A report of 38 unrecorded bacterial species in Korea within the classes Bacilli and Deinococci isolated from various sources

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A total of 38 bacterial strains within the classes Bacilli and Deinococci were isolated from various sources in Korea. Samples were collected from animal intestine, urine, soil, tidal flat mud, and kimchi. In the sequence comparison and phylogenetic analysis of 16S rRNA sequences, the 38 isolates were assigned to the classes Bacilli and Deinococci with sequence similarities more than 98.7%. Twenty-four strains and 13 strains were classified the order Bacillales and Lactobacillales in the class Bacilli, respectively. In the order Bacillales, there were nine species in the genus Bacillus, seven species in the genus Paenibacillus, and the remaining eight species in the genera Domibacillus, Halobacillus, Virgibacillus, Lysinibacillus, Paenisorosarcina, Planococcus, Savagea, and Staphylococcus. In the order Lactobacillales, there were four species in the genus Lactobacillus, three species in the genus Leuconostoe, three species in the genus Lactococcus, and the remaining three species in the genera Aerococcus, Enterococcus, and Streptococcus. One species was related to the genus Deinococcus of the order Deinococcales. Most of the isolated strains were Gram-stain-positive, but some were Gram-stain-variable or Gram-stain-negative. Cells were rod or cocci-shaped. Based on the results of 16S rRNA analysis, we report 38 strains as previously unrecorded species to Korea, and the basic characteristics of strains are described herein.

INTRODUCTION

Securing and conservation of biological resources are important in accordance with the Nagoya Protocol and the Convention on Biological Diversity (Jang et al., 2015). Bacteria need to be considered a biological resource because they can promote various fields such as the food, medical, and agriculture industries (Du et al., 2011; Rhee et al., 2011; Lee et al., 2015). For the bacteria isolation of unrecorded species, samples were collected from various domestic environments in 2017. Approximately 200 strains of unrecorded species were identified from diverse samples, and 38 strains of those belonged to the classes Bacilli and Deinococci. The class Bacilli is known for low G + C Gram-positive bacteria, with or without endospores. Most Bacilli bacteria are aerobes or microaerobes, while some are facultative anaerobes (Ludwig et al., 2009). The class Deinococci are Gram-positive, chemoorganotrophs, aerobic mesophilic, or thermophilic bacteria (Garrity et al., 2001). Some species of these two classes are recognized as important taxa because they are extremophiles (Takami et al., 2000; Makarova et al., 2001; Al-
bacterial environment, urine, and kimchi were isolated using MA, brain heart infusion (BHI), and MRS agars, respectively. These agar plates were incubated at 20-37°C for 2-7 days. After isolated strains were purified by streaking, bacterial cells were maintained as 10-20% glycerol stock at -80°C. The detailed information such as designated strain IDs, sources, culture media, and incubation conditions are listed in Table 1. The bacterial identification and phylogenetic position of 38 strains were determined using 16S rRNA sequence analysis. 16S rRNA sequences were obtained by PCR amplification and DNA sequencing. The closely related type species were retrieved and identified using the EzBioCloud server (Yoon et al., 2017). The 16S rRNA sequences of unrecorded and related type species were aligned by using the Clustal W (Thompson et al., 1994). Phylogenetic trees were constructed by neighbor-joining methods using MEGA7 (Kumar et al., 2016) with bootstrap resampling methods based on 1000 replicates (Felsenstein, 1985). Colony morphology was observed on agar plates and cellular morphology was examined by transmission electron microscopy. Gram-staining was performed using a Gram stain kit (Becton Dickinson) or the standard procedures (Magee et al., 1975). Oxidase activity was evaluated via the oxidation of 1% N,N,N′,N′-tetramethyl-p-phenylenediamine dihydrochloride (Sigma). Biochemical characteristics were tested by using API 20NE or API 20A galleries (bioMérieux) according to the manufacturer’s instructions.

