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Ed.

The Strandloper, official bulletin of the Conchological Society of Southern Africa, is issued as part of membership dues. It is published in March, June, September and December.

In this Issue:

I hope that you will enjoy this issue as much as I did when I did the layout...

Ed.

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The Editor

The Hidden Ocean Arctic 2005

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"Probably the greatest enticement for those who today are devoting their lives to the study of the sea is the lure of the unknown, the challenge of the undiscovered, the thrill of discovery on what is truly the last frontier on earth." - In Deep Challenge (1966) by H. B. Stewart.

Background

In June/July 2005, an international team of 45 scientists from the United States, Canada, China and Russia participated in a collaborative effort to explore the frigid depths of the Canada Basin, located in the deepest part of the Arctic Ocean. This expedition is named "The Hidden Ocean" because this part of the Arctic Ocean is covered with sea ice for most of the year and thus difficult to reach. Therefore very little information is currently available about the diversity of life in this region of the world although this information is urgently needed to build a baseline of data to evaluate the impacts of changing environmental conditions, including warming and ice melt in the Arctic over the last four decades.

Operating from the U.S. Coast Guard icebreaker Healy and funded by NOAA's Office of Ocean Exploration, scientists examined the hidden world of life in these extreme conditions with the aid of divers, photographic platforms and a remotely operated vehicle (ROV) specially designed to operate under ice and at great depth. More traditional techniques like ice coring, plankton nets and bottom trawls supported these efforts.

The scientific sampling approach covered the microscopic organisms found in the sea ice (sea ice biota) and in the sea water (mainly phytoplankton), as well as larger animals in the sea water (zooplankton) and at the sea floor (zoobenthos). These studies will try to understand linkages that exist between ice, water and sea floor in this harsh environment from the surface of the ice to the bottom of the deep sea.

Arctic Biodiversity

Biodiversity (or Biological diversity) refers to the variety of life forms or living organisms; it can be measured in terms of genetic, species, ecosystem, or landscape diversity. Our study focused on species and ecosystem diversity, although we also collectinged samples for genetic diversity studies.

Only the more obvious or abundant species are often targeted in such studies because they are believed to be more important in ecosystem function. Much of the diversity, however, is actually contributed by relatively rare species that are largely ignored because they are thought to be unimportant. By analogy, medical doctors are relatively rare in human communities, but their total absence would have grave consequences. Knowledge of such rare "species" in communities is, therefore, essential to discussions of climate change, in terms of its expressions on biological communities.

Consequently, there is a pressing urgency to obtain thorough baseline information on the composition, diversity and functioning of Arctic marine biological systems if we are to study the impact of climate changes.

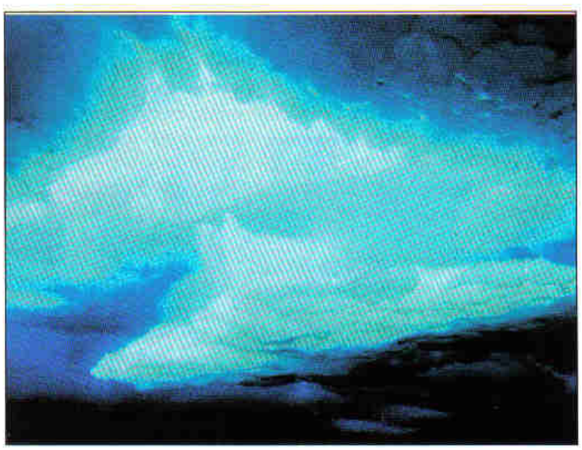
The USCGC Healy was built to conduct research in ice-covered waters of the Arctic and was commissioned in the year 2000.

The Arctic is unique in its species origins because they represent four biogeographic affinities: (1) Species that occur all over the Arctic and beyond, (2) Atlantic-origin species, (3) Pacific-origin species, and (4) species only found in the Arctic (endemics). The composition of these groups gives evidence about the geological history of the Arctic.

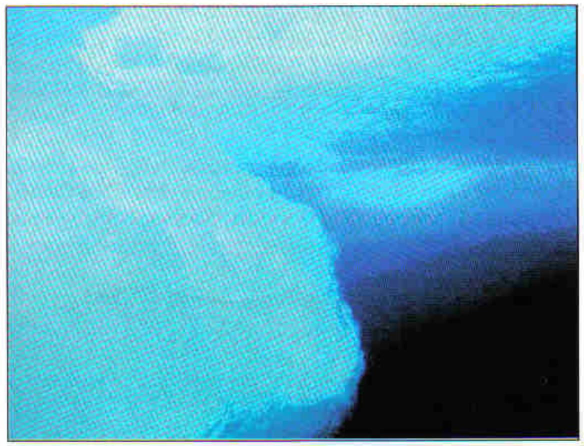
Planktonic species, while partly endemic to the Arctic, are believed to be mostly derived from Atlantic origins rather than Pacific, despite considerable inflow of Pacific species through the Bering Strait. For sea floor species, most investigators agree on the diverse origin of today's Arctic fauna (animal life). The lack of Pacific-origin deep-water species is considered to be a consequence of the closing of the deep connection to the Pacific 80-100 million years ago, which never re-opened. The shallow inflow through the Bering Strait today allows migration of shallow-water Pacific species, but not deep-water species, into the Arctic Ocean. The opening of the Arctic towards the Atlantic 27-40 million years ago happened at the same time as a cooling phase, enhancing the development of a cool-temperate Atlantic-character fauna, along with a gradual 'Atlantization' of the Arctic Ocean.

