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MARINE NOTES

SPOTLIGHT ON RESEARCH

Jellyfish: Studying Summer's Unwelcome Visitors

By Merrill Leffler

Each summer, flotillas of sea nettles invade the Chesapeake Bay. By July they have often grown so thick in the Bay's creeks, rivers and open waters that bathers begin an annual evacuation of the water. Not so for scientists. Stinging nettles and other gelatinous zooplankton have been enticing researchers to get as close as they can to determine just what role these jellied creatures — not only nettles but also ctenophores or comb jellies — have on the Bay ecosystem.

"For years, researchers worldwide tended to ignore gelatinous animals and their ecological function," says Jennifer Purcell, a scientist at the University of Maryland's Center for Environmental and Estuarine Studies (CEES). "They can be difficult to study and sometimes are simply a nuisance, clogging the nets of researchers trying to get Bay samples of zooplankton or fish."

But research over this last eight years by Purcell and other scientists in the Chesapeake region, Ed Houde at the CEES Chesapeake Biological Lab and Denise Breitburg at the Benedict Estuarine Research Lab, is making it impossible for ecologists to ignore these creatures. They are voracious feeders. "During the summer," says Ed Houde, "sea nettles are probably the most important predator

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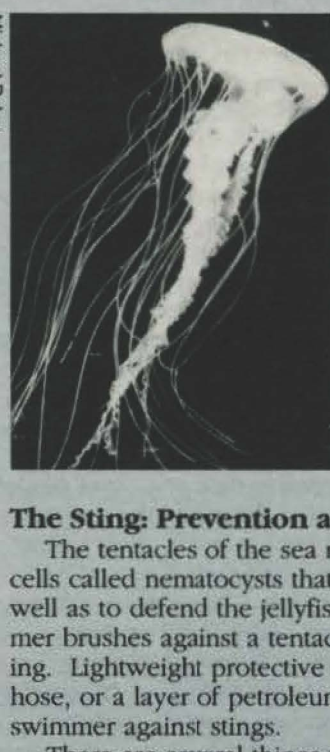
Neither Jelly nor Fish



Michael Reber

The stinging jellyfish which makes the Chesapeake Bay so inhospitable in the summer is the sea nettle, *Chrysaora quinquecirrha*. While sea nettles occur from Cape Cod south along the U.S. East Coast, Caribbean and Gulf of Mexico, they inhabit the Bay in numbers unequaled elsewhere. They are found most abundantly in the tributaries of the middle Bay where salinities are between 10 and 20 parts per thousand. At those salinities, they are white in color. In the southern Bay, where salinities are higher, they often have red/maroon markings on the long central tentacles and on the swimming bell, or medusa.

The Sting: Prevention and Treatment

The tentacles of the sea nettle contain millions of microscopic stinging cells called nematocysts that inject toxins to capture and paralyze prey as well as to defend the jellyfish from would-be predators. When a swimmer brushes against a tentacle, the resulting sting is painful and annoying. Lightweight protective clothing, like a Lycra "swim skin" or panty hose, or a layer of petroleum jelly spread on bare skin will protect a swimmer against stings.

There are several things that you can do if you get stung. If bits or pieces of tentacles are still on the skin, pour alcohol or baby powder on the area. Alcohol will stabilize the nematocyst so that it will not be triggered. Powders do the same by drying the cells out. Without such treatment, tentacles which are disturbed may release additional nematocysts, causing additional irritation and swelling.

Next, apply diluted ammonia, sodium bicarbonate, vinegar or meat tenderizer to the area to relieve pain. Meat tenderizer is one of the best sources of relief from stings. Add a small amount of water to the meat