RESULTS AND DISCUSSION

Based on the 16S rRNA sequence similarity comparison and phylogenetic analysis, 37 bacterial strains were assigned to the class Bacilli. The remaining one strain belonged to the class Deinococci (Table 1). The 37 strains were distributed in the orders Bacillales and Lactobacillales of the class Bacilli; 24 strains for the order Bacillales and 13 strains for the order Lactobacillales. Unrecorded bacterial strains in the order Bacillales were identified as following species (Fig. 1): Bacillus asahii (Yumoto et al., 2004), Bacillus clausii (Nielsen et al., 1995), Bacillus galliciensis (Balcazar et al., 2010), Bacillus gibsonii (Nielsen et al., 1995), Bacillus humii (Heyrman et al., 2005), Bacillus hunanensis (Chen et al., 2011), Bacillus patagoniensis (Olivera et al., 2005), Bacillus thermotolerans (Yang et al., 2013), Bacillus vireti (Heyrman et al., 2004), Dominibacillus enclensis (Sonalkar et al., 2014), Halobacillus faeis (An et al., 2007), Virgibacillus salinus (Carrasco et al., 2009), Paenibacillus assamensis (Saha et al., 2005), Paenibacillus chitinolyticus (Lee et al., 2004), Paenibacillus endophyticus (Carro et al., 2013), Paenibacillus odorifer (Berge et al., 2002), Paenibacillus polymyxa (Ash et al., 1993), Paenibacillus profundus (Romanenko et al., 2013), Paenibacillus provencensis (Roux et al., 2008), Lysinibacillus acetophoenoni (Azmatsunisa et al., 2015), Paenisororosarcina indica (Reddy et al., 2013), Planomicrobium alkanolicum (Dai et al., 2005), Savagaeaeaeus (Whitehead et al., 2015), and Staphylococcus hominis subsp. hominis (Kloos et al., 1998). Unrecorded bacterial strains of the order Lactobacillales were identified as following species (Fig. 2): Aerococcus urinaequi (Felis et al., 2005), Enterococcus gallinarum (Collins et al., 1984), Lactobacillus curvatus (Klein et al., 1996), Lactobacillus johnsonii (Fujisawa et al., 1992), Lactobacillus reuteri (Kandler et al., 1980), Lactobacillus taiwanensis (Wang et al., 2009), Leuconostoc citreum (Farrow et al., 1989), Leuconostoc pseudomesenteroides (Farrow et al., 1989), Leuconostoc rapi (Lyhs et al., 2015), Lactococcus lactis subsp. lactis (Schleifer et al., 1985), Lactococcus lactis subsp. lactis subsp. lactis (Perez et al., 2011), Lactococcus petauri (Goodman et al., 2017), and Streptococcus mitis (Coykendall et al., 1989). Strain NM-1 was closely related to Deinococcus gobiensis (Yuan et al., 2009) within the family Deinococcaceae of the order Deinococcales (Fig. 3). Most isolates were Gram-stain-positive, but some strains were Gram-stain-variable or Gram-stain-negative. Cells were rod- or cocci-shaped (Fig. 3). Other physiological and biochemical characteristics are detailed in the species descriptions. As a result, these 38 strains of the classes Bacilli and Deinococci are new records to Korea.

Description of Bacillus asahii 17J49-1

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for four days on R2A at 25°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase and urease is positive. Enzyme activity for gelatinase and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, adipic acid, malic acid and phenylacetic acid are assimilated. Capric acid and trisodium citrate are not assimilated. Nitrate is not
Table 1. Taxonomic affiliation and isolation information of the isolates belonging to the phylum Firmicutes and Deinococcus-Thermus.