Arctic Sea Ice

The Arctic Ocean has experienced strong environmental changes over the last decades. The Arctic sea ice cover extent has decreased by about 3% per decade over the last 25 years and observations from submarines indicate a loss in ice thickness in all parts of the Arctic. Climate models predict, that - related to the effects of greenhouse gases - the Arctic summer sea ice cover might be lost by 2100 which would turn the Arctic Ocean into an ice-free ocean for several months per year. Besides many economical implications of such changes, biological impacts will occur with e.g., changes in the range of individual species and possible species extinctions.



The icebreaking capabilities of the Healy allowed scientists to sample about 15 stations during the one month expedition covering water depths from less than 200m to about 3800m. At each station, scientist conducted studies on ice, water and sea floor biota using different sets of tools.



The Arctic sea ice provides a unique set of environments for hundreds of species that make a living in the network of so-called brine channels in the sea ice. Viruses, bacteria, fungi, unicellular plants and animals and metazoa are found within at the surface and at the bottom of the sea ice, several being unique (endemic) to the Arctic.

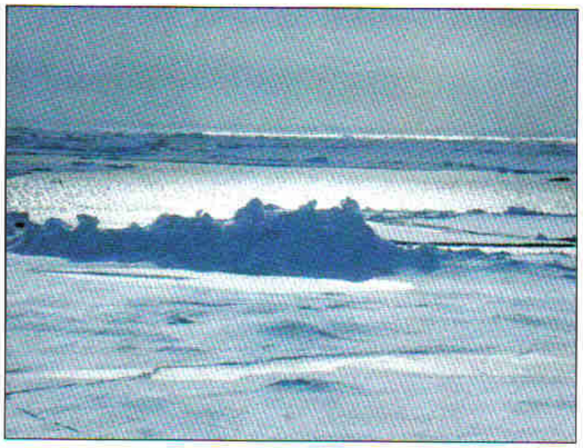
The central parts of the Arctic exhibit a year-round ice cover (so-called multi-year sea ice) while coastal and shelf locations are dominated by annual sea ice. Sea ice can freely drift with the currents (pack ice) or is attached to the coast (fast ice).

Photos taken underneath the ice surface show both the complexity of the ice structure as well as the stunning shades of blue. When ice floes push together, they form pressure ridges that are visible both above and below the surface forming a complex habitat that supports an abundant and diverse assemblage of organisms.

Unicelluar algae are the main primary producers in sea ice. They can occur in such high abundances that the color of the ice is no longer white/blue but instead brown/red. More than 200 algal species are known to exist in the Arctic sea ice but many species are likely not described so far. Microscopic observations on ice cores revealed that diatoms and flagellated taxa are the most important microorganisms inside the ice in terms of abundance and productivity. The plant life within the sea ice typically contributes between 2 to 50% of total plant production in the ice-covered waters of the Arctic.

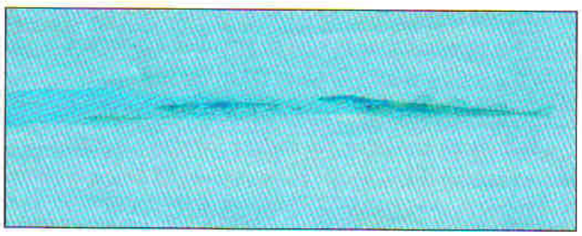
Sea ice is not a static substrate. It can break up and refreeze, and it can melt and disappear altogether, yet it plays an important role in ice-covered regions. When sea ice begins to form, growing ice crystals push the salt into pockets that get trapped in the ice. These are called brine channels and they create spaces in the ice where tiny plants and animals can live. Tiny, single-celled algae thrive in the bottom layers of the ice where they receive sunlight from above and nutrients from the water column below. Small, larval invertebrates colonize the ice to take advantage of this rich food source.

During melt periods the material drains down into the water column where it can be eaten by organisms below. The fish, Arctic cod, might be the most important link to marine



Sea ice landscape in the Canada Basin in late summer of 2002.

mammals and birds. Arctic cod feed on ice amphipods and zooplankton, and hide in the gaps between blocks of sea ice and in water wedges along the edges of floes.



Tiny animals, mainly unicellular protozoans and a few metazoans, in particular worms and crustaceans, use the sea ice algae as their food supply. An additional unique, partially endemic fauna lives at the underside of the ice floes. These animals (mainly amphipods) move along the bottom of the ice, feed on ice algae and find shelter against predators.

Spineless Wonders: The Pelagic Fauna

What forms of life drift in the world's oceans? For centuries, we have tackled this question by blindly pulling nets through the water, collecting primarily the smaller, slower, more numerous, and more robust planktonic species. Presently, we know a great deal about the more numerous crustacean zooplankton, such as the copepods (the sea's insects) and euphausiids (krill), that live in the upper layers of the ocean, but little about deep-water and fragile life-forms.

Spring pack ice cover in the Chukchi Sea. The Arctic pack ice is not a homogenous layer of ice, but consists of individual ice floes, that contain undeformed level ice and various amounts of pressure ridges. Some ridges can be deeper than 20m.

Undoubtedly, we have adequately sampled only a small fraction of the diversity present, resulting in significant gaps in understanding the linkages between algal production and the top predators in the oceans.