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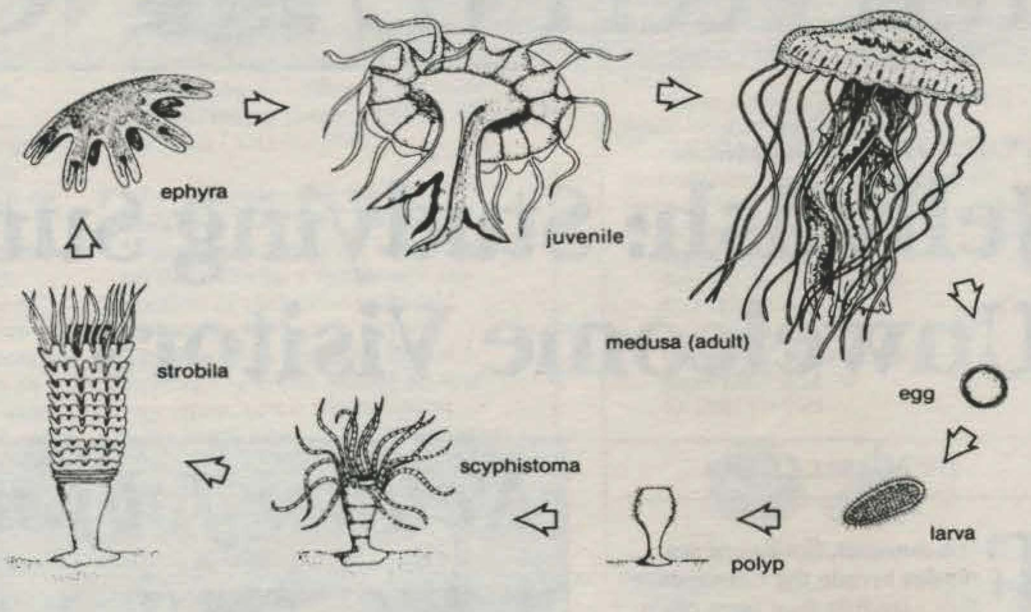
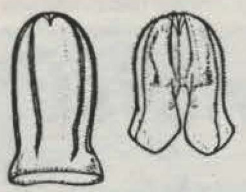
The Cheseapeake Bay's stinging jellyfish, called sea nettles, and their non-stinging cousins, the comb jellies, are both voracious feeders. (Illustration at right by Karin Grosz from The Delaware Estuary: Rediscovering a Forgotten Resource, *1988, Delaware Sea Grant; illustration below by Karen Teramura in* Chesapeake Bay: A Field Guide, *written by Christopher P. White and illustrated by Karen Teramura, 1989, Tidewater Publishers.)*

Life Cycle of the Sea Nettle *(Chrysaora quinquecirrha)*



Comb Jellies



Visitors, *continued*

of ichthyoplankton — the fish larvae that are so plentiful in the Bay." Researchers and resource managers alike want to know just how many young fish these jelly-like feeders are taking from the system and how they may affect adult abundance.

Jellyfish in the Chesapeake

Until the mid-1960s, hardly more was known about the sea nettle (*Chrysaora quinquecirrha*) than its basic biology, namely that it has two life stages, one where small, swimming larvae fasten to a surface and develop into fixed polyps, and a second where the mature polyps begin to bud off (strobilate) young nettles (ephyra) which mature into the large bell-shaped medusae that produce eggs and sperm.

The medusa — with its semi-transparent bell and streaming tentacles — is easy enough to see. But the polyp proved more elusive. "People knew what the polyp stage looked like back then," says Dave Cargo, "but nobody could actually find them in the Bay."

The problem, he says, is that they weren't looking in the right places. Like others, Cargo began looking for polyps on hard surfaces, primarily oyster shell, but he found those shells crowded with young oysters and other organisms, which left little room for nettle polyps. Only when he looked at the undersides of those shells did he discover them lurking there.

Now retired from the CEES Chesapeake Biological Lab, he began the first extensive field studies of nettles, studies that described the nettles' general habitat needs, their salinity tolerance, and their temperature requirements. Unlike many other jellyfish which flourish at ocean salinities, greater than 30 parts per thousand salt, nettles, he found, do best between 7 and 25 parts per thousand.

Beginning in 1960, Cargo began what has become a thirty-year monitoring of sea nettle abundance in the Patuxent River. That monitoring was not, he says, very sophisticated: each day at lunch during July and August, he would walk out on the 200-foot pier at CBL and simply count the number of nettles. His aim was to try and correlate sea nettle prevalence with climatic factors — temperature, waterflow, salinity — to see if he could predict the intensity of sea nettle infestations each summer. Though not rigorous by scientific standards, he points out that "after 25 years you have numbers you can hang your hat on." Houde is more emphatic — "Dave Cargo's is the kind of long-term data we rarely have. That's what makes it so important."

Jellyfish and the Food Web

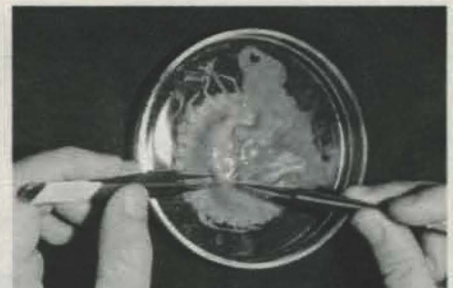
Some ecologists have hypothesized that, because of changes that have occurred at the bottom of the food chain, the sea nettle and other gelatinous species may be more plentiful in the Bay than when settlers first arrived in the Chesapeake region. According to one argument, the clearing of land and continued development of shorelines have made the Bay more susceptible to runoff of the soil's natural nutrients and, increasingly, more vulnerable to today's massive nutrient overloading from human, animal and agricultural wastes. The consequence, most researchers agree, has been explosive growth of phytoplankton, the single-celled plants that thrive on nutrients.

