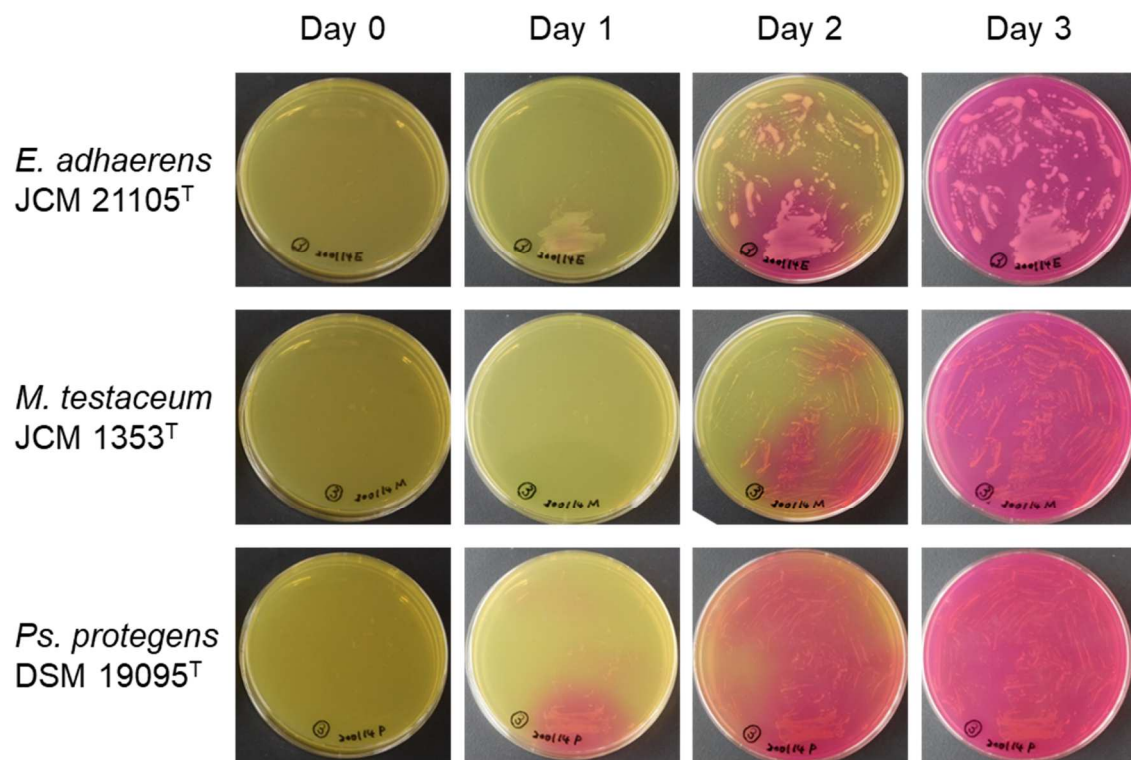
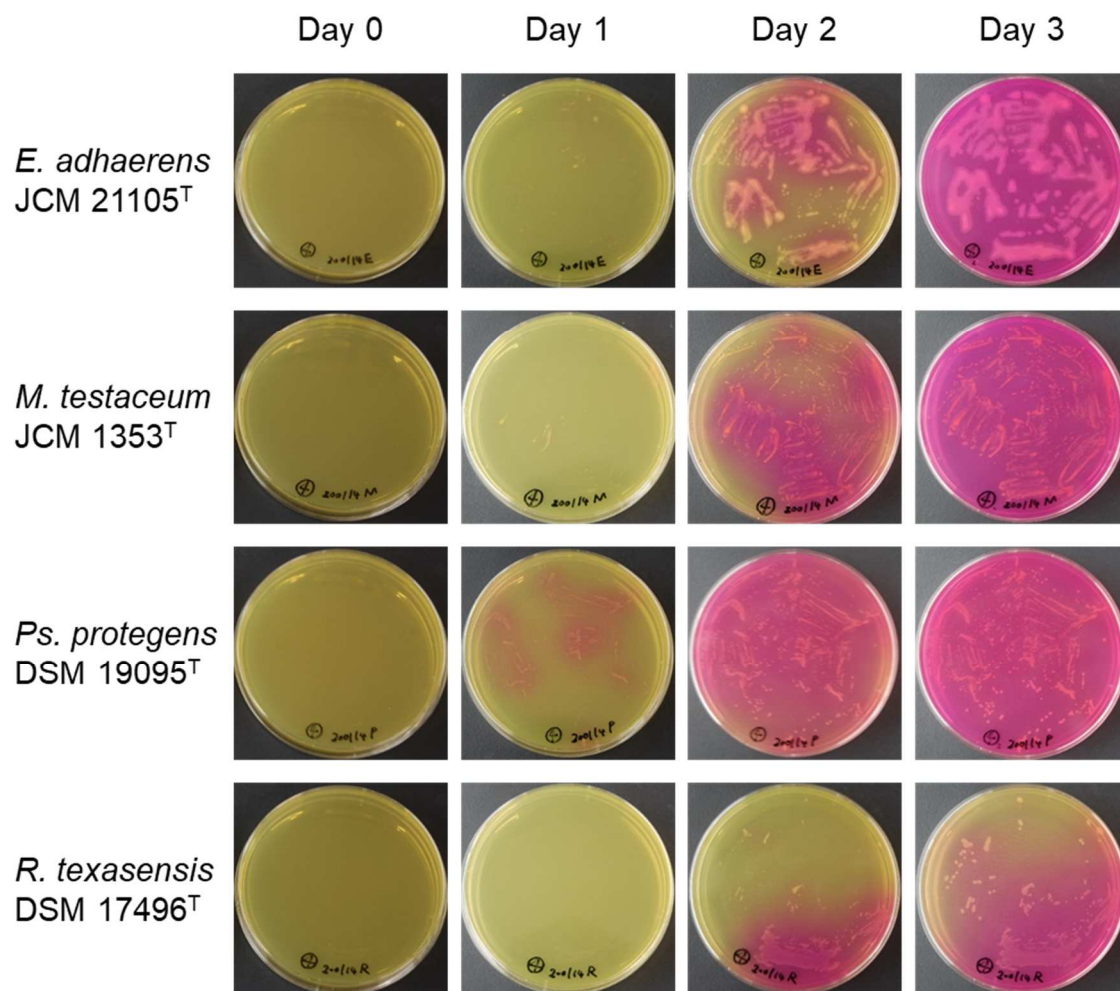
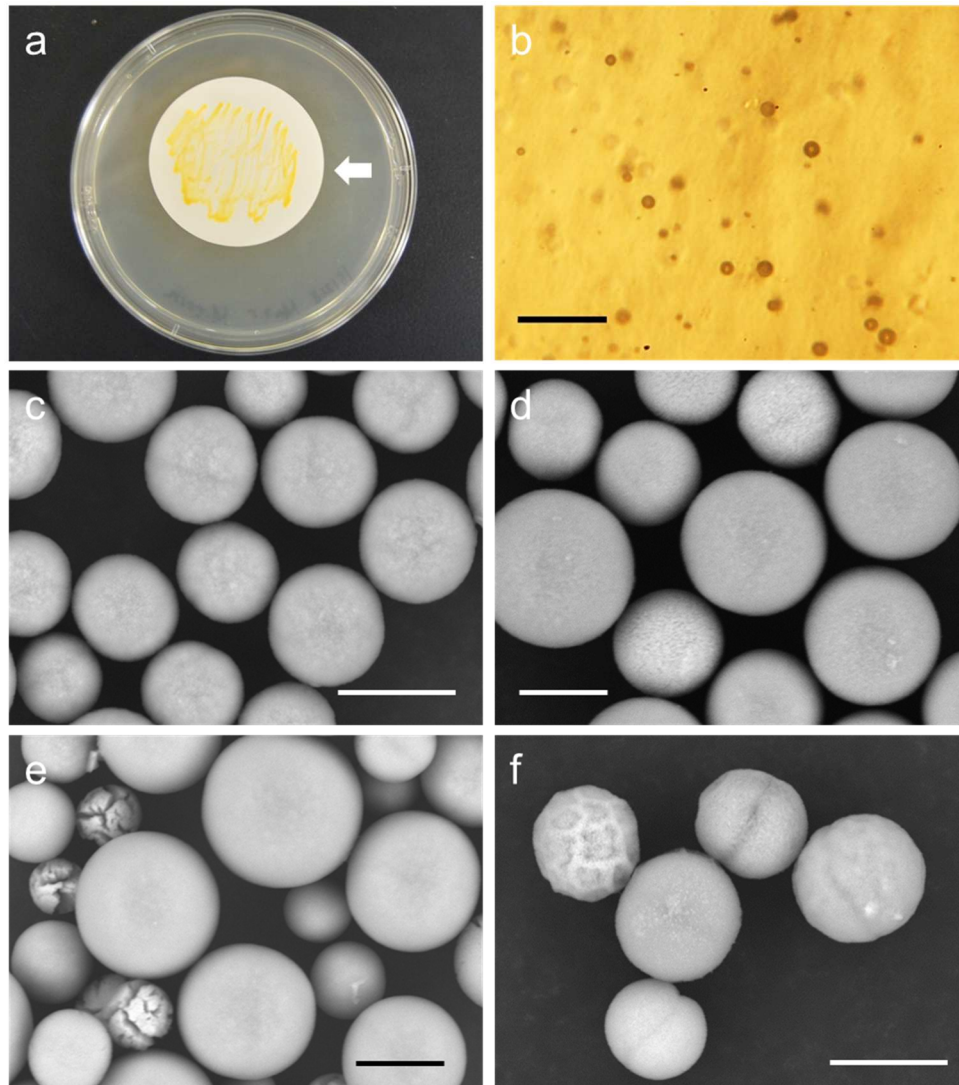




