Swimming crustacean eats unlikely food source in the deep ocean

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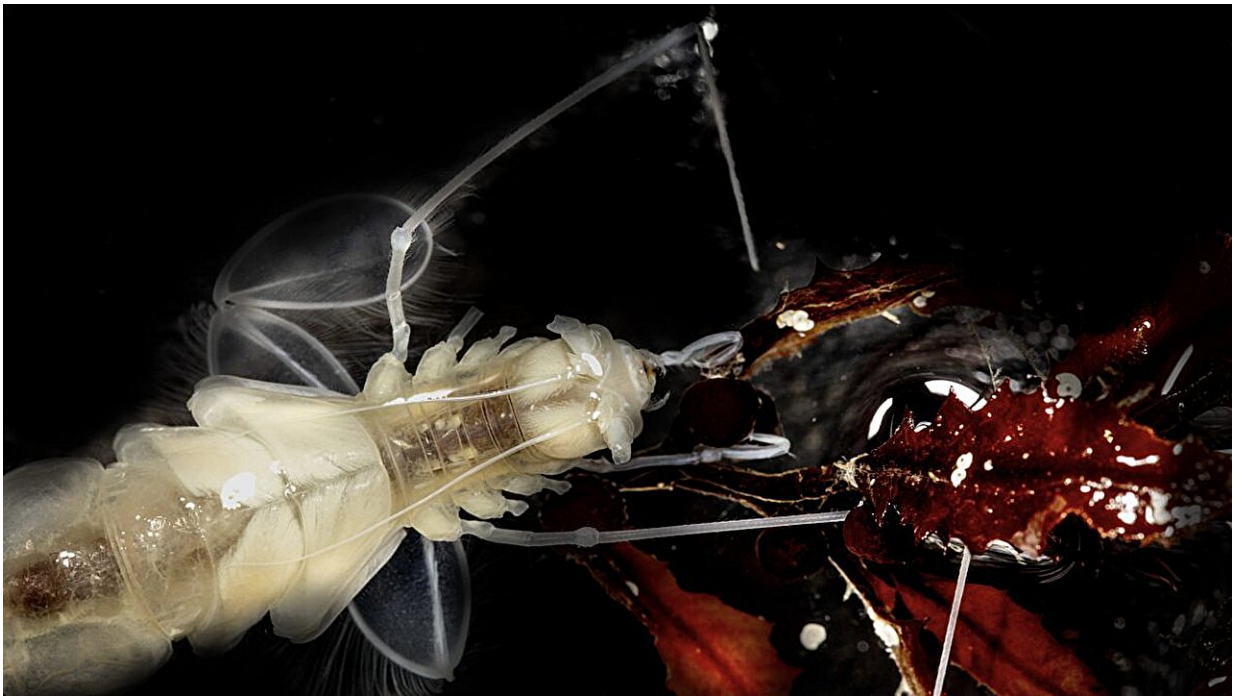


The team combined morphological analysis, CT-scanning, DNA sequencing, and microbiological studies to show that this isopod is physiologically and behaviorally adapted to use sargassum as a food source. Credit: Daniel Hentz, Woods Hole Oceanographic Institution

What do deep-sea crustaceans munch on? A new study titled "A deep-sea isopod that consumes Sargassum sinking from the ocean's surface," published in the journal *Proceedings of the Royal Society B: Biological*

Sciences, sheds light on a remarkable isopod species named Bathyopsurus nybelini, a deep-sea isopod that consumes Sargassum sinking from the ocean's surface.

Using the submersible Alvin, scientists encountered this isopod swimming 3.7 miles deep, with oar-like legs as long as your fingers, eating an unexpected food source, Sargassum.

Sinking forests of algae bring food to the deep ocean

Surprisingly, these isopods can be seen carrying something more common on the ocean's surface: large pieces of Sargassum algae. At the surface, Sargassum grows using photosynthesis, forming floating forests of algae.

In this new study, researchers at the Woods Hole Oceanographic Institution (WHOI), University of Montana, SUNY Geneseo, Willamette University, and the University of Rhode Island demonstrate that even when this algae sinks, its story isn't over. The isopod waits, specially adapted to find and feed on this sunken source of nutrients. These findings of a deep-ocean animal relying on sinking food from waters miles above underscore how closely connected the surface ocean is to the deep ocean.