<table>
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<tr>
<th>Class</th>
<th>Order</th>
<th>Family</th>
<th>Genus</th>
<th>Strain ID</th>
<th>NIBR ID</th>
<th>Most closely related species</th>
<th>Similarity (%)</th>
<th>Isolation source</th>
<th>Medium</th>
<th>Incubation condition</th>
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Fig. 1. Transmission electron micrographs of cells. Strains: 1, 17J49-1; 2, GH4-58; 3, GH1-30; 4, LM2308; 5, MMS17-SY053; 6, LM2412; 7, LM2319; 8, NA_4; 9, 17J48-21; 10, MMS17-SY085; 11, HMF8043; 12, GH4-63; 13, r2a103fa330; 14, HC_97; 15, 17J76-8; 16, 16_H1_F15; 17, LT3404; 18, HC, 63; 19, KYW1352; 20, 17J30-13; 21, 17J49-7; 22, GH4-13; 23, NA_7; 24, CAU 1472; 25, R2A_1; 26, VM3406; 27, CAU 1479; 28, LPB0164; 29, LPB0165; 30, LPB0166; 31, CAU 1476; 32, CAU 1477; 33, CAU 1478; 34, BT3501; 35, VR3408; 36, LR3301; 37, HMF7345; 38, NM-1.
Fig. 2. Neighbor-joining phylogenetic tree based on 16S rRNA sequences, showing the relationship between the isolates and their relatives of the order \textit{Bacillales}. Bootstrap values ($>70\%$) are shown. \textit{Escherichia coli} DSM 30083$^T$ (X801725) was used as an outgroup. Bar, 0.05 substitutions per nucleotide position.
reduced to nitrite. Indole is not produced and glucose is not fermented. Strain 17J49-1 (NIBRBAC000501327) was isolated from a soil sample, Jeju, Republic of Korea (33°30'14.9"N 126°27'55.5"E).
**Description of Bacillus clausii GH4-58**

Cells are Gram-stain-positive and rod-shaped. Colonies are punciform, convex, entire, and cream colored after incubation for four days on MA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannose, D-mannitol, N-acetyl-glucosamine and D-maltose are assimilated. L-Arabinose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain GH4-58 (= NIBRBA000501046) was isolated from a tidal flat mud sample, Incheon, Republic of Korea (37°35′33″N 126°27′29″E).

**Description of Bacillus galliciensis GH1-30**

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and cream colored after incubation for seven days on MA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase is positive. Enzyme activity for arginine dihydrolase, urease, and gelatinase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain GH1-30 (= NIBRBA000501044) was isolated from a tidal flat mud sample, Incheon, Republic of Korea (37°35′33″N 126°27′29″E).
Description of *Bacillus gibsonii* LM2308

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and beige colored after incubation for three days on MA at 20°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for gelatinase and \(\beta\)-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose, malic acid and trisodium citrate are assimilated. L-Arabinose, \(N\)-acetyl-glucosamine, potassium gluconate, capric acid, adipic acid, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain LM2308 (=NIBRBAC000501186) was isolated from an intestinal sample of an animal (pheasant), Gwacheon, Republic of Korea (37°25′39.7″N 127°01′01.2″E).

Description of *Bacillus humi* MMS17-SY053

Cells are Gram-stain-positive, flagellated, and rod-shaped. Colonies are circular, convex, entire, smooth, and pale yellow colored after incubation for three days on TSA at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for urease and \(\beta\)-galactosidase is positive. Enzyme activity for arginine dihydrolase and gelatinase is negative. D-Glucose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose and trisodium citrate are assimilated. L-Arabinose, D-mannose, potassium gluconate, capric acid, adipic acid, malic acid, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain MMS17-SY053 (=NIBRBAC000501211) was isolated from a soil sample, Gunsan, Republic of Korea (35°48′46″N 126°24′36″E).

Description of *Bacillus hunanensis* LM2412

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and beige-colored after incubation for three days on MA at 20°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for \(\beta\)-galactosidase is positive. Enzyme activity for arginine dihydrolase, urease, and gelatinase is negative. D-Glucose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose, and malic acid are assimilated. L-Arabinose, D-mannose, potassium gluconate, capric acid, adipic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain LM2412 (=NIBRBAC000501187) was isolated from an intestinal sample of an animal (*Lophura swinhoii*), Gwacheon, Republic of Korea (37°25′39.7″N 127°01′01.2″E).