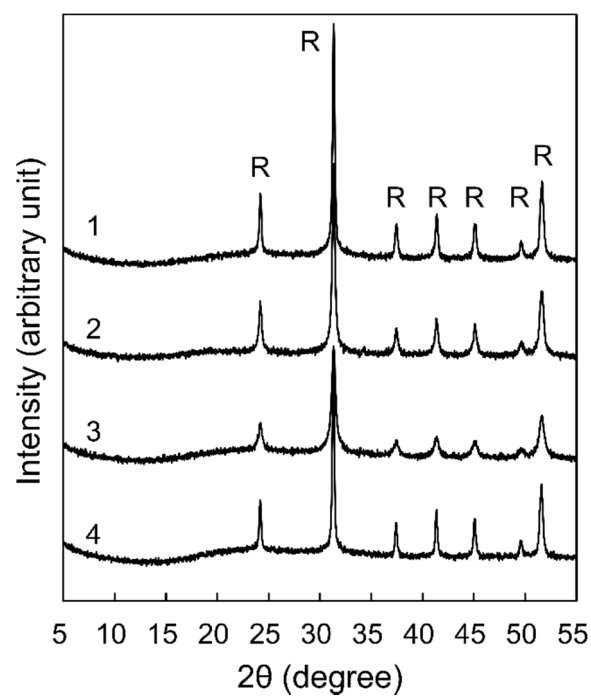
Supplementary Figure S1. Color change in phenol red in MRM agar (2.5). *E. adhaerens* JCM 21105^T, *M. testaceum* JCM 1353^T, and *Ps. protegens* DSM 19095^T were cultivated on MRM agar (2.5) containing phenol red (12 mg/L) at 28°C. The phenol red exhibits a gradual transition from yellow to red over the pH range 6.8 to 8.2. The precipitated manganese carbonate crystals were observed on Day 3.



