

PhyMet²: data sources

Supplemental materials

Michał Burdukiewicz, Przemysław Gagat, Michał Gaworski,
Sławomir Jabłoński, Paweł Mackiewicz, Marcin Łukaszewicz

Data in the PhyMet² database was extracted manually from following publications:

- Ahring, B. E. K. *et al.* (1993). removal on the production , composition , and Effect of Medium Composition and Sludge Removal on the Production , Composition , and Architecture of Thermophilic (55 C) Acetate-Utilizing Granules from an Upflow Anaerobic Sludge Blanket Reactor.
- Andrews, E. J. and Novak, P. J. (2001). Influence of ferrous iron and ph on carbon tetrachloride degradation by *Methanosarcina thermophila*. *Water research*, **35**(9), 2307–13.
- Balch, W. E. *et al.* (1979a). Methanogens: reevaluation of a unique biological group. *Microbiological reviews*, **43**(2), 260–96.
- Balch, W. E. *et al.* (1979b). Methanogens: reevaluation of a unique biological group. *Microbiological reviews*, **43**(2), 260–96.
- Balch, W. E. *et al.* (1979c). Methanogens: reevaluation of a unique biological group. *Microbiological reviews*, **43**(2), 260–96.
- Barber, R. D. *et al.* (2011). Complete genome sequence of *Methanosaeta concilii*, a specialist in acetoclastic methanogenesis. *Journal of bacteriology*, **193**(14), 3668–9.
- Bellack, A. *et al.* (2011). *Methanocaldococcus villosus* sp. nov., a heavily flagellated archaeon that adheres to surfaces and forms cell-cell contacts. *International journal of systematic and evolutionary microbiology*, **61**(Pt 6), 1239–45.
- Belyaev, S. S. *et al.* (1983). Methanogenic bacteria from the bondyuzhskoe oil field: general characterization and analysis of stable-carbon isotopic fractionation. *Applied and environmental microbiology*, **45**(2), 691–7.
- Biavati, B. *et al.* (1988). Isolation and Characterization of "Methanosphaera cuniculi" sp.nov. *Applied and Environmental Microbiology*, **54**(3), 768–771.
- Bleicher, K. and Winter, J. (1991). Purification and properties of F4 o- and NADP -t -dependent alcohol dehydrogenases of *Methanogenium liminatans* and *Methanobacterium palustre*, specific for secondary alcohols. *European Journal of Biochemistry*, **51**(1991), 43–51.
- Blotevogel, K.-H. and Fischer, U. (1985). Isolation and characterization of a new thermophilic and autotrophic methane producing bacterium: *Methanobacterium thermoaggregans* spec. nov. *Archives of Microbiology*, **142**(3), 218–222.