Description of *Bacillus patagoniensis* LM2319

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and beige colored after incubation for three days on MA at 20°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for gelatinase and \(\beta\)-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose, malic acid and trisodium citrate are assimilated. L-Arabinose, potassium gluconate, capric acid, adipic acid, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain LM2319 (=NIBRBAC000501181) was isolated from an intestinal sample of an animal (*Lophura swinhoii*), Gwacheon, Republic of Korea (37°25′39.7″N 127°01′01.2″E).

Description of *Bacillus thermotolerans* NA_4

Cells are Gram-stain-positive and oval-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for two days on NA at 30°C. Oxidase activity is negative. Aesculin is not hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and \(\beta\)-galactosidase is negative. Potassium gluconate, malic acid and phenylacetic acid are assimilated. D-Glucose, L-arabinose, D-mannose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose, capric acid, adipic acid, and trisodium citrate is not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain NA_4 (=NIBRBAC000500998) was isolated from a soil sample, Anseong, Republic of Korea (37°07′51″N 127°37′02″E).

Description of *Bacillus vireti* 17J48-21

Cells are Gram-stain-positive and rod-shaped. Colonies are irregular, undulate, convex, and cream colored after incubation for four days on R2A at 25°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and \(\beta\)-galactosidase is positive. D-Glucose, D-mannose, D-mannitol, \(N\)-acetyl-glucosamine, D-maltose, potassium gluconate, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are assimilated. L-Arabinose and capric acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain 17J48-21 (=NIBRBAC000501343) was isolated from a soil sample, Jeju, Republic of Korea (33°27′05.2″N 126°33′28.9″E).

Description of *Domibacillus enclensis* MMS17-SY085

Cells are Gram-stain-positive, flagellated, and rod-shaped. Colonies are circular, convex, smooth, and yellow colored after incubation for three days on TSA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for \(\beta\)-galactosidase is positive. Enzyme activity for arginine dihydrolase is positive. Enzyme activity for arginine dihydrolase, urease, and gelatinase
is negative. L-Arabinose, D-mannose, D-mannitol, N-acetylglucosamine, D-maltose, potassium gluconate, malic acid, and trisodium citrate are assimilated. D-Glucose, capric acid, adipic acid, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not reduced and glucose is not fermented. Strain MM15-\text{SY085} (= NIBRBAC000501206) was isolated from a soil sample, Gunsan, Republic of Korea (35°48'46"N 126°24'36"E).

**Description of *Halobacillus faecis* HMF8043**

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, smooth and pale orange-colored after incubation for three days on MA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannitol, N-acetylglucosamine, D-maltose, and potassium gluconate are assimilated. L-Arabinose, D-mannose, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain HMF8043 (= NIBRBAC000501166) was isolated from brine of a solar saltern, Shinan, Republic of Korea (34°59'47"N 126°10'02"E).

**Description of *Virgibacillus salinus* GH4-63**

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, smooth and cream colored after incubation for seven days on MA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetylglucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced, glucose is not fermented. Strain GH4-63 (= NIBRBAC000501047) was isolated from a tidal flat mud sample, Incheon, Republic of Korea (37°35'33"N 126°27'29"E).

**Description of *Paenibacillus assamensis* r2a103fa330**

Cells are Gram-stain-variable and rod-shaped. Colonies are circular and yellowish cream colored after incubation for two days on R2A at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase and gelatinase is positive. Enzyme activity for urease and β-galactosidase is negative. D-Glucose, D-maltose, N-acetylglucosamine, potassium gluconate, and malic acid are assimilated. L-Arabinose, D-mannose, D-mannitol, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain r2a103fa330 (= NIBRBAC000501078) was isolated from a soil sample, Anseong, Republic of Korea (37°00'12.1"N 127°14'00.0"E).

