to learn if conchs could be hatched from eggs and raised in enclosures or released into the wild to grow up and supplement the conch fisheries production. To make the decision, we had to understand the biology of the wild conch stocks. I studied the species at field stations in the Berry Islands named Little Cockroach, Vigilant, Cat, and Bird Cays. Our center of operations was on Little Whale Cay, and our hatchery was at the Rosenstiel School of Marine and Atmospheric Science, on Virginia Key in Miami.

The familiar, distinctive shell of the adult conch has a broad, flared "lip" and glossy inner surface in colors ranging from hues of rose to vivid pink to subtle, soft shades of

orange. The outside is usually a protective light sand color. The shell is pointed at both ends, with a series of blunt spines at the broader end. The living animal within is smooth and peach colored and has a narrow, black-speckled, strongly muscular foot which moves the animal about the sea bottom in a hopping motion. An *operculum*, a horny plate resembling a claw, partially blocks the shell entrance to intruders when the foot is withdrawn. The conch's eyes are on the end of two protruding stalks, between which is another protuberance, the snout, or mouth. It is a strange looking creature, considering the beauty of its shell.

The word *conch* comes from the Greek word for mussel and is used, generally, to describe large marine snails. The *ch* is pronounced hard in the Caribbean dialects, as in "conk". People who live in Key West, Florida, descendants of Bahamians, have called themselves "Conchs" for years. Just a few years ago, to express displeasure with some move by the State of Florida, they threatened to secede and become known as the "Conch Republic".

The conch is principally important as food, particularly to island dwellers. Queen conch is, by far, the most abundant of the conchs in the genus *Strombus*, and it is a nutritious and cheap food. The foot is the edible part and may be eaten in many different ways, raw in salad or cooked in fritters or chowders—all delicious.

The queen conch is native to warm semi-tropical and tropical waters from Bermuda



south through southeast Florida, the Bahamas, the West Indies, and along the coast from southern Mexico through the Caribbean around to Brazil. They have been fished for generations by local people throughout their range, and, because they are easy to see and are either motionless or very slow moving, they are easy to capture. Recreational fishing pressure, added to the already heavy commercial and subsistence fishing, has substantially reduced the stock's size. Other less abundant strombids are now being sought by fishermen. For example, in Bermuda and Venezuela, the milk conch (*S. costatus*) has more commercial potential than the queen conch, and in Brazil, *S. goliath* is growing increasingly important.

Queen conch has been utilized by man since prehistoric times. Evidence of its use as long as three thousand years ago was brought to light in Miami in the late 1970s, when an excavation of what had been a Tequesta Indian gravesite yielded pottery fragments, carved bones, and axes made from conch shells. Elsewhere in the Caribbean, Indian burial grounds and kitchen middens continue to yield articles made from conch shells—tools, dishes, and various objects of adornment. There are indications that it was used as food and as a horn of sorts. Having no hard rocks to make tools from, Indians used the next best hard object—shells found on the beaches or discarded after eating the meat. The heavy conch shell with both curved and flat areas was a fine source of material to work with. They even fashioned fish hooks from it. Records show that Columbus and his crew ate conch during their voyages to the West Indies and then carried the shells back to Europe, where conch found a new world of admirers.

Old conch shells provide homes to a variety of plants and animals—often while the animal is still alive. As the conch lies open-side down on the sea bottom, boring organisms drill into the heavy shell and encrusting organisms settle onto it until it appears as just another bump on the sea floor. Empty conch shells, especially smaller ones, often provide homes for sea hermit crabs. The bigger ones shelter small fishes.

As with many molluscs, the queen conch's life cycle involves rather extensive travels as a planktonic youngster, moving at the mercy of currents, and then a period of more localized existence as it develops its shell and becomes a recognizable young conch. Once its foot is sufficiently developed, its travel picks up again.

Queen conchs mate when they reach a length of about one foot, generally in water deeper than twenty feet. The female appar-

ently can retain the male's sperm after mating up to several weeks, releasing it to fertilize the eggs when they are laid. Optimum egg-laying sites are in clean coral sand containing little organic material where, upon hatching, the young can find water currents to carry them. In a process estimated to take as long as thirty-six hours, 300,000 to 485,000 eggs are laid in a single, continuous, sticky tube to which sand grains immediately adhere. This sand-covered mass, besides camouflaging the eggs and weighting them down to the bottom, probably also presents an unappetizing appearance to a hungry predator. Some females will spawn as many as six or eight times per season. The hatched young drift free as larvae for about three weeks, feeding on phytoplankton until a predator finds them, or, if lucky, until their shells develop, when they settle and begin a bottom-dwelling existence. Their diet at this time changes from plankton to microalgae and detritus. They reach sexual maturity between two and a half to four years, spawn, and thus complete the life cycle.

