Mass Mortality of Krill Caused by Parasitoid Ciliates

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Euphausiids, commonly known as krill, often dominate pelagic crustacean productivity of the world’s oceans. The ecology of these crustaceans has been extensively studied, but sources of mortality remain poorly understood. Predation and starvation are traditionally assumed to be the most important causes of death; however, little attention has been given to the identification of other sources of natural mortality (J). Here we report on a ciliate parasite with significant infection rates in euphausioid populations that causes death of the euphausiids, thus reducing productivity.

During six summer oceanographic cruises off the coast of Oregon, in the United States, we collected 71 euphausiids belonging to three species, Euphausia pacifica, Thysanoessa spinifera, and Thysanoessa gregaria, which were infected by an apostomatid ciliate of the genus Collinia. Endoparasitized adult euphausiids were collected at 7% of 313 stations sampled, mostly near the continental shelf break where euphausiids are usually most abundant (fig. S1). Shipboard incubations indicate that the infection, recognized by an orange and swollen cephalothorax (fig. S1), develops rapidly (<24 hours) and that the parasite undergoes obligatory polymorphic stages of infection, growth, proliferation, and encystment that correspond to specific life-history stages (2). The feeding stage (trophont) consumes all the organs including the lipid-rich gonads (fig. 1A). The reproductive stage (tomont) divides rapidly by palintomy to form transmission cells (tomites), which rupture the cephalothorax, usually killing the host within 40 hours of infection. This ciliate species is a parasitoid because it must kill the host to achieve transmission and complete the life cycle.

For euphausiids, swarming confers benefits such as improving capture of motile prey, increasing the probability of mating and decreasing predation risk. However, it may also increase susceptibility to parasitism and disease. Dense euphausiid aggregations may increase parasitoid transmission after an infected animal bursts and sinks through the aggregation, distributing infective stages. This phenomenon may lead to large-scale euphausiid mortality. We observed such a mass mortality event (June 2001) at the base of Astoria Canyon, Oregon (fig. 1B). Using a remotely operated vehicle (ROV), we discovered high densities of dead E. pacifica on the sea floor between 550 and 220 m depth along almost 1.5 km of ROV transect (fig. 1C). Euphausiid swarms and weak or dead adult euphausiids were observed close to the sea floor. Carcasses collected by the ROV contained the same parasitic ciliates and exhibited similar infection signs (partially empty and broken cephalothorax) as infected euphausiids from shipboard incubations.

Infection of euphausiids by a similar endoparasitic apostome ciliate Collinia beringensis has been observed in the Bering Sea with prevalences of 68 to 98% (3, 4). These reports were based on preserved specimens, and the appearance of infected live euphausiids and the effects of the ciliate were unknown. The Collinia species responsible for euphausiid mortality off Oregon is currently undescribed. It is morphologically distinct from Collinia beringensis having 15 to 20 rows of cilia compared with 24 to 80 in the corresponding stages of C. beringensis.

In the Northern California current, E. pacifica and T. spinifera are the dominant euphausiids (~90% of euphausiid biomass). Our surveys suggest that Collinia sp. endoparasitism is widespread within the euphausiid population, which indicates that the large-scale mortality event we observed is unlikely to be an isolated case. Parasites and pathogens are known to control animal populations in marine and terrestrial environments (5), and members of the genus Collinia are certainly among the most virulent euphausiid parasites known (2). The epizootic character of the euphausiid mortality observed in Astoria Canyon challenges the widely held notion that mortality in pelagic organisms can be primarily attributed to predation and starvation.

References and Notes
6. Supported by the U.S. GLOBEC Program (contribution 385) and NOAA’s Ocean Exploration Program.

Supporting Online Material
www.sciencemag.org/cgi/content/full/301/5631/339/DC1
Fig. 51

1 April 2003; accepted 6 June 2003

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