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Lipids in polar ctenophores and medusae: Visual observations of location and origin

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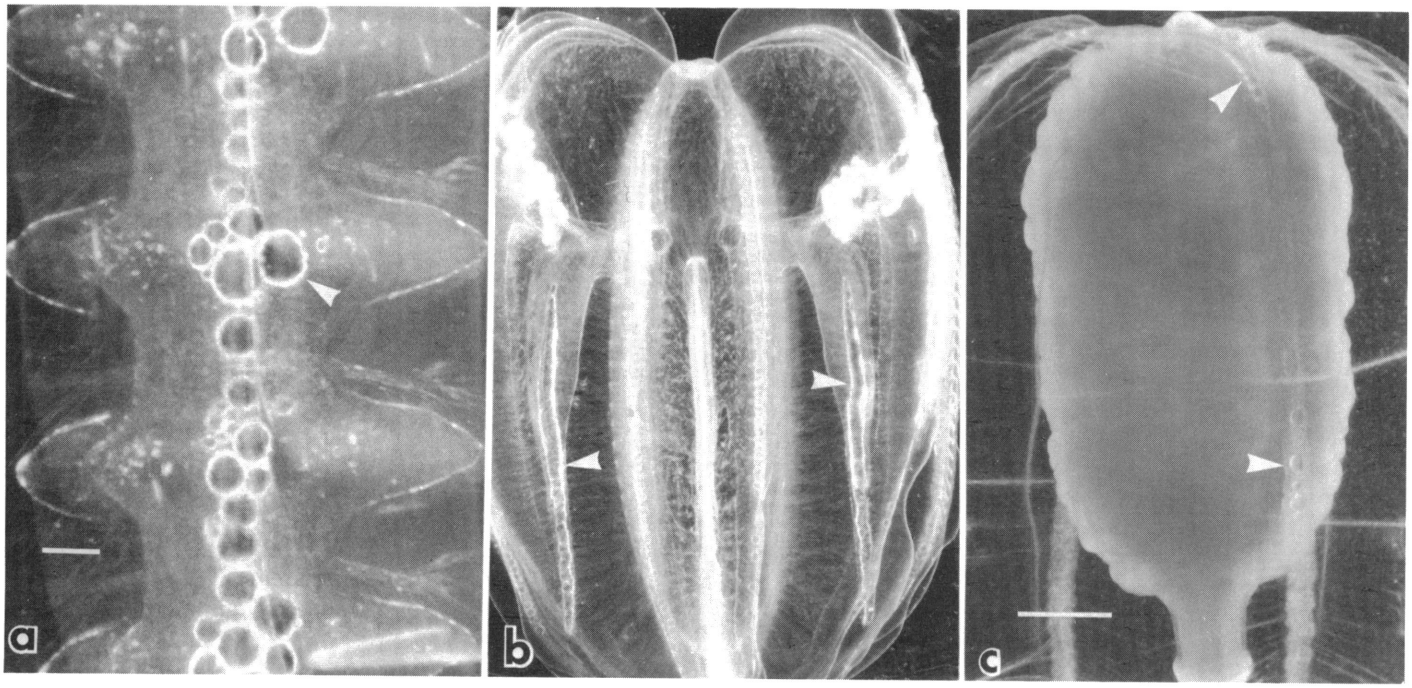
The presence or absence of accumulated lipids in arctic and antarctic medusae and ctenophores was determined by visual examination of living specimens with a dissecting microscope. In the Arctic (between Iceland and Svalbard), gelatinous zooplankton were hand-collected using scuba at depths of 0 to 25 meters in July and August 1988. Surface water temperatures ranged from −1 to 11 °C (averaging 2 to 4 °C) with a strong thermocline. In the Antarctic, studies were done at McMurdo Sound, Ross Sea (77°38′S 166°25′E) in November 1987 and December 1988. Specimens were collected using scuba and with a 1-meter plankton net fished through holes in the ice. Water temperatures in the upper 20 meters were nearly isothermal, ranging from −1.6 to −0.6 °C. Prior to this investigation, the location of lipids in polar gelatinous organisms was undocumented.