FROM LITTLE WHALE CAY we were able to reach several of our study areas by small outboard motorboats. Arthur Albury of Little Whale Cay piloted the larger inboard craft we used to get to more remote spots. En route from one cay to another he imparted to us some of the lore and conch facts of life—and he expressed alarm about the great reduction in the numbers of conchs throughout the islands. "See that boat? That's a Nassau boat. They come all the way up here (over forty miles) for conch to sell at Nassau." Or, "When I was a boy I lived on that island. There were so many conchs around there you could not count them. Now you can hardly find any." Later while looking through stomach contents from a ray and finding bits of conch shells: "I've often seen rays up where the small conchs are: I am sure they are eating them." And on limiting numbers of conchs caught by fishermen: "He needs conch to sell to make a living. Who will stop him?"

One of our tasks was to determine the growth rate of juvenile conch. While no practical means for measuring age of conchs has been found, estimates have been made using size measurements, radio isotopes, and dated tags. We scrubbed a portion of the animals' shells, applied numbered tags with epoxy, recorded the shell size, then released them to be picked up and remeasured the following month. We handled and recorded data on 2,500 conchs in this way.

On a typical morning we might head away from Little Whale in the small boat to our field stations at nearby cays passing

over deep, dark, jewellike channel waters, patches of grass, and pale sand flats. Through the crystal water we could see below brilliant vermilion starfish, some well over a foot in diameter, and silver fishes swimming. The clear cerulean sky would be afloat with puffy cumulus clouds subtly reflecting the water's many shades of blue-green, ranging from aquamarine through turquoise to emerald. The temperature was warm, the breeze caressing.

After beaching the boat on this particular morning we all set out with our net bags to collect conchs, each of us walking a particular section of the beach. We searched for tagged conchs, made the necessary measurements, then released them back to their natural habitat. Although we swam and snorkeled in water too deep for wading, most of the time we stayed close to shore where we found conchs generally ranging from about five to seven inches in length.

The average size of one-year-old conchs has been estimated at 4 inches, for two-year-olds, 6¾ inches, and three-year-olds, 8 inches, based on data from several areas in the Caribbean. Growth rates differ from place to place, probably due to temperature, density, and food availability. In the Berry Islands they seemed to grow slightly slower than elsewhere. We found that the most rapid growth period was from May to August, when warm temperatures induce rapid growth of algae and encourage conch feeding. The shells of small juveniles are very thin during periods of rapid growth; but when the conchs become adult (sexually mature) the large, flared lip forms on the shell, and spiral growth that had been characteristic up to that point ceases. The percentage of total weight that is shell is much larger in the adult conch than in a juvenile; only 10 to 12 percent of the adult's weight is marketable meat.

Because they appear so cumbersome and slow moving, one might expect that almost all the tagged conchs would be easy to find again on the following collecting trips. Not so. Some die, some bury in the substrate, and, even though their movement is limited, some simply walk away.

Unlike many other gastropods that slide along on a mucus or slime path, juvenile and adult conchs have a peculiar hopping movement whereby they place their foot against the bottom and push themselves forward much the same as a pole vaulter might do with a very short pole. We often saw their characteristic tracks over sand flats, made during periods of low tides. I measured meandering trails from a single low tide period that were as long as thirty feet. In Turks and Caicos islands, researchers found



movements of tagged conchs as much as one mile in two months and more than 700 yards in a single week. As they get older, their range increases.

The same powerful heavy foot allows the queen conch to dig out sand from under its shell and bury itself, safe from predators. As a result some small conchs are occasionally found with clean shells, with no plants or animals attached. Larger, older conchs carry around a dense growth of plants and animals on their shells. The presence of these symbionts suggests that the adult conch seldom needs to bury itself for protection. These hitchhikers provide a degree of camouflage to the conch from its large enemies, and in turn the plants and animals find a suitable place to attach and prosper.

MUCH OF OUR EFFORT in the field was spent in a frustrating search for very young conchs. We searched and we hunted. There are only a couple of records of scientists finding large numbers of live conchs about one inch or less in length. We followed the usual types of searches: we looked at night; we looked in deep water and in areas not far from where we found large concentrations of the smallest juveniles; and we pumped, strained, and examined huge amounts of sand and other bottom materials. Yet we found only a few. We concluded that the newly settled young spend nearly all their time buried in the bottom, at least until they reach a size of about 1½ to 2 inches.

We also studied the food and feeding habits of the queen conch. Animals occasionally are found in the queen conch's stomach, but so few that they are believed to be accidentally ingested rather than deliberately sought. We found that, contrary to common belief, conchs observed in *Thalassia* (turtle grass) beds with bits of the grass in their stomachs were not intentionally eating it. Instead, the small plants living on the thick blades are what they scrape off and eat. Using their long proboscises, conchs also graze over the bottom, ingesting microscopic algae attached to sand grains.