But how has massive phytoplankton growth affected the Bay's food web? For one thing, continuing overenrichment of nutrients, known as eutrophication, has been hypothesized to favor production of microorganisms like bacteria and microzooplankton (protozoans and rotifers) that feed on them. Some ecologists have proposed that these microscopic zooplankton support gelatinous species more than the "higher" forms of zooplankton, such as copepods, and fish larvae. Has the Bay's eutrophication meant more nettles?

Denise Breitburg is skeptical. She questions arguments that claim the Chesapeake Bay has a greater prevalence of sea nettles now than several hundred years ago simply because of changes at the bottom of the food chain. Estuarine ecosystems are not that simple, she says. "You have to look at details of trophic interactions higher up in the food chain," she argues, "and the behaviors of the various species involved." There is some evidence in her recent studies, for example, that nettles can tolerate low dissolved oxygen concentrations better than the larval fish or zooplankton they feed on. Though nettles were impaired, says Breitburg, they continued to feed at significantly high rates.

The prevalence of sea nettles themselves appears to be conditioned by the timing and intensity of spring rains, which in turn affect the budding of ephyrae by polyps. This year, for instance, cold spring temperatures and heavy rains have kept nettle production down — there aren't very many to count at the CBL pier. But these same environmental conditions also affect zooplankton concentrations, larval fish populations and temperature, all of which have ramifications for sea nettle and ctenophore behavior that cascade up and down the rest of the food chain.

Teasing out these ramifications has led Breitburg, Jennifer Purcell and Ed Houde to look closely at how these gelatinous species compete for food, what they consume, what they



don't consume, and how they behave under different environmental conditions. In effect, they have been working to quantify predation of sea nettles and other jellies on other Bay inhabitants. Purcell, for example, has done painstaking laboratory experiments to determine how sea nettles feed on oyster and other bivalve larvae. Because peak sea nettle abundance occurs in summer during the oyster spawning season, many scientists had assumed that nettles were consuming large numbers of the swimming larval oysters.

Research in Purcell's laboratory, however, has shown that sea nettles may help oysters. Oysters have a larval stage that spends about two weeks swimming in the Bay before they settle to grow into mature oysters. During this swimming stage, they are vulnerable to predators such as sea nettles and comb jellies. Although sea nettles can catch the larval oysters, Purcell discovered much to her surprise, that they spit them out undigested and unharmed. These findings may be the first reported evidence of oyster larvae passing alive through a carnivorous predator.

In contrast, comb jellies catch and digest the larvae readily. However, comb jellies are also a favorite food of sea nettles, and they reduce comb jelly populations to zero in the tributaries during the summer when oyster larvae are most abundant. "Therefore," says Purcell, "sea nettles appear to protect oyster larvae from a major predator."

Gelatinous species also feed on small zooplankton, fish eggs and larval fish. How much these species consume is especially important for bay anchovy, says Houde, which are hunting the same prey. As competitors with the anchovy, which are an important food for striped bass, bluefish and other Bay species, jellyfish could eventually have indirect impacts on their production. But explaining just what those impacts are will depend on experiments that detail predation rates among jellyfish and anchovy. In one related experiment, Houde — working with Jim Cowan, now at the University of South Alabama — found that the gelatinous predators "have the potential to consume 20 to 40 percent of the daily eggs and larvae of bay anchovy in mid-Chesapeake Bay." He also found, however, that when ctenophores and nettles occur in the Bay at the same time, there is a decrease in predation on larvae. This decrease may be due to diminished consumption of fish larvae by nettles because of their heavy consumption of ctenophores.

With sea nettle populations in the Chesapeake down this summer, you would guess, says Houde, that daily mortality of fish eggs and larvae would be down. But, he adds, "things are so variable — there could be compensating factors." In other words, the ever-changing food web may account for the decrease of one predator with the increase of another.

What Does the Future Hold?

