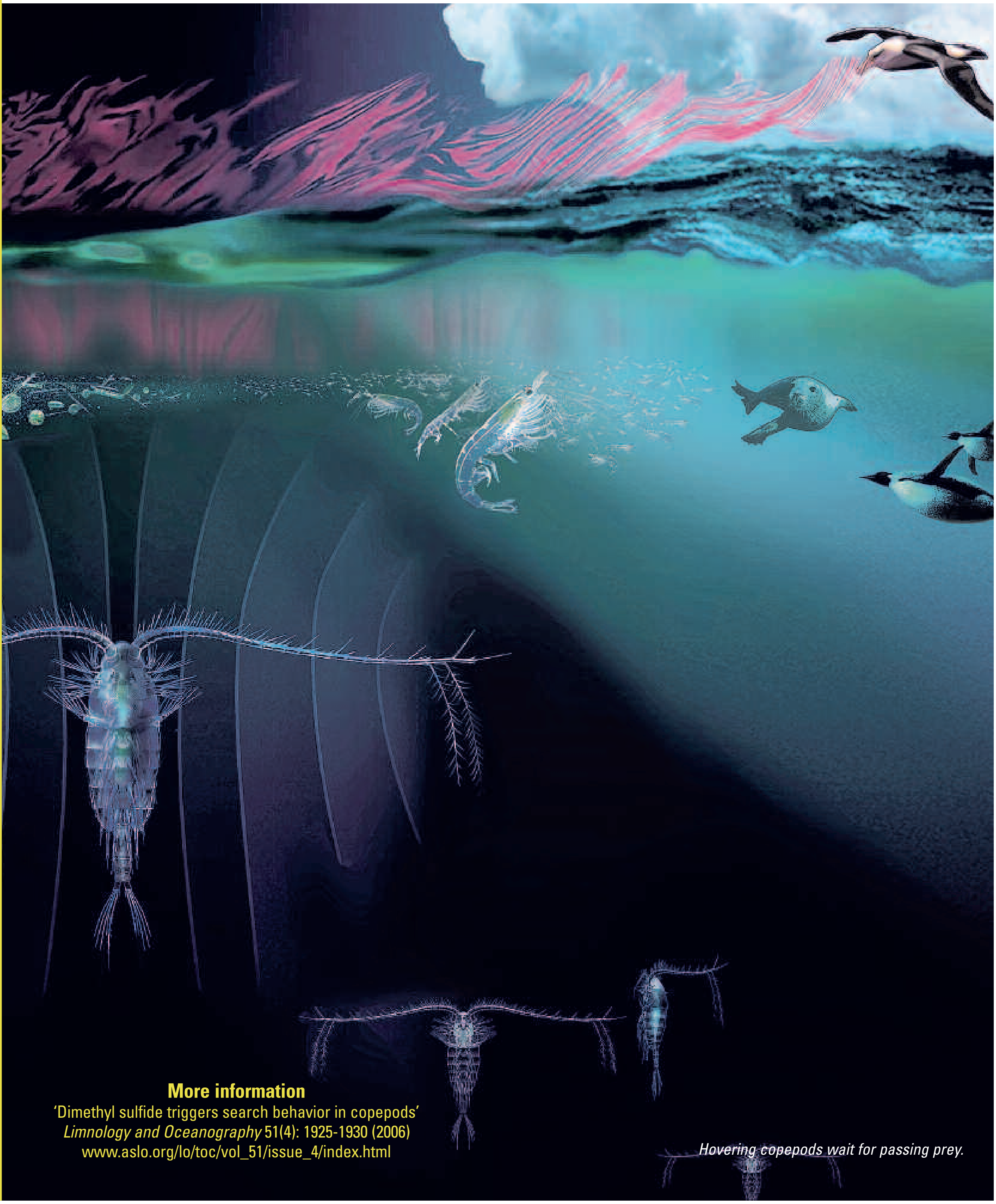
Ocean **odours**

The ocean's distinctive smell is caused by a single chemical released by plankton and other marine life, dimethyl sulphide or DMS. Michael Steinke is on the scent.



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More information
'Dimethyl sulfide triggers search behavior in copepods'
Limnology and Oceanography 51(4): 1925-1930 (2006)
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Hovering copepods wait for passing prey.

The strange world of DMS – dimethyl sulphide

DMS, which is produced by plankton, gives the oceans their distinctive smell. Do birds follow this scent to bountiful feeding grounds?