**Description of *Paenibacillus chitinolyticus* HC_97**

Cells are Gram-stain-variable and rod-shaped. Colonies are flat, irregular, and white colored after incubation for two days on R2A at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannose, N-acetylglucosamine, D-maltose, and potassium gluconate are assimilated. L-Arabinose, D-mannitol, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced. Glucose is fermented. Strain HC_97 (= NIBRBAC000501069) was isolated from a mud sample, Hwacheon, Republic of Korea (38°01'53.0"N 127°38'41.3"E).

**Description of *Paenibacillus endophyticus* 17J76-8**

Cells are Gram-stain-positive and rod-shaped. Colonies are irregular, flat, undulate, and cream colored after incubation for four days on R2A at 25°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, and β-galactosidase is positive. Enzyme activity for gelatinase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetylglucosamine, D-maltose, potassium gluconate, and malic acid are assimilated. Capric acid, adipic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain 17J76-8 (= NIBRBAC000501346) was isolated from a soil sample, Jeju, Republic of Korea (33°27'33.6"N 126°56'32.1"E).

**Description of *Paenibacillus odorifer* 16_H1_F15**

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, smooth, and cream colored after incubation for two days on TSA at 30°C. Oxidase activity is weakly positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, D-mannose, N-acetylglucosamine, D-maltose, malic acid, and trisodium citrate are assimilated. L-Arabinose, D-mannose, D-mannitol, potassium gluconate, capric acid, adipic acid, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced. Glucose is fermented. Strain 16_H1_F15 (= NIBRBAC000501079) was isolated from a sediment sample, Namyangju, Re-
Description of *Paenibacillus polymyxa* LT3404

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and transparent after incubation for three days on R2A at 37°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. N-Acetylg glucosamine and potassium gluconate are assimilated. D-Glucose, L-arabinose, D-mannose, D-mannitol, D-maltose, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain LT3404 (= NIBRBAC000501185) was isolated from an intestinal sample of an animal (*Lophura swinhoii*), Gwangcheon, Republic of Korea (37°32'51.6"N 127°14'21.1"E).

Description of *Paenibacillus profundus* HC_63

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, flat and, cream colored after incubation for three days on R2A at 30°C. Oxidase activity is weak positive. Aesculin hydrolyzed. Enzyme activity for urease, gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase is negative. D-Glucose, N-acetyl-glucosamine, D-maltose, potassium gluconate, and trisodium citrate are assimilated. L-Arabinose, D-mannose, D-mannitol, capric acid, adipic acid, malic acid, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain HC_63 (= NIBRBAC000501068) was isolated from a mud sample, Hwacheon, Republic of Korea (38°01'53.0"N 127°38'41.3"E).

Description of *Paenibacillus proveniens* KYW1352

Cells are Gram-stain-negative and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for three days on MA at 35°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain KYW1352 (= NIBRBAC000501134) was isolated from a seawater sample, Gwangyang, Republic of Korea (34°53'26.22"N, 127°45'23.52"E).

Description of *Lysinibacillus acetophenoni* 17J30-13

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for four days on R2A at 25°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, and gelatinase is positive. Enzyme activity for β-galactosidase is negative. D-Mannose, D-mannitol, N-acetyl glucosamine, D-maltose, potassium gluconate, and malic acid are positive. D-Glucose, L-arabinose, capric acid, adipic acid, trisodium citrate, and phenylacetic acid are negative. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain 17J30-13 (= NIBRBAC000501340) was isolated from a soil sample, Jeju, Republic of Korea (33°14'42.2"N 126°34'18.2"E).

Description of *Paenisporosarcina indica* 17J49-7

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for four days on R2A at 25°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, and gelatinase is positive. Enzyme activity for β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl glucosamine, D-maltose, potassium gluconate, and malic acid are positive. Potassium gluconate, capric acid, adipic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain 17J49-7 (= NIBRBAC000501328) was isolated from a soil sample, Jeju, Republic of Korea (33°30'14.9"N 126°27'55.5"E).