- Boone, D. R. and Whitman, W. B. (1988). Proposal of Minimal Standards for Describing New Taxa of Methanogenic Bacteria. *International Journal of Systematic Bacteriology*, **38**(2), 212–219.
- Boone, D. R. *et al.* (1993). Isolation and Characterization of *Methanohalophilus portucalensis* sp. nov. and DNA Reassociation Study of the Genus *Methanohalophilus*. *International Journal of Systematic Bacteriology*, **43**(3), 430–437.
- Borrel, G. *et al.* (2012). *Methanobacterium lacus* sp. nov., isolated from the profundal sediment of a freshwater meromictic lake. *International Journal of Systematic and Evolutionary Microbiology*, **62**(Pt 7), 1625–1629.
- Brambilla, E. *et al.* (2010). Complete genome sequence of *Methanoplanus petrolearius* type strain (SEBR 4847 T). *Standards in genomic sciences*, **3**.
- Bräuer, S. L. *et al.* (2011). *Methanoregula boonei* gen. nov., sp. nov., an acidiphilic methanogen isolated from an acidic peat bog. *International journal of systematic and evolutionary microbiology*, **61**(Pt 1), 45–52.
- Bruggen, J. J. A. *et al.* (1986). Isolation and characterization of *Methanoplanus endosymbiosus* sp. nov., an endosymbiont of the marine sapropelic ciliate *Metopus contortus* quennerstedt. *Archives of Microbiology*, **144**(4), 367–374.
- Bryant, M. and Robinson, I. (1961). An Improved Nonselective Culture Medium for Ruminant Bacteria and Its Use in Determining Diurnal Variation in Numbers of Bacteria in the Rumen. *Journal of Dairy Science*, **44**(8), 1446–1456.
- Bryant, M. P. and Boone, D. R. (1987a). Emended Description of Strain MST(DSM 800T), the Type Strain of *Methanosarcina barkeri*. *International Journal of Systematic Bacteriology*, **37**(2), 169–170.
- Bryant, M. P. and Boone, D. R. (1987b). Isolation and Characterization of *Methanobacterium fornicicum* MF. *International Journal of Systematic Bacteriology*, **37**(2), 171.
- Burggraf, S. *et al.* (1990). *Methanococcus igneus* sp. nov., a Novel Hyperthermophilic Methanogen from a Shallow Submarine Hydrothermal System. *Systematic and Applied Microbiology*, **13**(3), 263–269.
- Cadillo-Quiroz, H. *et al.* (2008). Characterization of the archaeal community in a minerotrophic fen and terminal restriction fragment length polymorphism-directed isolation of a novel hydrogenotrophic methanogen. *Applied and environmental microbiology*, **74**(7), 2059–68.
- Cadillo-Quiroz, H. *et al.* (2009). *Methanosphaerula palustris* gen. nov., sp. nov., a hydrogenotrophic methanogen isolated from a minerotrophic fen peatland. *International journal of systematic and evolutionary microbiology*, **59**(Pt 5), 928–35.
- Casanueva, A. *et al.* (2010). Molecular adaptations to psychrophily: the impact of 'omic' technologies. *Trends in microbiology*, **18**(8), 374–81.
- Cavicchioli, R. *et al.* (2000). Cold stress response in Archaea. *Extremophiles : life under extreme conditions*, **4**(6), 321–31.
- Cavicchioli, R. *et al.* (2002). Low-temperature extremophiles and their applications. *Current Opinion in Biotechnology*, **13**(3), 253–261.

- Cha, I.-T. *et al.* (2013). Methanomethylovorans uponensis sp. nov., a methylotrophic methanogen isolated from wetland sediment. *Antonie van Leeuwenhoek*, **104**(6), 1005–1012.
- Cheng, L. *et al.* (2007). Methermicoccus shengliensis gen. nov., sp. nov., a thermophilic, methylotrophic methanogen isolated from oil-production water, and proposal of Methermicoccaceae fam. nov. *International journal of systematic and evolutionary microbiology*, **57**(Pt 12), 2964–9.
- Cheng, L. *et al.* (2008). Isolation and characterization of Methanoculleus receptaculi sp. nov. from Shengli oil field, China. *FEMS microbiology letters*, **285**(1), 65–71.
- Cheng, L. *et al.* (2011). Isolation and characterization of Methanothermobacter crinale sp. nov., a novel hydrogenotrophic methanogen from the Shengli oil field. *Applied and environmental microbiology*, **77**(15), 5212–9.
- Chong, S. C. *et al.* (2002). Methanogenium marinum sp. nov., a H₂-using methanogen from Skan Bay, Alaska, and kinetics of H₂ utilization. *Antonie van Leeuwenhoek*, **81**(1-4), 263–70.
- Conway de Macario E. *et al.* (1986). Antigenic determinants distinctive of Methanospirillum hungatei and Methanogenium cariaci identified by monoclonal antibodies. *Arch Microbiol*, **144**, 20–24.
- Corder, R. E. *et al.* (1983). Isolation and characterization of two new methane-producing cocci: Methanogenium olentangi, sp. nov., and Methanococcus deltae, sp. nov. *Archives of Microbiology*, **134**(1), 28–32.
- Cuzin, N. *et al.* (2001). Methanobacterium congolense sp. nov., from a methanogenic fermentation of cassava peel. *International journal of systematic and evolutionary microbiology*, **51**(Pt 2), 489–93.
- Davidova, I. a. *et al.* (1997). Taxonomic description of Methanococcoides euhalobius and its transfer to the Methanohalophilus genus. *Antonie van Leeuwenhoek*, **71**(4), 313–8.
- DeLong, E. F. (1992). Archaea in coastal marine environments. *Proceedings of the National Academy of Sciences of the United States of America*, **89**(12), 5685–9.
- Dianou, D. *et al.* (2001). Methanoculleus chikugoensis sp. nov., a novel methanogenic archaeon isolated from paddy field soil in Japan, and DNA-DNA hybridization among Methanoculleus species. *International journal of systematic and evolutionary microbiology*, **51**(Pt 5), 1663–9.
- Doerfert, S. N. *et al.* (2009). Methanolobus zinderi sp. nov., a methylotrophic methanogen isolated from a deep subsurface coal seam. *International journal of systematic and evolutionary microbiology*, **59**(Pt 5), 1064–9.
- Dong, X. and Chen, Z. (2012). Psychrotolerant methanogenic archaea: diversity and cold adaptation mechanisms. *Science China. Life sciences*, **55**(5), 415–21.
- Dridi, B. *et al.* (2012). Methanomassiliicoccus luminyensis gen. nov., sp. nov., a methanogenic archaeon isolated from human faeces. *International journal of systematic and evolutionary microbiology*, **62**(Pt 8), 1902–7.
- Elberson, M. A. and Sowers, K. R. (1997). Isolation of an Aceticlastic Strain of Methanosarcina siciliae from Marine Canyon Sediments and Emendation of the Species Description for Methanosarcina siciliae. *International Journal of Systematic Bacteriology*, **47**(4), 1258–1261.

