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The vertical distribution and biological transport of marine microplastics across the epipelagic and mesopelagic water column

C. Anela Choy[1,5], Bruce H. Robison[1], Tyler O. Gagne[2], Benjamin Erwin[1], Evan Firl[2], Rolf U. Halden[3], J. Andrew Hamilton[1], Kakani Katija[1], Susan E. Lisin[2], Charles Rolsky[3] & Kyle S. Van Houtan[2,4]

Plastic waste has been documented in nearly all types of marine environments and has been found in species spanning all levels of marine food webs. Within these marine environments, deep pelagic waters encompass the largest ecosystems on Earth. We lack a comprehensive understanding of the concentrations, cycling, and fate of plastic waste in sub-surface waters, constraining our ability to implement effective, large-scale policy and conservation strategies. We used remotely operated vehicles and engineered purpose-built samplers to collect and examine the distribution of microplastics in the Monterey Bay pelagic ecosystem at water column depths ranging from 5 to 1000 m. Laser Raman spectroscopy was used to identify microplastic particles collected from throughout the deep pelagic water column, with the highest concentrations present at depths between 200 and 600 m. Examination of two abundant particle feeders in this ecosystem, pelagic red crabs (*Pleuroncodes planipes*) and giant larvaceans (*Bathochordaeus stygius*), showed that microplastic particles readily flow from the environment into coupled water column and seafloor food webs. Our findings suggest that one of the largest and currently underappreciated reservoirs of marine microplastics may be contained within the water column and animal communities of the deep sea.

The practical allure of plastic – a durable synthetic material that resists chemical and physical degradation – has translated to widespread environmental concern. Derived from petrochemicals, plastic was brought into large-scale global production during the mid-20th century[1]. Plastic debris was first recorded at the surface of the Atlantic and Pacific Oceans in the early 1970s[2,3]. Given the continued, and now accelerating, large-scale production, use, and mismanaged disposal of plastic since that time, marine plastic pollution is now a significant environmental challenge spanning nearly all ecosystem types, and all levels of marine food webs[4]. Physical and chemical hazards related to entanglement in and ingestion of plastic debris across a diverse range of plastic sizes and types have generated broad ecological concerns[5–7]. Further, human health impacts stemming from both the chemical exposure to plastic debris from seafood consumption, as well as from toxins that adsorb onto plastic debris from the surrounding seawater, are currently unknown[8,9].

Most global scientific studies describing the extent and amounts of oceanic marine plastic pollution have been confined to the surface layer of the ocean. However, deep pelagic waters within marine ecosystems dwarf all other available living space on Earth, and growing evidence demonstrates that plastic is accumulating within the animals, bottom sediments, and trenches of the deep sea[10–14]. Recent global inventories of floating plastic waste point to size-selective fragmentation and transport of microplastics to deeper waters through physical and biological processes[15,16], as well as movement into marine food webs following trophic uptake (ingestion) and other physical processes (e.g., gill ventilation[17]), and passage through the food web[18–21]. To understand the distribution

[1]Monterey Bay Aquarium Research Institute, 7700 Sandholdt Road, Moss Landing, California, 95039, USA. [2]Monterey Bay Aquarium, 886 Cannery Row, Monterey, California, 93940, USA. [3]Arizona State University, Tempe, Arizona, 85287, USA. [4]Nicholas School of the Environment, Duke University, PO Box 90328, Durham, NC, 27708, USA. [5]Present address: Scripps Institution of Oceanography, University of California San Diego, 9500 Gilman Drive, La Jolla, California, 92093-0218, USA. Correspondence and requests for materials should be addressed to C.A.C. (email: anela@ucsd.edu) or K.S.V.H. (email: kvanhoutan@mbayaq.org)