

Interactive comment on “Coupling of fog and marine microbial content in the near-shore coastal environment” by M. E. Dueker et al.

M. E. Dueker et al.

med2109@columbia.edu

Received and published: 14 December 2011

General comments:

We would like to thank Anonymous Referee 1 for constructive comments on our manuscript. We are pleased that the reviewer agrees that our results are carefully analyzed and provide both interesting and important information on the topic of aerosols and the microbial composition of aerosols in the near-shore environment. As the reviewer points out, our choice of media type (Luria Bertani agar (LB)) has consequences for the range of microbes that can be cultivated and we will be sure that caveats associated with this fact are more clearly stated in the revised manuscript.

RC = reviewer comment; AC = author comment

C4876

Specific comments:

RC1: "Like any such approach there are biases based on the use of agar media to obtain aerosol microbes."

AC1: We agree. The use of culture-based methods has both advantages and disadvantages. Media-based approaches do not allow all groups of microbes to be cultivated, therefore introducing a bias in the microbes detected. However, using this method allowed us to be confident that the microbes sampled were viable (with cellular machinery still intact) when they deposited. This is a very useful piece of information when compared to culture-independent studies, especially in terms of public health and other issues related to pathogen ecology (including human, animal, plant pathogens), but also for understanding the potential for biogeochemical transformations in the air and upon deposition. Of course, as stated above, we are only sampling a subset of the viable microbes, the ones capable of growth on LB media. We will make this caveat more clear in the revised manuscript.

RC2: "In this case the authors chose LB plates, which are based on rich media and have relatively low salinity. Other authors have used plates based on more saline media (e.g. Baltic seawater Fahlgren et al 2010 used Zobell Baltic seawater based plates). The authors have thus greatly biased the types of bacteria they could find and not surprisingly find marine Vibrios. These can grow on LB plates but most other common marine bacteria cannot. Just because they did not see bacteria or Vibrios in non-fog conditions does not mean that marine bacteria were not there or that fog increased the viability of the Vibrios. The authors' conclusions thus need these caveats to be better stated in the paper."

AC2: While we agree that not all viable bacteria will grow on LB plates once they deposit due to incompatibility with the media, the same media was exposed during both foggy and non-foggy conditions, so the relative difference between conditions is informative. Luria Bertani agar (LB) plates were chosen because they have been used

C4877

in the past to characterize culturable microbial aerosols in a broad range of environments, including coastal areas (for example, see Lighthart and Shaffer 1995; Shaffer and Lighthart 1997; Tong and Lighthart 1997). More specifically, we utilized the Miller formulation of LB media, which has a higher salt content (10 g/L) than some other LB formulations, but a lower salt content than many marine media formulations. While every media comes with biases, we selected this intermediate salt content media as an appropriate choice for a study aiming to cultivate a wide range of bacteria, from both marine and terrestrial sources. We will be more specific about this choice in the methods of the revised manuscript. In addition, unpublished results from our lab based on sampling conducted at both coastal and inland sites has demonstrated that a wide variety of both terrestrial and marine bacteria are capable of growth when deposited on this formulation of LB plates. Therefore, based on previous studies and data from our own laboratory, we were confident that LB would allow the growth of a combination of marine and non-marine bacteria. In the paper we do not assert that *Vibrios* specifically are favored by fog, but that microbial aerosols in general appear to be (and at this site those aerosols were primarily marine in origin). The presence of *Vibrios* in our samples and in Cho et al. (2011) (who used marine agar, TSA, and R2A media) but not in other published studies (particularly the culture-independent libraries) was striking. We interpret *Vibrio* presence as a function of sampling proximity to ocean surface, and it may be related to aerosol residence times. However, choice of media does constrain the range of bacteria that are detected and we will be more clear about the biases associated with our culture-dependent methods in the revised manuscript.

Technical comments:

RC3: "Urbano et al was not a terrestrial based tower; this was Fahlgren 2010."

AC3: We will correct this error in the revised manuscript.

RC4: "The differences between this paper and Urbano are very striking based on Figure 3. This might be again due to the plate issues mentioned above."

C4878

AC4: We agree. Media choice influenced the results from this study and all other studies using culture-dependent approaches. Also, sampling height may introduce microbial aerosol differences, given the decreased residence times of larger, locally-produced marine aerosol particles. Urbano et al. (2011) sampled more than 12 m above the water surface (12 m pier height + pumphouse height), whereas Dueker et al. (2011) sampled at 1 m and Cho et al. (2011) sampled at 11 m. We will clarify this in the revised manuscript.

Works Cited:

Cho, B. C. and C. Y. Hwang (2011). "Prokaryotic abundance and 16S rRNA gene sequences detected in marine aerosols on the East Sea (Korea)." *Fems Microbiology Ecology* 76(2): 327-341.

Dueker, M. E., K. C. Weathers, et al. (2011). "Environmental Controls on Coastal Coarse Aerosols: Implications for Microbial Content and Deposition in the Near-Shore Environment." *Environmental Science Technology* 45(8): 3386-3392.

Lighthart, B. and B. T. Shaffer (1995). "Viable bacterial aerosol particle size distributions in the midsummer atmosphere at an isolated location in the high desert chaparral." *Aerobiologia* 11: 19-25.

Shaffer, B. T. and B. Lighthart (1997). "Survey of culturable airborne bacteria at four diverse locations in Oregon: Urban, rural, forest, and coastal." *Microbial Ecology* 34(3): 167-177.

Tong, Y. Y. and B. Lighthart (1997). "Solar radiation is shown to select for pigmented bacteria in the ambient outdoor atmosphere." *Photochemistry and Photobiology* 65(1): 103-106.

Urbano, R., B. Palenik, et al. (2011). "Detection and phylogenetic analysis of coastal bioaerosols using culture dependent and independent techniques." *Biogeosciences* 8(2): 301-309.

C4879

C4880