Undersea vehicles have vastly expanded our knowledge about behavior, biodiversity and vertical distribution of pelagic animals. Remotely Operated Vehicle (ROV's) and submersibles offer opportunities for direct observations of the species that are normally missed by plankton nets because they are too rare, too fragile, too deep, or too fast for us to catch. In addition, submersible tools can capture live, undamaged specimens of soft-bodied or "gelatinous" animals for further observation or experimental study.

Divers suiting up

SCUBA divers sampling the under-ice environment in the Canada Basin.

Gelatinous zooplankton range from the weird to the wonderful. Most are fragile and range from completely translucent to vividly pigmented. Individuals range in size from only few millimeters to several meters in length, while colonial forms may string tens of meters in deep-water. These animals are ubiquitous in the oceans, and many species have persisted for hundred of millions of years, yet we know relatively little about them. Collecting these animals with nets usually destroys or breaks them into fragments that are then ignored, discarded, or misidentified. Equally problematic, conventional preservatives often liquefy them, leaving behind no identifiable remains.

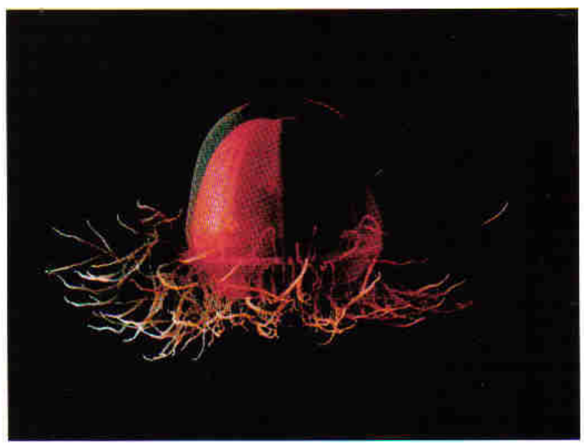
In contrast, deep-water zooplankton are poorly known not only because many are gelatinous, but because they require more specialized electronic plankton nets, and take much longer to collect. For example, collecting with inexpensive traditional plankton nets to 100m might only take 10-20 minutes, while collecting to 3000m requires more than 3 hours, making you unpopular with shipmates wanting to get to the next station!

Historically, most scientists assumed that these soft-bodied zooplankton were unimportant to ecosystem functions, yet recent investigations have demonstrated that they are capable of much higher rates of ingestion, growth, and reproduction than crustaceans. Higher rates allow them to respond more rapidly to shifts in ecosystem productivity. Deep-water species may be present only in low numbers, but when summed over the wide depth ranges in which they live, their importance becomes significant.

Benthic seastar

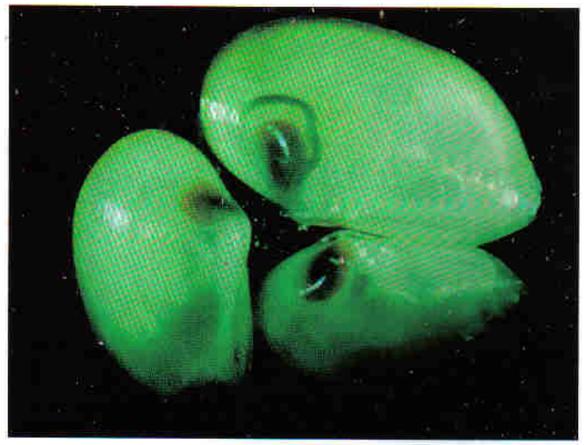
Deep Sea Fauna

Early marine researchers assumed the deep-sea floor to be devoid of any life. We now know that this is not true and that the diversity of species living in the deep-sea may rival that in tropical coral reefs. At first, scientists found the co-existence of manifold species puzzling because they believed that the deep sea was rather homogeneous and harsh; it therefore seemed logical that little variety of creatures would settle and survive there. Today, we think that the small-scale heterogeneity caused by sand ripples, animal tracks and worm burrows may partly explain the high richness of species that more and more researchers are finding at 5,000 feet and beyond. The arctic deep-sea, however, has received much less attention than other deep areas of the ocean world.



Crossata sp.

Eusirus holmii

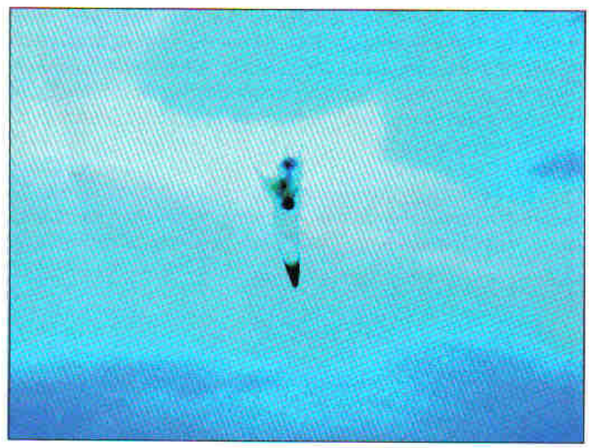


These are just a few of the thousands of images collected during the expedition displaying the incredible beauty and diversity of life that exists in the remote Arctic Ocean...

