How much crude oil can zooplankton ingest? Estimating the quantity of dispersed crude oil defecated by planktonic copepods

We investigated and quantified defecation rates of crude oil by 3 species of marine planktonic copepods (Temora turbinata, Acartia tonsa, and Parvocalanus crassirostris) and a natural copepod assemblage after exposure to mechanically or chemically dispersed crude oil. Between 88 and 100% of the analyzed fecal pellets from three species of copepods and a natural copepod assemblage exposed for 48 h to physically or chemically dispersed light crude oil contained crude oil droplets. Crude oil droplets inside fecal pellets were smaller (median diameter: 2.4-3.5 μm) than droplets in the physically and chemically dispersed oil emulsions (median diameter: 6.6 and 8.0 μm, respectively). This suggests that copepods can reject large crude oil droplets or that crude oil droplets are broken into smaller oil droplets before or during ingestion. Depending on the species and experimental treatments, crude oil defecation rates ranged from 5.3 to 245 ng-oil copepod(-1) d(-1), which represent a mean weight-specific defecation rate of 0.026 μg-oil μg-C-copepod(-1) d(-1). Considering a dispersed crude oil concentration commonly found in the water column after oil spills (1 μl L(-1)) and copepod abundances in high productive coastal areas, copepods may defecate similar to 1.3-2.6 mg-oil m(-3) d(-1), which would represent similar to 0.15%-0.30% of the total dispersed oil per day. Our results indicate that ingestion and subsequent defecation of crude oil by planktonic copepods has a small influence on the overall mass of oil spills in the short term, but may be quantitatively important in the flux of oil from surface water to sediments and in the transfer of low-solubility, toxic petroleum hydrocarbons into food webs after crude oil spills in the sea. (C) 2015 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).