To assist with digestion, queen conchs have a rod-shaped gelatinous structure in the anterior end of their stomach called a *crystalline style*. The style may be about two inches long in a large adult conch, and, as it rotates, it releases enzymes needed for the conch's digestive system. The unproven story in the islands is that it is an aphrodisiac, and persons cleaning conch routinely eat the style and hope.

We often saw still-bright bits of recently broken conch shell on the sea floor as we searched for tagged conch. We found whole, newly empty shells and others with a partly

broken shell where a crab or a lobster cracked it to get a grip on the conch and pull it out. A wide variety of predators, from crabs and turtles to sharks and rays, devour conch.

Conch are able to detect the presence of some of their predators. The mucus of some of the conch-eating snails, particularly the tulip snail (*Fasciolaria tulipa*), apparently contains chemicals that the conch can detect. When a tulip comes close the conch exhibits great excitement, using its powerful foot to leap away as fast as it can. One of our group, unaware of this behavior, dropped a tulip snail he wanted to look at later into a pail of conchs and started to walk away. He came running back when he heard a clatter of shell against shell in the bucket. He found the conchs in a frenzy to get away from the tulip as it lay quietly in their midst.

A small fish, *Astropogon stellatus*, is often found inside the queen conch's mantle cavity. This "conch fish" seemingly benefits from using the conch shell as a protective abode. At night the fish ventures forth in search of food but remains in the safety of the mantle cavity during the day. What, if any, benefit the conch derives from this arrangement is not known.

FORTUNATELY FOR MAN, but unfortunately for the conch, conch fishing is a cheap, simple operation that is carried on in small, inexpensive vessels affordable to Caribbean fishermen and requiring only a minimum of equipment. The older sailing sloops (twenty to thirty-five feet in length) have been used for generations. Fishermen usually locate a good fishing area in water twenty to thirty feet deep, then set out from the sloop in small boats, searching the sea bottom for conchs through glass-bottomed buckets. Some dive for them, while others capture them with hooked poles. One man with one pole in an area of high conch density can load his boat with 600 or more conchs per day! While this time-honored method is still in use, many fishermen are now using diesel-powered vessels and small outboard motor skiffs to cover a larger area.

Skyrocketing demand has led to decimation of Florida's conch populations and created markets for Caribbean conch. Now, the conch populations of the exporting countries are declining also. Turks and Caicos islands make a good example. Few conch populations remain there of sufficient size to sustain the flow to the export markets and at the same time supply the local demands. Fishermen from Nassau must now sail to Eleuthera and other islands to find commercial quantities.

The conch is not yet an endangered spe-

cies, but it supports an endangered fishery. It is painfully evident that some kind of management is needed for these Caribbean conch fisheries. Unlike many commercial and recreational fisheries, efficient regulations are difficult to suggest and even more difficult to enforce in remote "out" islands. Limiting the numbers and sizes of conch they can take and closed seasons have worked successfully for fisheries in other areas throughout the world. Bans on exports, as in the Bahamas, will go a long way to prevent overexploitation of conch stocks. But many fishermen depend on conch for subsistence as well as for a small part of their income.

The habits of the conch have led many scientists to suggest that this species would be suitable for either intensive farming (in enclosures with a lot of husbandry) or extensive mariculture (raised in hatcheries and then released into natural surroundings to supplement natural stocks). To attempt to answer these questions we developed a hatchery system to raise conch from egg masses collected in nature.

We enclosed small conchs from the wild in pens of several different sizes in varying densities. The juvenile penned conchs grew very much slower than the control conchs outside the pens, and in some pens we were not able to detect any growth at all even during the warm summer months when the growth of wild stocks is most rapid. The disappointing results combined with the expense of keeping the pens mended to exclude predators suggest that this method holds little promise for mariculture. Only in certain protected locations with good water exchange, where pen construction is inexpensive, and where pens can be monitored regularly, is there hope for success. While hatcheries can produce enough young conch to restock some badly decimated areas, as is being done in Bonaire in the Lesser Antilles, they cannot be expected to support the export levels that Caribbean nations would like.

The governments of these nations must confront this problem of managing the conch fishery forcefully and soon. For it is not just a question of preserving the queen conch but of protecting those who depend on it. These animals cannot continue to support an economy as generously as they have in the past, but they can provide some support. Few nations can afford to allow such a strong economic pillar to be misused and abused any longer.

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*Clockwise from top: A queen conch can cover more than 100 yards a day with its distinctive one-foot hop. [Seaquarium, Miami, Florida] Researchers collect and examine tagged specimens*

*to get data on growth and survival rates. [Darryl Jory] The conch shell's smooth inner wall is camouflaged by its spiny, sand-colored outer surface. [Roberto Hensen] Years of heavy fish-*

*ing of this easily caught delicacy—and important food source—have decimated conch stocks. Tagged juveniles await return to their natural habitat. [Darryl Jory]*