Description of *Planomicrobium alkanoclasticum* GH4-13

Cells are Gram-stain-positive and rod-shaped. Colonies are circular, convex, entire, and orange colored after incubation for five days on MA at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain GH4-13 (= NIBRBAC000501037) was isolated from a tidal flat mud sample, Incheon, Republic of Korea (37°35'33"N 126°27'29"E).

Description of *Savageae faecisuis* NA_7

Cells are Gram-stain-positive and oval-shaped. Colonies are circular, convex, and cream colored after incubation for two days on NA at 30°C. Oxidase activity is negative. Aesculin is not hydrolyzed. Enzyme activity...
for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. Malic acid and trisodium citrate are assimilated. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain CAU 1472 (= NIBRBAC000500999) was isolated from a soil sample, Anseong, Republic of Korea (37°07'51"N 127°37'02"E).

Description of *Staphylococcus hominis* subsp. *hominis* CAU 1472

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, raised, smooth, opaque, and cream colored after incubation for two days on BHI at 37°C. Oxidase activity is negative. Aesculin is not hydrolyzed. Enzyme activity for arginine dihydrolase and urease is positive. Enzyme activity for gelatinase and β-galactosidase is negative. D-Glucose is assimilated. L-Arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain CAU 1472 (= NIBRBAC000501236) was isolated from urine, Seoul, Republic of Korea (37°33'13.1"N 127°09'28.0"E).

Description of *Aerococcus urinaeaequi* R2A_1

Cells are Gram-stain-positive and oval-shaped. Colonies are circular, raised, and white colored after incubation for two days on R2A at 30°C. Oxidase activity is positive. Aesculin is not hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, D-maltose, potassium gluconate and malic acid are assimilated. L-Arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, capric acid, adipic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain R2A_1 (= NIBRBAC000501000) was isolated from a soil sample, Anseong, Republic of Korea (37°07'51"N 127°37'02"E).

Description of *Enterococcus gallinarum* VM3406

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, flat, entire, and white colored after incubation for two days on TSA at 37°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase and β-galactosidase is positive. Enzyme activity for urease and gelatinase is negative. D-Mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, and potassium gluconate are assimilated. D-Glucose, L-arabinose, capric acid, adipic acid, malic acid trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced. Glucose is fermented. Strain VM3406 (= NIBRBAC000501190) was isolated from an intestinal sample of an animal (*Vultur gryphus*), Gwacheon, Republic of Korea (37°25'39.7"N 127°01'01.2"E).

Description of *Lactobacillus curvatus* CAU 1479

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, convex, smooth, transparent, and cream colored after incubation for two days on MRS at 30°C. Aesculin is hydrolyzed. Oxidase activity is negative. Enzyme activity for arginine dihydrolase, urease, gelatinase and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced. Glucose is fermented. Strain CAU 1479 (= NIBRBAC000501229) was isolated from kimchi, Seoul, Republic of Korea (37°33'04.9"N 126°57'48.9"E).

Description of *Lactobacillus johnsonii* LPB0164

Cells are anaerobic, Gram-stain-positive, and coccus-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for three days on MRS at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for urease, gelatinase, and catalase is negative. D-Glucose, D-lactose, D-saccharose and D-mannose are acidified. D-Mannitol, D-maltose, salicin, D-xylene, L-arabinose, glycerol, D-cellobiose, D-melezitose, D-raffinose, D-sorbitol, L-rhamnose, and D-trehalose are not acidified. Indole is not produced. Strain LPB0164 (= NIBRBAC000501024) was isolated from an intestinal sample of mouse, Seoul, Republic of Korea (37°35’10.3"N 127°01’30.5"E).