Arctic and deep-sea animals have adapted to permanently low temperatures in various ways. One adaptation is that their body processes, such as respiration and reproduction, work at a slower rate than those of organisms in warmer waters. This does not mean that deep-sea organisms do not do as well as organisms from warmer waters. Rather, these animals' body chemicals and life-maintaining processes work best at ambient low temperatures and at high pressure. Most deep-sea organisms would die in tropical temperatures or if they were kept in an aquarium. A consequence of the slow 'rate of living', deep-sea and Arctic animals tend to grow very slowly. In fact, some arctic deep-sea organisms grow as much in 10 years as some tropical organisms grow in one year! Slow growth usually also means high longevity. A polar sea urchin can get as old as your grandparents, but a tropical one would likely die before its 10th birthday.

High longevity, slow growth and late reproduction are partly consequences of low temperatures, but food also plays a very important role. Sea floor animals depend primarily on food particles that rain down from the top of the water column where microscopic algae, the bottom of the so-called food web, grow and provide a rich food source. A good portion of these algae are eaten by animals in the upper water column, leaving the deep-sea creatures with what little is left over or with fecal pellets and molts of those animals at the ocean surface. The food that does reach the seafloor often is no longer fresh and has lost much of its nutritional value. Moreover, ice-covered areas get less algal production than non-ice-covered areas, resulting in even less "food rain" for the Arctic deep-sea benthos. As a result, many deep-sea animals, especially bristle worms, ingest sediment and extract whatever organic matter is left within it.

The Arctic deep-sea floor, or those animals living within the sediment. This community was dominated by polychaetes (bristle worms) as is typical for most soft bottom regions of the world oceans. Other groups found were bivalves and crustaceans of various sorts. Among the crustaceans, we discovered at least three new species of isopods



Clione, a shell-less snail known as the sea-butterfly, swims in the shallow waters beneath Arctic ice

Wayne Smith, DFO Winnipeg, in his drysuit working his way back onto an ice floe after a dive in the Canada Basin.

Bottom trawl treasures from the Chukchi Sea shelf near the Canada Basin: Sea stars, brittle stars, clams, some snails and crabs.

(crustaceans related to pill bugs). Overall, the density and biomass of the infaunal animals was low which again is typical of deep-sea areas elsewhere. The species richness (number of species), however, was rather high and was dominated by species of Atlantic origin.

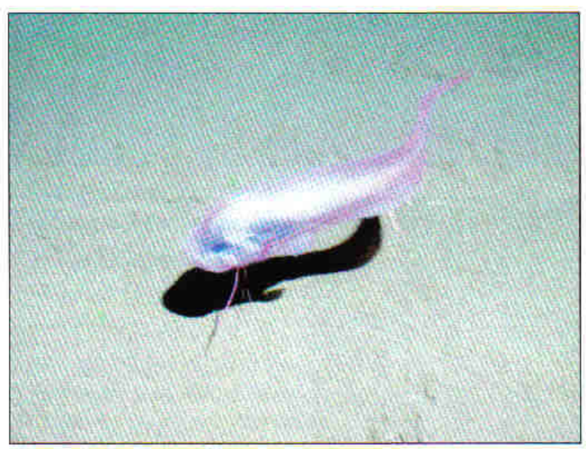
Muddy Jewels and Images of the Deep

To learn more about these creatures living in the deep, we used a variety of tools including a benthic trawl to collect the animals, and an underwater camera system to estimate their abundance and distribution. Deploying a benthic trawl net in an ice-covered ocean, however, is not simple. First we needed an open stretch of ocean with little to no ice cover- a rare occurrence on our route!

The net was full of soft, sticky deep-sea mud, hiding its treasures inside. After 2 hours of sieving, we picked out our little jewels: Several 3 cm long, white sea cucumbers called *Elpidia*; a handful of small pale anemones; some clams, crustaceans and a number of yet unidentified creatures. Catching specimens of seafloor animals for identification and analysis is important, but seeing where and how they live is another important part of our study. To see what lives in over 3,850 meters of water, we assembled a photographic platform that could perform down to depths of 6000 meters. The photo-platform is built to carry a camera in an underwater housing along with a big, powerful flash for lighting. The camera is pre-programmed to take images at time intervals of 10-20 sec using a time-lapse circuit. It uses powerful batteries, essentially two golf-cart batteries in an oil-filled container, to run the system. While in operation, a conductivity, temperature and depth sensor sends real time information about its depth and altitude off the bottom, as well as data on the water temperature, salinity, etc.

Unlike an ROV, there is no way to see the pictures taken by the photo platform until it returns to the ship. To take good pictures the platform needs to be no more than 5 m off the bottom, but if you get too close, your risk getting mud on the camera lens, or worse, damaging the system.

Despite the difficulties, everything had worked out well- we collected 266 well-exposed images of the bottom that clearly showed bivalves, sea cucumbers, and anemones. Living animals were rarer than their trials, fecal coils, and burrows. Using the photo platform to image the deep-sea fauna while concurrently taking trawl samples confirmed the species composition of the area sampled. After seeing the images collected by the platform we were thrilled with the trawl results: The cucumbers, anemones and other creatures collected seemed to be those that we had seen on the images taken by the photographic platform and the ROV.



A snail fish in the Canada Basin at roughly 6000 feet water depth, photographed by the Global Explorer ROV camera.

Fertile Findings at an Unusual Site

East of the Canada Basin and approaching the Northwind Abyssal Plain, site 12 was to be our Northern-most station and had been positioned to explore a series of deep depressions, called pockmarks, detected by an earlier expedition with HEALY. Most of the deep seafloor is flat and level. Even steep slopes tend to be quite level on their surface. Deep depressions signal active geologic processes — some of which can have biological significance. For example, in the Gulf of Mexico, pockmarks are often caused by gas or fluid eruptions and the chemical enrichment provided by these processes can support dense communities of chemosynthetic organisms.

