Reverse-engineered computer model provides new insights into larval behavior

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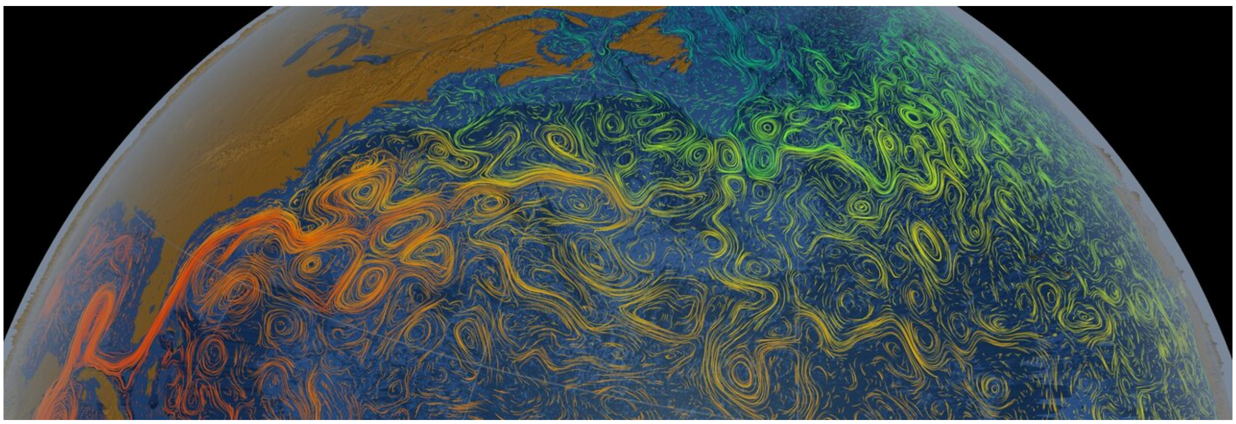

Ocean flows coloured with sea surface temperature data -- the new model assesses how larvae behave in order to catch these currents and subsequently disperse. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio

Scientists have developed a new approach to describe the behaviours of microscopic marine larvae, which will improve future predictions of how they disperse and distribute.

A study by the University of Plymouth and the National Oceanography Centre, published in *Proceedings of the National Academy of Sciences*, abandons previously used methods to reveal new insights into larval behaviour in the ocean through reverse-engineering.

Computer simulations of the ocean are commonly used to predict how animals and plants move through water, an approach known as biophysical modelling.

The models combine in-depth knowledge of ocean currents with predictions of how larvae may behave and respond to environmental and biological cues such as light, gravity or pheromones.

These factors lead to changes in how they are distributed throughout the water column, and understanding this is especially important as many marine organisms are weak swimmers and rely on ocean currents—which reduce in speed and change direction with depth—to help them move.

Previously, researchers have described larval behaviour by scaling-up laboratory observations—for instance, programming simulated larvae to swim up and down in the water column in response to light cues—but since little is known about how effectively larvae respond to these cues in nature, it can result in the models failing to accurately predict dispersal.

The new research allows scientists to predict the direction and speed that larvae would have to swim for models to best match the patterns observed in nature, without knowledge of the mechanisms of their movement.

The study was led by Ph.D. candidate Molly James and Associate Professor in Marine Ecology Dr. Antony Knights, from the University of Plymouth's School of Biological and Marine Sciences, and they found the swimming behaviours of larvae necessary to replicate natural patterns were markedly different to those suggested by laboratory studies.

They believe this ground-breaking method for assessing larval behaviour—which can be applied to any species with a dispersive larval phase—will dramatically enhance our understanding of how the tiniest lifeforms disperse in marine, freshwater and even terrestrial environments.

Molly, a BSc (Hons) Marine Biology and Oceanography graduate, said: "The majority of marine species have a larval development stage, and these larvae are a key component of ocean food webs. Understanding the ecology of larvae is therefore critical, as it will enhance our wider knowledge of the marine environment. Our research does go against previous thinking, but we believe it provides a real step change in how scientists can predict the dispersal of marine species now and in the future."

Dr. Knights, whose research involves using field-based experiments and theoretical models to assess how populations respond to anthropogenic and environmental pressures, added: "Species dispersal has been a key research focus for many years. Global climate change leads to shifts and expansion in the distribution of terrestrial and marine species altering the structure and functioning of ecosystems, therefore understanding dispersal is imperative to ecosystem management. Our study provides a toolbox for dispersal modellers, providing a realistic insight into behaviour that hasn't been available before."

More information: M. K. James el al., "Using field-derived vertical distribution profiles to infer larval swimming behaviors: A reverse-engineering approach," *PNAS* (2019).
www.pnas.org/cgi/doi/10.1073/pnas.1900238116

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