Review of MS by Kim et al: “Collection of large benthic invertebrates ….”

I think that this is an amazing observation and absolutely deserves to be published quickly.

Outside of the Mager papers I was not aware of until asked to review this, I think that these authors have put together the most scholarly and complete discussion of anchor ice I have ever seen. I am still struggling to understand how those animals got there and will talk about some ideas, but the important thing is to get the paper published so the general community can discuss it. I cannot emphasize strongly enough that I consider it important irrespective as to whatever the ultimate explanation turns out to be, this represents a very unusual situation that will much enhance our understanding of polar marine ecosystems.

The following comments are not meant to be criticisms that stand in the way of publication, but just my efforts to understand the processes that lead to these animals falling into the traps. I do think that the issues I discuss merit some discussion in the text if only to focus other scientists on the issue of dispersal to the trap area and the density of invertebrates transported to the area above the traps. Also, I offer an alternative hypothesis that has never been considered before, but I think it merits some sort of mention in the paper.

First, these are shallow water species assuming they are *Parborlasia corrugatus* (the worm), *Sterechinus neumayeri* (the urchin), and *Adamussium colbecki* (the scallop). I think I can assert that they were not uplifted from deep water near the traps, but rather were sourced in shallow water far from the traps.

The traps are small, 80 cm aperture diameter, but still extremely tiny compared to the ocean bottom! Anchor ice in my McMurdo experience does lift animals, but not many and the slimy ones such as nemerteans or anemones fall out of the ice quickly, and I would not expect to see nemerteans transported very far, if at all. So, my own personal experience with anchor ice would agree that it is possible for a very few tiny pectin or urchins to be transported out to sea, but relatively few. It would be an amazing put possible coincidence for anchor ice to carry an urchin or pectin and have it fall in the trap. But a single one arriving this way would be astounding. You have many. The probability of anchor ice getting so many shore-based animals so far to sea falling into a tiny orifice is remote beyond calculation.

I offer an alternative explanation for which there is absolutely no evidence (but nor is there any evidence before this paper of such transportation). These are very small immature animals that have just settled and metamorphosed. In almost 1,000 dives at McMurdo I have never seen any baby nemerteans, none. If those are Parborlasia, this in itself is extraordinary to see so many baby nemerteans. And that many tiny urchins and scallops are also rare in the natural situations I have seen. I offer the following hypothesis that might explain so many very young animals falling into the traps.

A lot of light comes through thin annual sea ice and there are dense growths of diatoms and other algae on the undersurface of the ice. Sometimes these diatoms and *Phaeocystis* chains

hang down from the ice. Now assume that there is a thick layer of frazil ice platelets formed by upwelling of super cooled water. Furthermore, brine flows out from annual sea ice making stalactites and leaving large cavities and tunnels in the sea ice that become rich algal farms that are colonized by amphipods and small fish (at McMurdo *Pagothenia borchgrevinki*). Assuming that this happened in your area, and the entire "roof" above your traps had all this biological activity, it is unheard of but possible for the pelagic larvae of the invertebrates that you recovered to have experienced a very heavy recruitment in this "farm" of algal food (for the urchins and pectins; the amphipods and other tiny metamorphosized invertebrates would be food for the nemertean recruits to have eaten. Now you have large populations of the same animals you trapped above your traps. So assume that the surface waters warmed and the platelets melted , and your Amundsen Sea might have large numbers of invertebrates sinking to the bottom and falling into your traps.

I actually think that this is a better explanation than anchor ice uplift and transport and I suggest that you find a way to work it into your paper. But again, absolutely, the paper deserves to be accepted one way or another as it is a very unusual and interesting observation.

Good luck,

Paul Dayton