Collaborative Research: Climate Change and Predatory Invasion of the Antarctic Marine Environment

PROJECT SUMMARY

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Global climate change is altering polar marine ecosystems through rising temperatures and ocean acidification. Marine communities in Antarctica face an additional threat: climatically driven biological invasions from temperate and subpolar latitudes. Durophagous (skeleton-breaking) crabs from warmer environments are on the verge of invading shallow-benthic habitats. If invasive predators establish viable populations, that could spell disaster for the endemic shelf fauna and its unique trophic structure. Because the marine environment surrounding Antarctica remains largely unexplored, the extent of established crab populations is unknown. NSF's Special Opportunity for Science Aboard the Swedish Icebreaker *RVIB Oden* provides the ideal opportunity to sample areas of the Bellingshausen and Amundsen Seas rarely visited by marine scientists. This study will assess the status of crab populations in western Antarctica and their potential to disrupt benthic communities.

The marine fauna of Antarctica currently lacks the durophagous predators that structure benthic food webs in nearshore habitats elsewhere. Climatic cooling beginning in the Eocene eliminated durophagous fish and crustaceans from Antarctic waters. Since that time, the benthos has evolved toward an archaic, quasi-Paleozoic community structure in the absence of those top predators. Sea temperatures are now rising rapidly and the physiological barriers to predatory reinvasion are coming down. Adult and juvenile anomuran king crabs have been discovered recently on the continental slope off the Antarctic Peninsula, where water temperatures are slightly warmer than on the shelf. In addition, larvae of brachyuran and anomuran crabs are entering Antarctic waters entrained in warm-core rings (mesoscale eddies) from the Antarctic Circumpolar Current. If crabs invade the Antarctic shelf, they could re-modernize the benthic fauna and homogenize it with marine faunas elsewhere. The extent and consequences of the ongoing invasion will be assessed by: (1) sampling the water column for larvae; and (2) sampling bottom water for demersal larvae and surveying the benthos for juveniles and adults, and for localized changes in community structure.

This international collaborative study will take a three-pronged approach. First, crab larvae and larvae of other invading taxa, and the holoplankton associated with them, will be sampled by net tows at discrete depths in the water column. The holoplankton in combination with remote-sensing altimetry data will be used to identify the eddy structures that brought the invasive larvae into Antarctic waters. Second, an epibenthic sledge and a small dredge will be used to sample demersal plankton, specifically targeting the demersal larvae of king crabs. Third, a towed underwater vehicle (AUV on a sledge) will be used to image the bottom fauna, providing density estimates of crabs on the slope and on the shelf. The bottom fauna associated with crab populations will be compared quantitatively to the macrofauna in crab-free areas at the same depths to determine the current impact of the crabs and also which benthic components are most vulnerable to predation.

This research will explore the effects of climate change on the Antarctic marine environment, a subject of deep concern to the scientific community and the public. The study will promote collaboration between scientific teams from the U.S., Sweden, and the United Kingdom. This project will provide undergraduate and graduate training, include a research component for minority students, promote the advancement of women in scientific careers, generate curricular materials for K–12 education, and provide important information to managers and policymakers. It will generate data on marine invasions, which are urgently needed for long-term tracking of ecological change in Antarctica.