Lipids were seen in many of the more than 200 gelatinous zooplankton specimens collected. They always consisted of various sized droplets and larger masses within the lumen of the gastrovascular system (figure). In ctenophores, lipids were seen in the meridional canals below the comb rows, or in one species (*Mertensia ovum*) in special sacs extending from the tentacular canals (figure, block B). In medusae, they occurred either in the stomach, ring, and/or radial canals (figure, block C).

Lipids were seen in 9 of 14 species of arctic medusae examined, including *Aegina citrea, Aglantha digitale, Euphysa japonica, Halitholus pauper, Hybocodon prolifer,* and *Sarsia princeps.* In antarctic medusae, lipids were seen only in the stomach of *Solmundella bitentaculata;* none were seen in *Diplulmaris antarctica, Kollikerina maasi, Leuckartiara* sp., or *Mitrocomella frigida.* All arctic ctenophores examined, including *Beroe cucumis, Bolinopsis infundibulum,* and *Mertensia ovum,* contained visible lipids. In *B. infundibulum* small oil droplets (0.1 to 0.3 millimeters) occurred in the meridional canals (figure, block A). *Mertensia ovum,* the most abundant species of gelatinous zooplankton in the Arctic, was unique in that large amounts of lipids (up to 10 to 20 milligrams) occurred in specialized "oil sacs" extending orally along the tentacle bulbs (figure, block B). In the antarctic ctenophore *Callianira antarctica,* juvenile specimens (1 to 2 millimeters in length) contained an abundance of lipid droplets both in the stomodeum and in the meridional canals, whereas in larger specimens (12 to 45 millimeters) lipids were confined to the stomodeum.

Accumulation of lipids was observed in feeding animals, suggesting that the prey-derived lipids were unmodified. In the Arctic, when *Calanus* spp. copepods were fed to *M. ovum,* lipids were seen in the canals within 12 to 18 hours and subsequently began to accumulate in the paired oil sacs. In the Antarctic, when *Calanoides acutus* copepods were fed to *C. antarctica,* lipids accumulated in the gut as the prey were digested and remained there for more than 2 weeks. In the ctenophore *B. cucumis,* an abundant and sometimes dominant species of ctenophore in both the Arctic and Antarctic, most arctic specimens contained some small, reddish-colored oil droplets (0.05 to 0.3 millimeters) within the meridional canal. These lipids apparently came from its prey *M. ovum,* as was verified by feeding experiments. Antarctic specimens of *B. cucumis* contained only a few small droplets in the meridional canals.

Disappearance of lipids in starved animals suggested that lipids are taken up and assimilated. *Calanus* spp. copepods with large oil sacs were fed to starved arctic medusae and



A. *Bolinopsis infundibulum* meridional canal below comb row with numerous lipid droplets (arrow). Bar is 0.25 millimeter. B. *Mertensia ovum* with paired oil sacs (arrows). Specimen 24 millimeters total length. C. *Euphysa japonica* manubrium and radial canals showing lipids in radial canals (arrows). Bar is 1 millimeter.

ctenophores that contained either no visible lipid, or to animals where the amount of lipid was previously categorized. Within 6 hours after feeding, large amounts of lipids were seen at the base of the stomachs of the medusae *Catablema* sp. and *H. pauper*. After 12 hours, the lipids appeared as small droplets in the radial canals and after 1 to 3 days no lipids were seen.

Previous studies have documented the importance of lipids in polar gelatinous zooplankton (Percy and Fife 1981; Clarke 1983, 1984; Reinhardt and Van Vleet 1984; Clarke et al. 1987; Hagen 1988), but it was not apparent that in the Antarctic, the average lipid content of ctenophores and medusae is about 3 percent of dry weight (range is 0.4 to 6 percent), whereas in the Arctic it is nearly three times higher, about 8 percent of dry weight (range is 1.5 to 22 percent). These differences are probably related to the amounts of lipids in their prey. The abundance of lipid-rich *Calanus* spp. copepods in the Arctic may be responsible for the high levels of lipids in arctic gelatinous predators.

The lipid deposits that we observed in polar ctenophores and medusae could provide a significant energy reserve. For example, a ctenophore or medusa with a lipid deposit equalling only 5 percent of total dry weight could fast for about 1 month without weight loss.

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