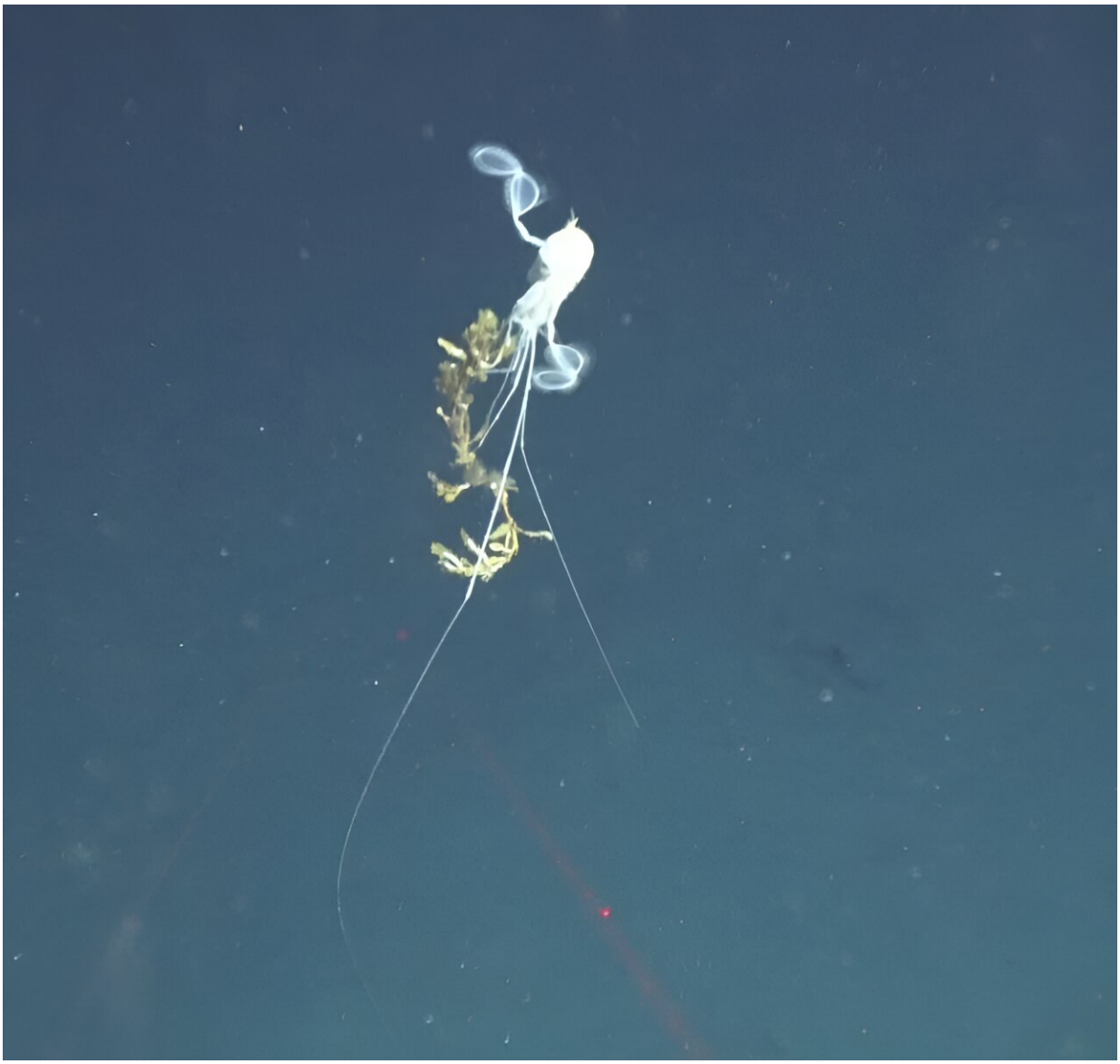
Unveiling the deep-ocean connection

In the summer of 2022, an interdisciplinary team of researchers and engineers embarked on the human-occupied submersible Alvin at the Puerto Rico Trench and the Mid-Cayman Spreading Center in the Caribbean Sea. Alvin had recently completed an overhaul, including increased dive capabilities.