Supplementary Figure S2. Color change in phenol red in MRM agar (1.0). *E. adhaerens* JCM 21105^T, *M. testaceum* JCM 1353^T, *Ps. protegens* DSM 19095^T, and *R. texasensis* DSM 17496^T were cultivated on MRM agar (1.0) containing phenol red (12 mg/L) at 28°C. The phenol red exhibits a gradual transition from yellow to red over the pH range 6.8 to 8.2. The precipitated manganese carbonate crystals were observed on Day 3.



Supplementary Figure S3. A photograph of MRM agar, and microscopic images of manganese carbonate crystals in the membrane filter culture method. (a): photograph of MRM agar in the membrane filter culture method; arrow indicates the cellulose acetate membrane filter (cultivated strain: *M. testaceum* JCM 1353^T). (b): phase-contrast light microscope image of manganese carbonate crystals precipitated in a portion of the MRM agar that was separate from the cells of *M. testaceum* JCM 1353^T. (c-f): LV-SEM images of manganese carbonate crystals precipitated using this method, with *E. adhaerens* JCM 21105^T (c), *M. testaceum* JCM 1353^T (d), *Ps. protegens* DSM 19095^T (e), and *R. texasensis* DSM 17496^T (f). Scale bars in (b): 100 μm . Other scale bars: 10 μm .



Supplementary Figure S4. XRD patterns of manganese carbonate crystals induced by *E. adhaerens* JCM 21105^T (1), *M. testaceum* JCM 1353^T (2), *Ps. protegens* DSM 19095^T (3), and *R. texasensis* DSM 17496^T (4); R: rhodochrosite peak.

Supplementary Table S1. Statistical analysis of the difference (*P* value) in the mean particle sizes of precipitated manganese carbonate crystals shown in Tables 1 and 2, using Welch's one-way analysis of variance and the Games-Howell *post hoc* test.

Data of the mean particle size: 1, 14.9 ± 3.0 (Table 1); 2, 17.7 ± 2.9 (Table 1); 3, 10.5 ± 3.3 (Table 1); 4, 9.6 ± 2.0 (Table 1); 5, 13.2 ± 2.7 (Table 1); 6, 8.7 ± 1.9 (Table 1); 7, 12.0 ± 4.4 (Table 1); 8, 6.7 ± 1.3 (Table 2); 9, 10.0 ± 2.1 (Table 2); 10, 7.1 ± 1.8 (Table 2); 11, 7.3 ± 1.7 (Table 2).

Data	2	3	4	5	6	7	8	9	10	11
1	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
2	—	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
3	—	—	0.040*	0.000*	0.000*	0.013*	0.000*	0.665	0.000*	0.000*
4	—	—	—	0.000*	0.000*	0.000*	0.000*	0.812	0.000*	0.000*
5	—	—	—	—	0.000*	0.048*	0.000*	0.000*	0.000*	0.000*
6	—	—	—	—	—	0.000*	0.000*	0.000*	0.000*	0.000*
7	—	—	—	—	—	—	0.000*	0.000*	0.000*	0.000*
8	—	—	—	—	—	—	—	0.000*	0.613	0.015*
9	—	—	—	—	—	—	—	—	0.000*	0.000*
10	—	—	—	—	—	—	—	—	—	0.972

**P* < 0.05: Statistically significant difference