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RELATIVE CONTRIBUTION OF VIRAL LYSIS AND GRAZING TO BACTERIAL MORTALITY IN TROPICAL COASTAL WATERS OF PENINSULAR MALAYSIA

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ABSTRACT

We investigated the relative importance of viral lysis and heterotrophic nanoflagellate (HNF) grazing in bacterial mortality as part of a study to understand the microbial loop functioning in tropical waters of Straits of Malacca and South China Sea above the Sunda Shelf. Bacterial abundance ranged from 0.8×10^6 to 2.9×10^6 cells ml^{-1} and bacterial production ranged from 0.7×10^5 to 4.2×10^5 cells ml^{-1} hr^{-1}. HNF and viral abundance ranged from 0.6×10^3 to 10.1×10^3 cells ml^{-1} and 0.3×10^7 to 1.4×10^7 virus particles ml^{-1}, respectively. HNF grazing rates were from 1.1×10^4 to 16.8×10^4 cells ml^{-1} hr^{-1}, whereas viral lysis rates ranged from 0.7×10^4 to 3.9×10^4 cells ml^{-1} hr^{-1}. There was predator-prey coupling across the stations with both viral lysis and HNF grazing rates significantly correlated with bacterial production. HNF grazing accounted for 26.1% ± 14.6 of bacterial production, whereas viral lysis was 9.0% ± 3.5 of bacterial production. Bacterial mortality by both HNF and viruses averaged 35.5% ± 13.9, and was outpaced by bacterial production. Other loss factors, such as grazing by ciliates, sedimentation, benthic filter feeders, autolysis, or predatory bacteria, could be important.

Since Pomeroy's (1974) seminal paper on marine food web functioning, there have been significant advances in our understanding of bacteria and their role in marine food webs (Karl 2007). We now know that bacteria are the main respirers and they recycle a large pool of dissolved organic matter to higher trophic levels. Due to the importance of bacteria in marine biogeochemical cycles, their productivity, abundance, and distribution have been intensely studied in most of the world's oceans (Ducklow 1999), but data for the tropical Sunda Shelf waters in southeast Asia are still few.

Factors that regulate both bacterial production and biomass are often divided into bottom-up (or resource control) and top-down (or predator control, Gasol et al. 2002). The two major top-down controls of bacterial production are grazing by protists and lysis by viruses (Sherr et al. 2007, Suttle 2007). Grazing removes a varying percentage of bacterial production, from undetected to > 200% (Šolić and Krstulović 1994, Anderson and Rivkin 2001, Caron et al. 2009). Among the protists, heterotrophic nanoflagellates (HNFs) are the most important (Sherr and Sherr 2002), although mixotrophic phytoflagellates are equally important, especially in oligotrophic ocean waters (Zubkov and Terran 2008). In most studies, when HNF grazing is insufficient to explain bacterial mortality and does not balance bacterial production (Caron et al. 2009), the discrepancy is often attributed to virus mediated bacterial mortality (Suttle 2007).

Viruses are the most abundant biological entity and the second largest component of biomass (after prokaryotes) in aquatic systems, and a majority is lytic bacteriophage (Fuhrman and Noble 1995, Wommack and Colwell 2000, Suttle 2007). Viral