Plankton produce DMS when stressed, for example in very hot weather or if ultra violet (UV) rays are particularly intense. We know DMS can seed clouds, so are plankton deliberately creating clouds to protect themselves?

Viruses frequently attack phytoplankton but DMS protects some species from viral infections. Do the high DMS concentrations in algal blooms prevent healthy cells from catching a virus?

DMS can protect algal cells from harmful oxygen radicals. Is DMS the 'Vitamin C of the sea'?

Coral reefs are 'hotspots' for DMS production. Their vibrant colours come from DMS-producing algae living within the coral polyps, where they are protected by hard calcium shells. DMS has a role in helping the coral cope with high temperatures and UV light. Is DMS reducing the damaging effects of global change on corals?

Did you ever get hungry walking down the high street? A whiff of grilled sausages from the stall just around the corner may have given you those cravings. Could similar cues in the ocean spark a ravenous appetite in a sea creature? We know that sensing odours is important to life in the oceans. You may have witnessed the fascinating behaviour of sharks in Steven Spielberg's '*Jaws*'. Usually, sharks aren't bothered by swimmers – but beware, just that little cut by sharp coral, a drop of blood, that is all it takes for hell to break loose. I've been investigating odours in the ocean. I am particularly interested in one remarkable chemical, dimethyl sulphide, or DMS, and how this chemical affects the appetite of marine creatures.

Finding food in the vast ocean can be very difficult for tiny predators, such as copepods. These crustaceans feed on microzooplankton, microscopic floating creatures that are just above phytoplankton in the ocean's food web. Copepods – pronounced ko-pee-pods – have hard shells and look a bit like miniature lobsters – they are often just a few millimetres long. Some copepods just hang out motionless in the water and listen for the sounds of approaching prey before launching surprise attacks on their victims. Others rely on chemical sensors that are similar to the taste buds on our tongue and respond to chemical cues, for example waste products released by copepod prey – the microzooplankton. Interestingly, microzooplankton food – phytoplankton – release significant amounts of DMS when stressed, for example when microzooplankton attack them. Could phytoplankton be using copepods to protect themselves from their own predators – microzooplankton – by making them smellier and so easier to find?

> Could phytoplankton be using copepods to protect themselves from their own predators

Lets look at some scent mechanisms that have evolved on land, to see if we can find any comparative behaviour. The fragrance of a beautiful flower is pleasant to us and attractive to nectar-searching bees. In contrast, flies are often drawn to odours rather unpleasant to the human nose. The value of an odour is only as good as the chemical sensors, taste buds or receptors, that have evolved to recognise it. As soon as an odour has been identified, bees and flies can adapt their feeding strategy, fly to where they find the strongest smell and stuff their little bellies.

We don't know whether DMS can stimulate the chemical sensors of copepods and how these animals would react to different concentrations of this compound so we thought we should investigate. I teamed up with Jacqueline Stefels and Eize Stamhuis from the University of Groningen in The Netherlands to look at copepod behaviour in a stream of DMS. They use a technique called laser-sheet particle image velocimetry to monitor the water flows produced by aquatic animals. Three components are necessary to make this method useful to us: a powerful red laser beam that can produce a very thin sheet of light, reflective particles that have the same density as the medium surrounding the studied organism (seawater in our experiments), and a camera that compares the position of individual particles in two snapshots taken just split-seconds apart. This is very similar to the trick the police use with their speed-cameras. By taking two successive photos and comparing the position of a car in relation to a grid painted on the road surface, they can calculate the speed the car was travelling at when the pictures were taken.

So with all this equipment we could look closely at how DMS affects copepods. We used a capillary loaded with a seawater solution spiked with DMS and slowly injected this into the current in front of the tethered animal. When the DMS hit the copepod, the animal reacted with a search behaviour that is comparable to the reaction of a male copepod after encountering the trail of female sexual attractants. This demonstrates that copepods can smell the DMS and suggests that this and possibly other compounds released by phytoplankton and microzooplankton may help copepods in finding their prey. So, could the rapid release of DMS be part of a clever trick used by the phytoplankton to attract the enemies of their enemies? We know plants on land can signal for help to rid themselves of their attackers. Beans, for example, produce a cocktail of gases when they are infected with herbivorous insects that drill into the plant and suck its sweet sap. These gases help meat-eating or carnivorous insects to find their prey and provide a mutual relationship between the plant and the carnivore. We are still some way from finding the first example for such an interaction between three different levels in aquatic food webs – phytoplankton, microzooplankton and copepods – but our finding on DMS marks an important step towards a better understanding of these interactions in the oceans.

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