The Beam Trawl is back on board with a muddy load! The mud has to be sieved before the creatures within it will be found, identified and analyzed.

We ended up sampling a site further south than originally planned, but it was still an area with a 10-mile long row of depressions and possible pockmarks. We were able to complete a 10-hour ROV dive, three box cores, and gather 820 bottom photos with the photo-platform.

What did we find? The exciting thing is that this is hands-down the most populated bottom area we sampled. There were thousands of sea cucumbers and anemones! Benthic jelly fish hovered above the bottom while fish and shrimp finned slowly by. There were large burrows, countless trails, and many burrowing urchins. The site was clearly a garden spot compared with the much less populated areas we had already explored. The puzzling thing was that we saw no evidence for gas or fluid seeps. No bacterial mats and no chemosynthetic animals of any kind. So the causes for the lush benthic life remain unclear.

Life at the seafloor: Arctic sea star *Ctenodiscus crispatus*.

Anemones and sea cucumbers were observed at the pockmark site in unusually high densities compared to other sites visited during the cruise.

Surprises from Comb Jellies in the Arctic

The comb jellies, also known as *ctenophores* (meaning "comb bearers"), have provided us with a wealth of new and interesting information during our cruise. Comb jellies are not true jellyfish; unlike jellyfish, they do not sting. These animals are among the most poorly known in the world's oceans because they have extremely fragile bodies. Traditional sampling methods involving plankton nets and formalin preservation destroy their delicate bodies. Some species are so delicate they pour like liquid out of our collecting jars! To overcome these sampling problems, we are observing and collecting ctenophores by SCUBA diving in the surface waters and using an ROV in deep waters down to 2800 m. We are finding ctenophores living at all depths, from the surface to the deep ocean bottom.

There is a shallow-dwelling community of jellies that occupies only 1% of the total water column depth. This community includes the ctenophore, *Mertensia ovum* , which feeds with sticky tentacles on large copepods in the top 20 meters of the water column. *Mertensia* is a robust species known throughout Arctic waters. During our 2002 Arctic cruise, I had been impressed with the abundance of *Mertensia* near

Mette Nielson and Rolf Gradinger work on ice cores in the Arctic. Understanding the role of sea-ice in the Arctic food web will help scientists determine what impact declining ice cover might have on the Arctic community as a whole.

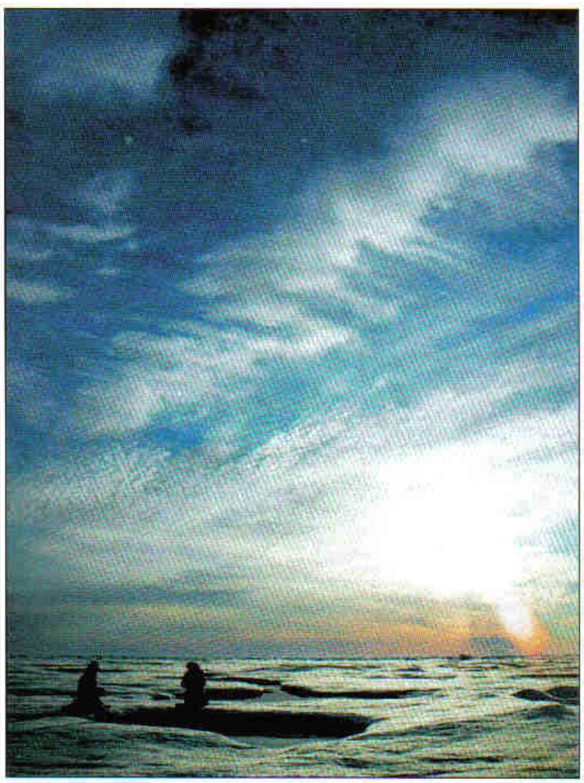
the surface because I didn't expect any animals to be abundant in these waters of supposedly low productivity. Also feeding on near-surface copepods is the ctenophore, *Bolinopsis infundibulum* , which catches prey inside large, translucent lobes. *Bolinopsis* is extremely fragile, and its biology was poorly studied in the Arctic until now.

The shallow ctenophore community also includes two specialized predators. The ctenophore, *Beroe cucumis* , eats only other ctenophores. At our Arctic locations, *Beroe* has a bright red gut, perhaps caused by eating the red-tentacled *Mertensia* . The second specialist found was previously known only in Antarctica and the eastern Arctic; *Dryodora gladiformis* eats only planktonic tunicates known as larvaceans. Finding such restricted diets is surprising in animals that cannot locate their prey using any specialized sensory organs (eyes, ears or noses) in an environment where prey are widely scattered in a three-dimensional water column.

The ctenophore, Beroe cucumis , is specialized to eat other ctenophores.

Deeper in the water column, three types of ctenophores previously unknown to Arctic waters are being found. Around 300 m depth, we are seeing several ctenophores with teardrop-shaped tentacle branches. At 1375-2625 m depth, we are seeing ctenophores with dark purple guts and finely-branched tentacles that have been observed in other waters, but have not been formally described and named.