Whether the Chesapeake Bay has more sea nettles now than in the past remains a provocative question, but one that seems too premature to answer. "I could not have predicted some of our research results from theory," says Denise Breitburg. "Our studies have confirmed my feeling that you have to look at the details of these trophic interactions, the behaviors of the different species involved." In short, there is simply a great deal we do not yet know about jellyfish, says Jennifer Purcell.

As much as we might like to blame the presence of jellyfish in the Bay on increased nutrients or other changes, it will take a good deal of study before we fully understand the role of jellyfish in the Bay ecosystem. ■

Jellyfish, *continued*

tenderizer to make a paste and smear it on the inflamed area. Meat tenderizer is an enzyme which breaks down proteins. Jellyfish ven-om is made of protein and is consequently destroyed by the meat tenderizer.

Few Predators, No Good Controls

The sea nettle is unusual in its ability to live in low salinity water. Most jellyfish species live at ocean water salinity, about 35 parts per thousand, while the sea nettle prefers waters with as little as 12 parts per thousand salinity. This means that it usually has estuaries like the Chesapeake Bay to itself without serious competition from most other jellyfish. In fact, sea nettles eat their most abundant competitors in the Bay, comb jellies, or ctenophores.

Adult sea nettles have few natural predators in the middle reaches of the Chesapeake Bay. Sea turtles, which are known to eat Portuguese man-of-war and some other jellyfish, rarely come far into the Bay. And fish species (harvestfish and butterfish) observed feeding on sea nettles prefer waters of higher salinity.

A lot of effort was spent on jellyfish control in the Bay in the 1960s, but no method was very successful. Nets and bubble screens were used to keep them away from swimming areas. The jellyfish tended to clog the nets and to break into pieces that continued to sting. The bottom-living polyp stage also was targeted. Chemicals that killed the polyps also killed many other organisms, and so were unsuitable. Researchers found a small species of sea slug that ate polyps, but culture methods to produce large numbers of the sea slugs were unsuccessful and they also did not live well at the low salinities favored by the polyps.

The only thing known to reduce jellyfish populations is an influx of fresh water. Experiments have shown that sea nettles reproduce poorly at less than 7 parts per thousand salinity. Hurricane Agnes in 1972 caused the greatest reduction of jellyfish populations in recent years. ■

Environmental Finance Conference

Who is going to pay for it? This is the question heard over and over, at meetings for the Chesapeake Bay's new Tributary Strategy, in small towns and in counties throughout the region. Environmental projects can place serious budgetary demands on small municipalities, and even states struggle with the question of how to pay for environmental protection and restoration.

In Maryland, for example, Governor William Donald Schaefer has appointed a Blue Ribbon Panel to examine new and innovative ways of funding the Chesapeake Bay Tributary Strategy, which aims to decrease nutrient loads by forty percent by the year 2000. That panel should complete its work in October 1994, at which time it will issue a number of recommendations.

To better understand how local governments are addressing the question of environmental finance, and to help generate new approaches that could help them, the University of Maryland System's Coastal and Environmental Policy Program is sponsoring a two-day conference on September 8 and 9 at the Center of Adult Education on the College Park campus. Governor Schaefer will deliver welcoming remarks at the conference. A variety of speakers and panelists will discuss the current status of the budgetary challenges that face both small and large local governments, and describe various approaches that could help communities build better waste water, drinking water or storm water systems.

Communities around the country are experimenting with public-private partnerships, creative fee and rate structures, and a range of cost-reduction measures, including load reduction and pollution prevention. Representatives from investment firms and others from the private sector with experience and expertise in bonds, loans and securitization will participate in the conference, to help educate attendees about current finance practices and to join in discussions about new and innovative alternatives. In addition to discussion sessions, the conference will include exhibit/poster sessions and an evening reception.

The conference is part of an ongoing effort by the Environmental Finance Center, established by the University's Coastal and Environmental Policy Program. Current efforts include "charrettes" held in communities throughout the region which address environmental finance problems and coursework in Environmental Finance offered through the School of Public Affairs (UMCP), which now offers a concentration in Environmental Finance.

Conference registration costs $175.00 and includes admission to exhibit and discussion sessions, two breakfasts, two lunches and the evening reception. Exhibitors' fees are as follows: $350.00 (commercial), $175.00 (national non-profit) and $75.00 (regional non-profit). Conference information is available in printed and electronic form. To request an electronic copy of the program, use the following e-mail address: cordova@mbimail.umd.edu. For general information or to request a copy of the printed conference program, contact: Beth Hickey, Coordinator, Environmental Finance Center, at (301) 405-6383, fax (301) 314-9581. Student grants are also available for the conference — call for details. ■