Repeated detection of polystyrene microbeads in the Lower Rhine River

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Microplastics are emerging pollutants in water bodies worldwide. The environmental entry areas must be studied to localise their sources and develop preventative and remedial solutions. Rivers are major contributors to the marine microplastics load. Here, we focus on a specific type of plastic microbead (diameter 286-954 pm, predominantly opaque, white beige) that was repeatedly identified in substantial numbers between kilometres 677 and 944 of the Rhine River, one of Europe's main waterways. Specifically, we aimed (i) to confirm the reported abrupt increase in microbead concentrations between the cities of Leverkusen and Duisburg and (ii) to assess the concentration gradient of these particles along this stretch at higher resolution. Furthermore, we set out (iii) to narrow down the putative entry stretch from 81.3 km, as reported in an earlier study, to less than 20 km according to our research design, and (iv) to identify the chemical composition of the particles and possibly reveal their original purpose. Surface water filtration (mesh: 300 mu m, n = 9) at regular intervals along the focal river stretch indicated the concentration of these spherules increased from 0.05 to 8.3 particles m(-3) over 20 km. This spot sampling approach was supported by nine suspended solid samples taken between 2014 and 2017. encompassing the river stretch between Leverkusen and Duisburg. Ninety-five percent of microbeads analysed (202/212) were chemically identified as crosslinked polystyrene-divinylbenzene (PS-DVB, 146/212) or polystyrene (PS. 56/212) via Raman or Fourier-transform infrared spectroscopy. Based on interpretation of polymer composition, surface structure, shape, size and colour, the PS(-DVB) microbeads are likely to be used ion-exchange resins, which are commonly applied in water softening and various industrial purification processes. The reported beads contribute considerably to the surface microplastic load of the Rhine River and their potential riverine entry area was geographically narrowed down.

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