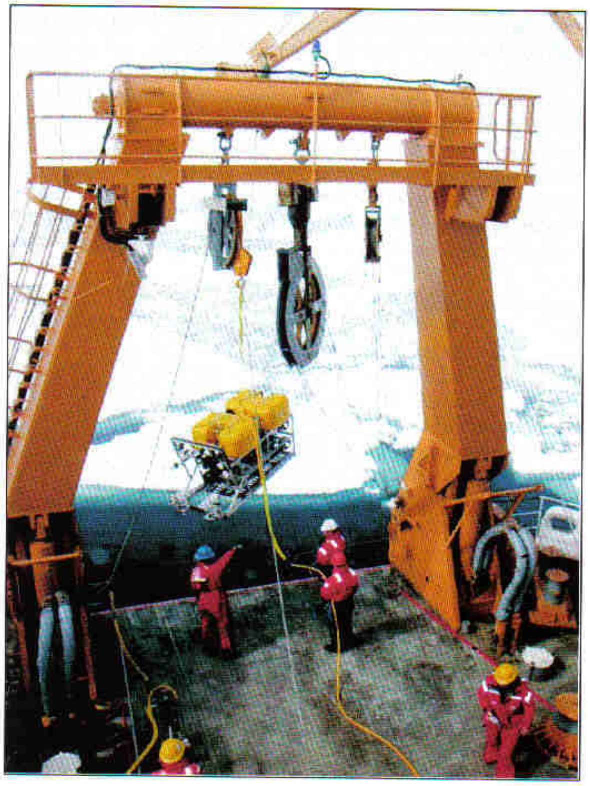
From 350-1100 m, we are seeing a ctenophore species previously described deep in Monterey Bay, California, and the North Atlantic. This amazing animal, *Aulacoctena* , is the size and color of an orange. I like to think of it as the



Scientists gather samples from a sea ice melt pond in the middle of the Arctic 'night.'

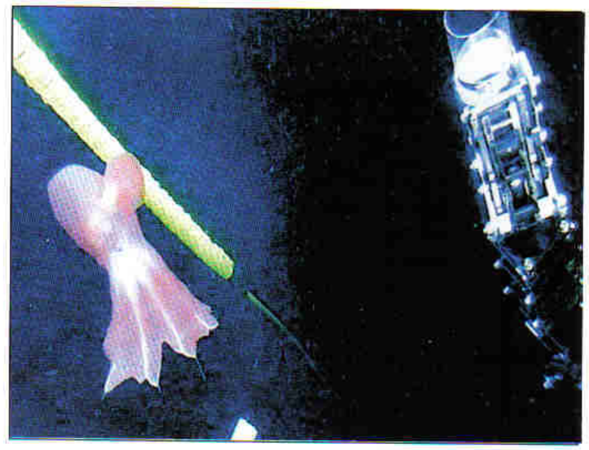
The new jellyfish is in the order Narcomedusae. It has four tentacles, 12 stomach pouches, and most interestingly, four small secondary tentacles at the very edge of the bell. While foraging for food, this species holds its long tentacles, covered with poison filled stinging cells, out in front while it swims, perhaps to ambush its prey more effectively.

The ROV is deployed off the back of the boat using the Healy's A-Frame.



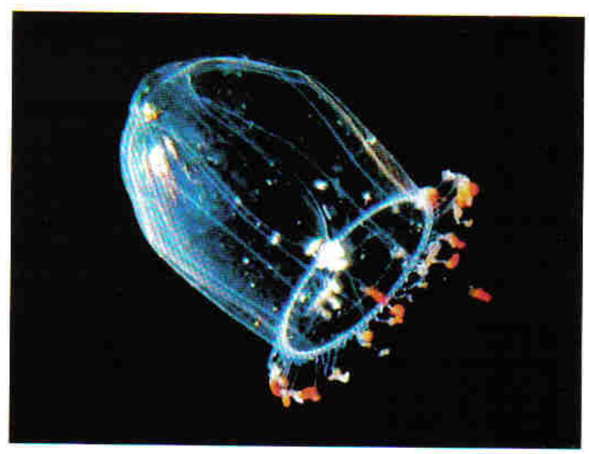
'Sunkist' ctenophore. It has two tentacles that are white, thick, unbranched and very sticky; during collection the tentacles managed to stick strongly to the ROV. We speculated about what such an unusual ctenophore might eat; other tentaculate predators with similar tentacles feed on large, active prey. Few large animals, however, live at such great depths in the mid-water realm. Finding the answer to this mystery was not expected, but the very first specimen collected regurgitated the remains of a meal in the container - mainly a partly digested nemertean worm. We had seen and collected this large, orange worm at similar depths.

Finned octopods, known technically as cirrates, are sometimes called "Dumbos" because the large fins make them look like flying cartoon elephants flapping their ears. They are among the largest organisms of the deep sea. The species seen in the Canada Basin can grow to 1.5 m in length. Because they are difficult to collect, their biology and ecology are poorly known.