Description of *Lactobacillus reuteri* LPB0165

Cells are anaerobic, Gram-stain-positive, and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for three days on MRS at 30°C. Oxidase activity is negative. Aesculin is not hydrolyzed. Enzyme activity for urease, gelatinase, and catalase is negative. D-Glucose, D-lactose, D-saccharose, D-maltose and D-glucose are acidified. D-Mannitol, D-maltose, salicin, D-xylene, L-arabinose, glycerol, D-cellobiose, D-melezitose, D-raffinose, D-sorbitol, L-rhamnose, and D-trehalose are not acidified. Indole is not produced. Strain LPB0165 (= NIBRBAC000501005) was isolated from an intestinal sample of mouse, Seoul, Republic of Korea (37°35’10.3"N 127°01’30.5"E).
N 127°01'30.5"E).

**Description of Lactobacillus taiwanensis LPB0166**

Cells are anaerobic, Gram-stain-positive, and rod-shaped. Colonies are circular, convex, smooth, and cream colored after incubation for three days on MRS at 30°C. Oxidase activity is negative. Aesculin is not hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced. Glucose is not fermented. Strain CAU 1476 was isolated from kimchi, Seoul, Republic of Korea (37°33'04.9"N 126°57'48.9"E).

**Description of Leuconostoc citreum CAU 1476**

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, convex, smooth, transparent, and cream colored after incubation for two days on MRS at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced. Glucose is not fermented. Strain CAU 1476 (= NIBRBC000501225) was isolated from an intestinal sample of a mouse, Seoul, Republic of Korea (37°33'04.9"N 126°57'48.9"E).

**Description of Leuconostoc pseudomesenteroides CAU 1477**

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, convex, smooth, transparent, and cream colored after incubation for two days on MRS at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain CAU 1477 (= NIBRBC000501222) was isolated from kimchi, Seoul, Republic of Korea (37°33'04.9"N 126°57'48.9"E).

**Description of Leuconostoc rapi CAU 1478**

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, convex, smooth, transparent, and cream colored after incubation for two days on MRS at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for arginine dihydrolase, urease, gelatinase, and β-galactosidase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain CAU 1478 (= NIBRBC000501227) was isolated from kimchi, Seoul, Republic of Korea (37°33'04.9"N 126°57'48.9"E).
Enzyme activity for urease and gelatinase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced. Glucose is fermented. Strain LR3301 (= NIBRBAC000501183) was isolated from an intestinal sample of an animal (Lophura swinhoii), Gwangcheon, Republic of Korea (37°25′39.7″N 127°01′01.2″E).

Description of Streptococcus mitis HMF7345

Cells are Gram-stain-positive and diplococci-shaped. Colonies are circular, convex, smooth and, white-colored after incubation for three days on R2A at 30°C. Oxidase activity is negative. Aesculin is hydrolyzed. Enzyme activity for β-galactosidase is positive. Enzyme activity for arginine dihydrolase, urease, and gelatinase is negative. D-Glucose, L-arabinose, D-mannose, D-mannitol, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is reduced to nitrite. Indole is not produced and glucose is not fermented. Strain HMF7345 (= NIBRBAC000501157) was isolated from soil, Yongin, Republic of Korea (37°20′18″N 127°16′11″E).

Description of Deinococcus gobiensis NM-1

Cells are Gram-stain-positive and coccus-shaped. Colonies are circular, convex, entire, and pink colored after incubation for three days on R2A at 30°C. Oxidase activity is positive. Aesculin is hydrolyzed. Enzyme activity for gelatinase and β-galactosidase is positive. Enzyme activity for arginine dihydrolase and urease is negative. D-Mannitol and malic acid are assimilated. D-Glucose, L-arabinose, D-mannose, N-acetyl-glucosamine, D-maltose, potassium gluconate, capric acid, adipic acid, malic acid, trisodium citrate, and phenylacetic acid are not assimilated. Nitrate is not reduced to nitrite. Indole is not produced and glucose is not fermented. Strain NM-1 (= NIBRBAC000501033) was isolated from a mud sample, Jeju, Republic of Korea (33°25′23″N 126°29′18″E).

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