Investigation of surface functional group selectivity in barnacle settlements using newly developed experimental system

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【Introduction】Barnacle settlements cause serious biofouling problems such as increases of fluid resistance in ships. Although antifouling paints including organotin compounds had been widely used to prevent barnacle settlements, it has banned from use in ship paints because of its considerable endocrine disrupting effects in other marine organisms[1]. Therefore, developments of low environmental impact materials is highly demanded. In our laboratory, we conducted settlement test using an experimental system consisting of silicone wells and test substrates, and investigated the effects of surface functional groups on barnacle settlements. As results, we found that OH groups inhibit barnacle settlements, while COOH groups attract barnacle settlements. However, it was difficult to directly evaluate the settlement selectivity of barnacles in previous method. In this study, we created a box type experimental system that can simultaneously evaluate plural test substrates, and reported the effects of surface functional groups on barnacle settlements using self-assembled monolayer (SAM) substrate.

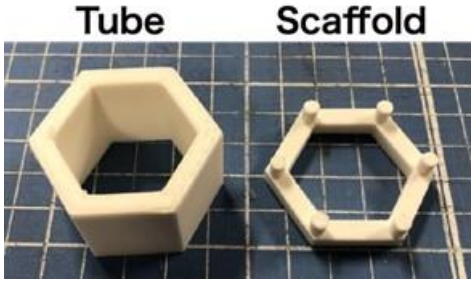

Fig. 1 Photograph of the box type experimental setup prepared by using a 3D printer

【Experiment 1 (Section 3)】Creation of new settlement experimental system

By printing a tube and scaffold with a 3D printer (Fig. 1), and fixing the substrates on the inner wall, plural substrates could be evaluated at the same time. In addition, the shape of the tube and scaffold can be easily changed depending on the number of substrates. Hereafter, settling experiments were carried out using the box-type experimental system.

【Experiment 2 (section 4)】 Settlement test on SAM substrate

The settlement rates on the Au substrate and the COOH group substrate were high, and the settlement rates on the other SAM substrates were low (Fig. 2). It was found that Cyprus larvae preferred the Au and the COOH group substrates. In addition, when some cypris larvae settled on the Au or

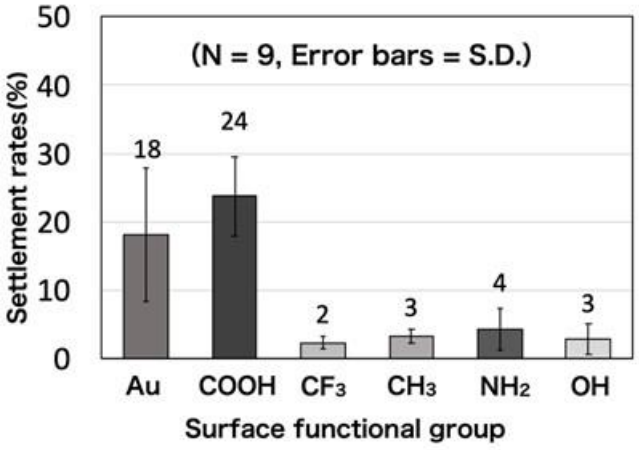

Fig. 2 Graph of the barnacle settlement rate on SAM substrates at 12th of the experiment.

the COOH group substrates, the other cypris larvae are attracted by the footprint and metamorphosed cypris larvae. Therefore, settlement rates on the other substrates were suppress low, and difficult to compare its effects.

【Experiment 3 (section 4) 】

Settlement test on the mixed SAM substrate

The settlement rate was highest when the mixing ratio was 8 : 2 (OH : COOH) (Fig. 3). In the previous research, if 80% or more OH groups were existed on surfaces, antifouling effects were generated. However, the opposite results were shown. In nature, there are many hydrophilic substances containing OH groups, such as rocks and proteins secreted by microorganisms. Therefore, a little difference of the experimental conditions were strongly affected on settlements, and around 80% would be threshold value.

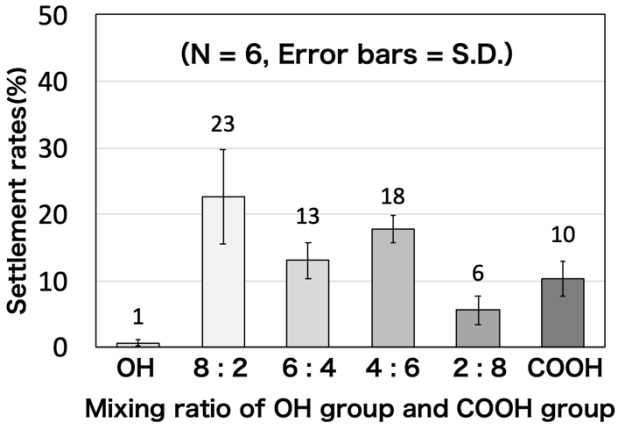

Fig. 3 Graph of the barnacle settlement rate on mixed SAM substrates at 12th of the experiment.

【Reference】

[1] International Marine Organization 1999 Resolutions Summaries A 895(21)