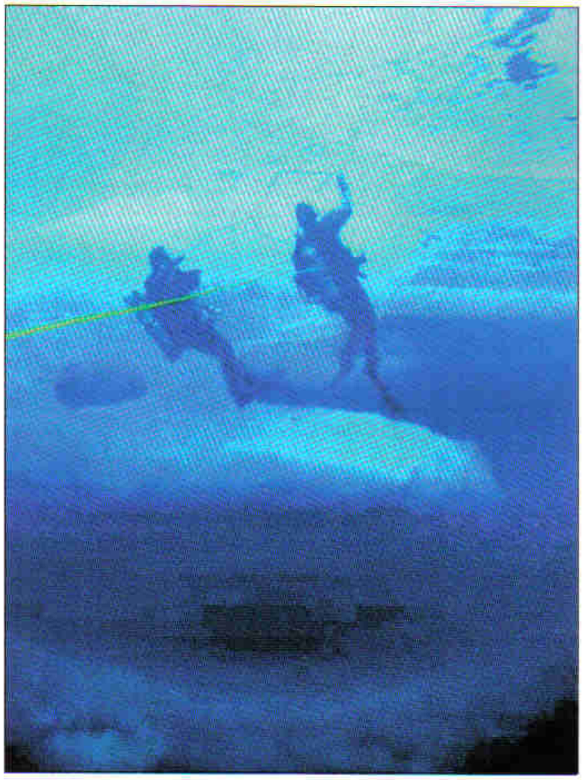
The finned (or cirrate) octopod Cirroteuthis muelleri.

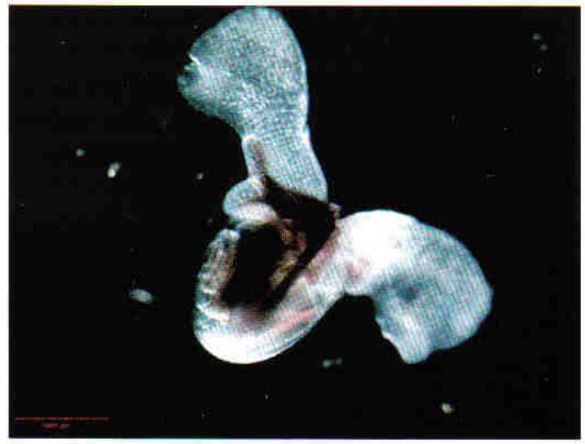
Chief Scientist Rolf Gradinger is silhouetted by the Arctic sun while collecting one of the last ice cores of the cruise.



Aglantha digitale, a small hydrozoan medusae common in the upper waters of the Arctic.

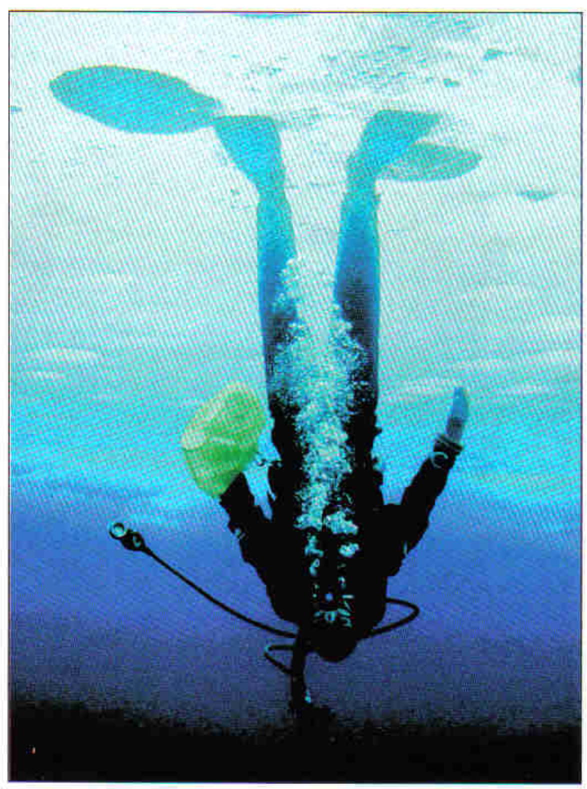
Ice divers use a quadrat to study the density of creatures living on the underside of ice floes. Their research has shown higher densities of amphipods and other creatures in under ice areas with more physical relief; the little holes and crevices in the ice provide habitat and protection from predators.



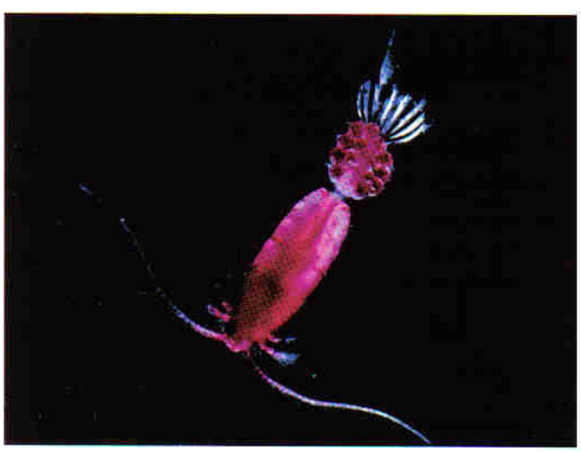


Pelagic snail (Limacina helicina).

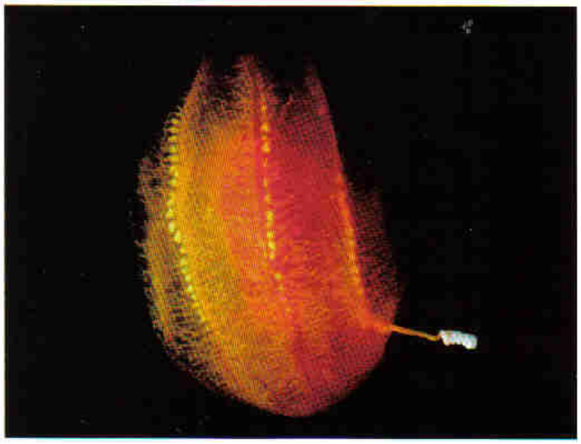
Ice diver Shawn Harper "stands" on the ice ceiling above him. Ice diving on this cruise is different from other types of diving as work is conducted on the ice close to the surface while thousands of meters of blue water unfold below.

