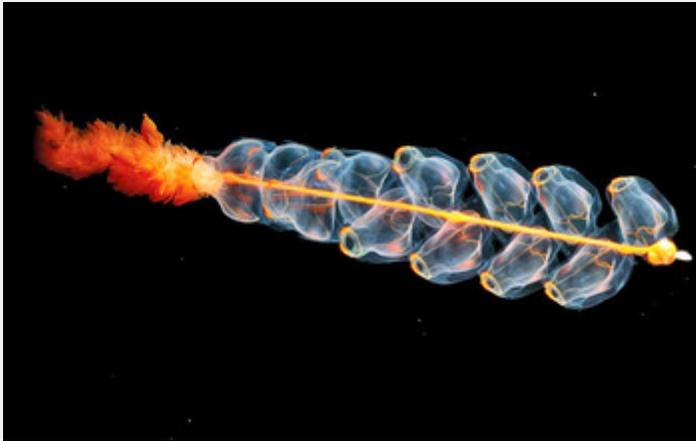


## Discovery

# Clues to Future of Undersea Exploration May Reside Inside a Jellyfish-like Creature

Siphonophore holds secrets of oceanic "jet propulsion"



A siphonophore, an animal with colonies of propulsion jets, glides through the sea.

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Siphonophores, they're called: marine animals that navigate inner space like undersea mini-versions of the starship *Enterprise*.

Most siphonophores are long, thin, transparent floaters. At 130 to 160 feet long, one species is among the longest animals in the world.

Although siphonophores appear to be single organisms, they are in fact colonies of many individual animals. Like crew members aboard the *Enterprise*, each colony has a role in guiding the "ship," in this case, largely in turning or forward-thrust.

Marine animals that swim via jet propulsion, such as jellyfish and squid, are fairly common in the sea. But it's rare to find a colony of animals that coordinates multiple jets for the movement of an entire individual, says marine biologist Jack Costello of Providence College.

Costello and colleagues recently published results of a study on one siphonophore's locomotion methods, a common species known as *Nanomia bijuga*, in the journal *Nature Communications*. Co-authors of the paper are Sean Colin of Roger Williams University, Brad Gemmill of the University of South Florida, John Dabiri of Stanford University, and Kelly Sutherland of University of Oregon.

The researchers found that *N. bijuga* uses a sophisticated, multi-jet propulsion system that's based on a division of labor between younger and older members of the colony.

"These investigators have given us some of the first information about how this complex colonial organism coordinates its swimming activity," says David Garrison, a program director in the National Science Foundation (NSF)'s Division of Ocean Sciences, which supported the research.

### **Nothing wasted**

"This siphonophore is a highly efficient system in which no developmental stage is wasted," Costello says. The young members at the front of the colony use their smaller jets for turning and steering. The older, larger members farther back provide more powerful thrust as the colony moves from place to place.

"It's a sophisticated design in what would initially seem like a simple organism," Costello says.

*N. bijuga* belongs to a group of colonial animals called physonect siphonophores. They're related to jellyfish, anemones and corals. Voracious plankton-feeders, these siphonophores migrate to the ocean's surface at night to find prey, then return to darker depths by day to avoid predators such as fish.

### **The nectosome: the seat of power**

The jet-propulsion members of a siphonophore colony, called nectophores, are genetically identical clones arranged in what's known as a nectosome. The nectosome is only a few inches long, but it tows much longer groups of reproductive and feeding units across distances that can reach 650 feet or more each day.

It's the equivalent, Costello says, of an adult human running a marathon every day, while towing the equivalent of its own body mass behind it.

To analyze *N. bijuga*'s swimming abilities, Costello and colleagues measured particle flows around the siphonophore as it moved. The results revealed the size and thrust of individual jets.

The youngest ones, the researchers found, pushed the least amounts of water. However, because they're located at the tip of the nectosome, far from where it connects with the rest of the siphonophore's body, a directed force by these young members has an outsized effect on rotating the whole colony. "Just because the young ones are small, doesn't mean they aren't important," Costello says.

"These younger members have a long lever arm," he says. "They're like handles on doors. If you push a door near its hinges, the door is hard to open. But if you push on a door's handle, the door opens easily. A little force from a big lever arm has a big effect on turning, and so it is with this siphonophore."

The young colony members allow *N. bijuga* to rapidly alter course--and to completely reverse its swimming direction.

As new nectophores bud at the tip of the nectosome, older ones move farther back where their larger contractions are important for thrust.

"This set-up allows all members of the colony to help with the maneuvering that's critical for siphonophores as they find their way through the ocean," Costello says.

### **Siphonophores: the future of undersea exploration?**

The pattern offers insights into the biomechanical success of siphonophores and provides "a basic understanding of a natural solution to multi-engine organization that may contribute to the expanding field of underwater-distributed propulsion vehicle design," write the scientists in their paper.

Costello imagines an undersea exploration vehicle that, like *N. bijuga*, twirls through the depths using elegantly placed thrusters that extend from front to back.

"We can perhaps peer into our own future in the sea," he says, "by studying how this seemingly simple animal jets from one part of the ocean to another, relying on its youngest crew members."

As Captain Kirk observed from the *Enterprise* deck, "Galloping around the cosmos is a game for the young." Little did he know.

--Cheryl Dybas