At 6,100 meters deep, Alvin's upgraded 4K imaging system captured an isopod swimming upside down and away from the seafloor, carrying a frond of Sargassum as long as its body. During this expedition, Alvin filmed 32 individual isopods from 5,001- to 6,284-meter depths and collected two samples for study at the surface.

The study's co-lead author, Johanna Weston, a hadal ecologist at WHOI, explained, "It was exciting to see this beautiful animal actively interacting with Sargassum, deep in the ocean. This isopod is so rarely seen; only a handful of specimens were collected during the groundbreaking 1948 Deep Sea Swedish Expedition, which proved that life could survive in the deepest half of the ocean.

"The last photo of one was taken in 2011. Using Alvin and its recently updated capabilities to capture video and collect samples increases our understanding of what makes this isopod so special."



An isopod swims backward and upside down in the deep ocean using large paddle legs, carrying Sargassum algae that has sunk from the surface miles above. Credit: L. Peoples (UMT), NDSF Alvin Group, NSF, Woods Hole Oceanographic Institution

Specialized adaptations allow this isopod to feed on sunken algae

The team combined morphological analysis, CT-scanning, DNA sequencing, and microbiological studies to show that this isopod is physiologically and behaviorally adapted to use this sunken resource. This integrative process of observation and analysis led to the unveiling of this important link in the ocean food web, a significant contribution to deep-ocean ecology.

Co-lead author Mackenzie Gerringer, a deep-ocean physiologist at SUNY Geneseo, says, "Deep-ocean ecosystems seem like harsh environments, but the animals living in these habitats are well-suited to meet these conditions.

"This isopod illustrates that an animal in a dark and high-pressure environment at the bottom of the seafloor has evolved multiple adaptations to feed on algae that grow in a sunlit ecosystem. We're excited to share its amazing story of adaptation and this important reminder that habitats and organisms on our planet are deeply and intricately connected."

One particular adaptation is its specialized swimming stroke. This isopod moves upside down and backward with large paddles, allowing it to carry Sargassum fronds off the seafloor. This distinctive locomotion might be an evolutionary strategy to avoid predation by lifting its food source into the water column. The isopod also possesses serrated and grinding mouthparts, ideal for tearing and consuming the tough Sargassum, and has bacteria in its gut to assist digestion.

Algae, like Sargassum, is difficult for many animals to digest because the cell walls are built of strong, complex molecules called polysaccharides. This isopod's gut microbiome has genes that break down these tough compounds. As found in the human gut, the microbiome provides important carbon and nitrogen nutrients for these hosts. As lead author Logan Peoples, an aquatic microbial ecologist at

Flathead Lake Biological Station, shared, "Life everywhere, even in the deepest depths of the sea, is inexorably connected to the microorganisms around it."

One ocean: Processes at the surface impact deep waters

The abundance and distribution of Sargassum in the tropical Atlantic and Caribbean Sea appears to be changing, with large blooms creating ecological and economic impacts for coastal communities in the region. With these changes, there is still much to understand about the abundance and use of Sargassum at great depths. The presence of Sargassum at such depths has significant implications for carbon cycling and storage.

Further studies will need to evaluate how much and where Sargassum arrives at the seafloor, how the algae's sinking changes over seasonal and long-term timescales, and its relative importance to the broader deep-ocean food web. Understanding the ecological impact of altered Sargassum deposition will be crucial for predicting the responses of deep-ocean communities to changing environmental conditions.

A continued window to our deep ocean

The discovery of isopods feeding on Sargassum enriches our understanding of deep-sea biodiversity. Advanced technologies like the submersible Alvin and other integrative tools provide invaluable opportunities to observe and sample these key ecosystems.

Chief Scientist for the National Deep Submergence Facility and co-author Anna Michel explains, "In 2022, Alvin was certified to dive to 6,500 meters. The discovery described in this paper was possible due to

its new deeper diving capabilities, which is very exciting for the Alvin team."

As human activities continue to affect oceanic conditions, from pollution to climate change, understanding the connections between surface processes and deep-ocean ecosystems will be essential for developing strategies to mitigate these impacts.

More information: Logan M. Peoples et al, A deep-sea isopod that consumes Sargassum sinking from the ocean's surface, *Proceedings of the Royal Society B: Biological Sciences* (2024). DOI: 10.1098/rspb.2024.0823

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