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LITERATURE CITED

- Andrea, M.O. (1990). Ocean-atmosphere interactions in the global biogeochemical sulfur cycle. *Mar. Chem.* 30: 1-29
- Ayers, G.P., Gras, J.L. (1991). Seasonal relationship between cloud condensation nuclei and aerosol methanesulphonate in marine air. *Nature* 353: 834-835
- Ayers, G.P., Ivey, J.P., Gillett, R.W. (1991). Coherence between seasonal cycles of dimethyl sulphide, methanesulphonate and sulphate in marine air. *Nature* 349: 404-406
- Barnard, W.R., Andreae, M.O., Iverson, R.L. (1984). Dimethylsulfide and Phaeocystis poucheti in the southeastern Bering sea. *Cont. Shelf Res.* 3: 103-113
- Billen, G., Joiris, C., Meyer-Reil, L., Lindeboom, H. (1990). Role of bacteria in the North Sea ecosystem. *Neth. J. Sea Res.* 26: 265-293
- Bürgermeister, S., Georgii, H.-W. (1991). Distribution of methanesulfonate, NSS sulfate and dimethylsulfide over the Atlantic and the North Sea. *Atmosph. Environm.* 25: 587-595
- Cadée, G.C., Hegeman, J. (1986). Seasonal and annual variation in Phaeocystis poucheti (Haptophyceae) in the westernmost inlet of the Wadden Sea during the 1973 to 1985 period. *Neth. J. Sea Res.* 20: 29-36
- Cantoni, G.L., Anderson, D.G. (1956). Enzymatic cleavage of dimethylpropiothetin by Polysiphonia lanosa. *J. Biol. Chem.* 222: 171-177
- Charlson, R.J., Lovelock, J.E., Andreae, M.O., Warren, S.G. (1987). Oceanic phytoplankton, atmospheric sulfur, cloud albedo and climate. *Nature* 326: 655-661
- Cooper, W.J., Matrai, P.A. (1989). Distribution of dimethyl sulfide in the oceans: a review. In: Saltzman, E.S., Cooper W.J. (eds.) *Biogenic sulfur in the environment*. ACS Symp. Ser. 393, Washington DC. p. 140-151
- Dacey, J.W.H., Wakeham, S.G. (1986). Oceanic dimethylsulfide: production during zooplankton grazing. *Science* 233: 1314-1316
- Dacey, J.W.H., Blough, N. (1987). Hydroxide decomposition of DMSP to DMS. *J. Geophys. Res. Lett.* 14: 1246-1249
- Dickson, D.M.J., Kirst, G.O. (1987a). Osmotic adjustment in marine eukaryotic algae: the role of inorganic ions, quaternary ammonium, tertiary sulphonium and carbohydrate solutes. I. Diatoms and a Rhodophyte. *New Phytol.* 106: 645-655
- Dickson, D.M.J., Kirst, G.O. (1987b). Osmotic adjustment in marine eukaryotic algae: the role of inorganic ions, quaternary ammonium, tertiary sulphonium and carbohydrate solutes. II. Prasinophytes and Haptophytes. *New Phytol.* 106: 657-666