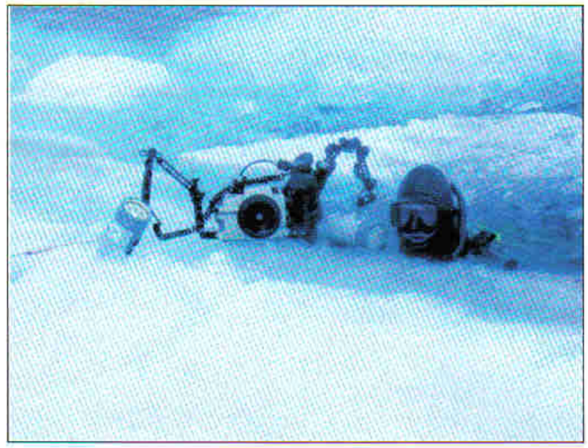


Pelagic copepod Euchaeta barbara.



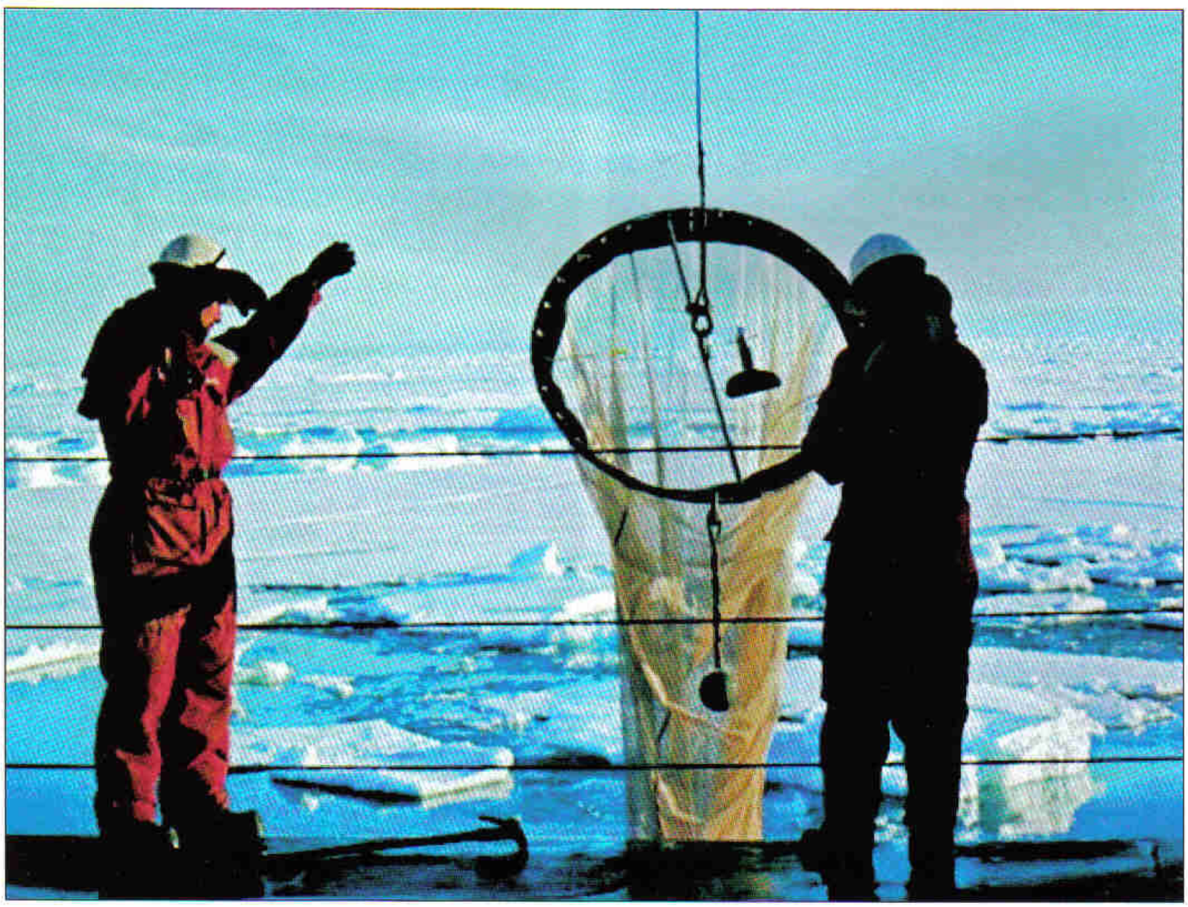
Aulococtena is the size and color of an orange and has two tentacles that are white, thick, unbranched and very sticky. This species has been encountered from 350-1100 meters deep on this expedition.





National Geographic Magazine photographer Paul Nicklen after an ice dive in the Canada Basin in 2002.

A "live net" is deployed in Arctic waters. Live net sampling allows us to determine the abundance of ctenophores and other Jellies.



A close-up of Boreo Atlantic Armhook Squid, Gonatus fabricii.