- Dixon, M., Webb, E.C. (1979). *Enzymes*, 3 edn. Longman, London
- Fitzgerald, J.W. (1991). Marine aerosols: a review. *Atmosph. Environm.* 25: 533-545
- Foley, J.A., Taylor, K.E., Ghan, S.J. (1991). Planktonic dimethylsulfide and cloud albedo: an estimate of the feedback response. *Climatic Change* 18: 1-15
- Gibson, J.A.E., Garrick, R.C., Burton, H.R., McTaggart, A.R. (1990). Dimethylsulfide and the alga Phaeocystis pouchetii in antarctic coastal waters. *Mar. Biol.* 104: 339-346
- Gröne, T., Kirst, G. O. (1992). The effect of nitrogen deficiency, methionine and inhibitors of methionine metabolism on the DMSP contents of Tetraselmis subcordiformis (Stein). *Mar. Biol.* 112: 497-503
- Ishida, Y. (1968). Physiological studies on the evolution of dimethylsulfide. *Mem. Coll. Agric. Kyoto Univ.* 94: 47-82
- Karsten, U., Wiencke, C., Kirst, G.O. (1990). The β -dimethyl-sulfoniopropionate (DMSP) content of macroalgae from Antarctica and southern Chile. *Bot. Mar.* 33: 143-146
- Keller, M.D., Bellows, W.K., Guillard, R.R.L. (1989). Dimethyl sulfide production in marine phytoplankton. In: Saltzman, E.S., Cooper W.J. (eds.) *Biogenic sulfur in the environment*. ACS Symp. Ser. 393, Washington DC. p. 167-182
- Kelly, D.P., Smith, N.A. (1990). Organic sulfur compounds in the environment: biogeochemistry, microbiology and ecological aspects. In: Marshall, K.C. (ed) *Advances in microbial ecology*, Vol. 11, Plenum Press, New York/London, p. 345-385
- Kiene, R.P. (1990). Dimethylsulfide production from dimethylsulfoniopropionate in coastal seawater samples and bacterial cultures. *Appl. Environm. Microbiol.* 56: 3292-3297
- Kiene, R.P., Bates, T.S. (1990). Biological removal of dimethyl sulfide from sea water. *Nature* 345: 702-705
- Kiene, R.P., Service, S.K. (1991). Decomposition of dissolved DMSP and DMS in estuarine waters: dependence on temperature and substrate concentration. *Mar. Ecol. Prog. Ser.* 76: 1-11
- Kirst, G.O. (1989). Salinity tolerance of eukaryotic marine algae. *Annu. Rev. Plant Physiol. Plant Mol. Biol.* 40: 21-53
- Kirst, G.O., Thiel, C., Wolff, H., Nothnagel, J., Wanzek, M., Ulmke, R. (1991). Dimethylsulfoniopropionate (DMSP) in ice-algae and its possible biological role. *Mar. Chem.* 35: 381-388
- Liss, P.S., Slater, P.G. (1974). Flux of gases across the air-sea interface. *Nature* 247: 181-184
- Nguyen, B.C., Belviso, S., Mihalopoulos, N., Gostan, J., Nival, P. (1988). Dimethyl sulfide production during natural phytoplankton blooms. *Mar. Chem.* 24: 133-141
- Paul, J.H. (1982). Use of Hoechst dyes 33258 and 33342 for enumeration of attached and planktonic bacteria. *Appl. Environm. Microbiol.* 44: 939-944
- Prospero, J.M., Savoie, D.L., Saltzman, E.S., Larsen, R. (1991). Impact of oceanic sources of biogenic sulphur on sulphate aerosol concentrations at Mawson, Antarctica. *Nature* 350: 221-223
- Reed, R.H. (1983). Measurement and osmotic significance of β -dimethylsulfoniopropionate in marine microalgae. *Mar. Biol. Lett.* 4: 173-178
- Schwartz, S.E. (1988). Are global cloud albedo and climate controlled by marine phytoplankton? *Nature* 336: 441-445
- Sieburth, J.M. (1960). Acrylic acid, an "antibiotic" principle in Phaeocystis blooms in Antarctic waters. *Science* 132: 676-677

- Sieburth, J.M. (1961). Antibiotic properties of acrylic acid, a factor in the gastrointestinal antibiosis of polar marine animals. *J. Bacteriol.* 82: 72-79
- Taylor, B.F., Kiene, R.P. (1989). Microbial metabolism of dimethyl sulfide. In: Saltzman, E.S., Cooper W.J. (eds.) *Biogenic sulfur in the environment*. ACS Symp. Ser. 393, Washington DC. p. 202-221
- Turner, S.M., Malin, G., Liss, P.S., Harbour, D.S., Holligan, P.M. (1988). The seasonal variation of dimethyl-sulfoniopropionate concentrations in near-shore waters. *Limnol. Oceanogr.* 33: 364-375
- Turner, S.M., Malin, G., Liss, P.S. (1989). Dimethyl sulfide and (dimethylsulfonio)propionate in European coastal and shelf waters. In: Saltzman, E.S., Cooper W.J. (eds.) *Biogenic sulfur in the environment*. ACS Symp. Ser. 393, Washington DC. p.183-200
- Utermöhl, H. (1958). Zur Vervollkommnung der quantitativen Phytoplankton Methodik. *Mitt. Int. Verein. theor. angew. Limnol.*9: 1-38
- Vairavamurthy, A., Andrea, M.O., Iverson, R.L. (1985). Biosynthesis of dimethyl sulfide and dimethylpropiothetin by *Hymenomonas carterae* in relation to sulfur source and salinity variations. *Limnol. Oceanogr.* 30: 59-70
- van Boekel, W.H.M., Hansen, F.C., Riegman, R., Bak, R.P.M. (1992). Lysis-induced decline of a *Phaeocystis* spring bloom and coupling with the microbial foodweb. *Mar. Ecol. Prog. Ser.* 81: 269-276
- Veldhuis, M.J.W., Admiraal, W. (1987). The influence of phosphate depletion on the growth and colony formation of *Phaeocystis pouchetii* (Hariot) Lagerheim. *Mar. Biol.* 95: 47-54
- Wakeham, S.G., Dacey, J.W.H. (1989). Biogeochemical cycling of dimethyl sulfide in marine environments. In: Saltzman, E.S., Cooper W.J. (eds.) *Biogenic sulfur in the environment*. ACS Symp. Ser. 393, Washington DC. p. 152-156
- White, R.H. (1982). Analysis of dimethyl sulfonium compounds in marine algae. *J. Mar. Res.* 40: 529-536