- Euzeby, J. P. (1998). Taxonomic note: necessary correction of specific and subspecific epithets according to Rules 12c and 13b of the International Code of Nomenclature of Bacteria (1990 Revision). *International Journal of Systematic Bacteriology*, **48**(3), 1073–1075.
- Fathepure, B. Z. (1987). Factors Affecting the Methanogenic Activity of *Methanothrix soehngenii* VNBft. **53**(12), 2978–2982.
- Ferguson, T. J. and Mah, R. A. (1983). Isolation and Characterization of an H₂-Oxidizing Thermophilic Methanogen. *Applied and Environmental Microbiology*, **45**(1).
- Ferrari, A. *et al.* (1994). Isolation and characterization of *Methanobrevibacter oralis* sp. nov. *Current Microbiology*, **29**(1), 7–12.
- Ferry, J. *et al.* (1974). *Methanospirillum*, a New Genus of Methanogenic Bacteria, and Characterization of *Methanospirillum hungatii* sp. nov. *International journal of systematic bacteriology*, **24**(4), 465–469.
- Franzmann, P. *et al.* (1992). A Methanogenic Archaeon from Ace Lake, Antarctica: *Methanococcoides burtonii* sp. nov. *Systematic and Applied Microbiology*, **15**(4), 573–581.
- Franzmann, P. D. *et al.* (1997). *Methanogenium frigidum* sp. nov., a Psychrophilic, H₂-Using Methanogen from Ace Lake, Antarctica. *International Journal of Systematic Bacteriology*, **47**(3), 1068–1072.
- Freitas, T. A. K. *et al.* (2004). Ancestral hemoglobins in Archaea. *Proceedings of the National Academy of Sciences of the United States of America*, **101**(17), 6675–80.
- Galagan, J. E. *et al.* (2002). The genome of *M. acetivorans* reveals extensive metabolic and physiological diversity. *Genome research*, **12**(4), 532–42.
- Ganzert, L. *et al.* (2014). *Methanosarcina spelaei* sp. nov., a methanogenic archaeon isolated from a floating biofilm of a subsurface sulphurous lake. *International journal of systematic and evolutionary microbiology*, **64**, 3478–3484.
- Giaquinto, L. *et al.* (2007). Structure and function of cold shock proteins in archaea. *Journal of bacteriology*, **189**(15), 5738–48.
- Godsy, E. M. (1980). Isolation of *Methanobacterium bryantii* from a Deep Aquifer by Using a Novel Broth-Antibiotic Disk Method. *Applied and environmental microbiology*, **39**(5), 1074–5.
- Goevert, D. and Conrad, R. (2009). Effect of substrate concentration on carbon isotope fractionation during acetoclastic methanogenesis by *Methanosarcina barkeri* and *M. acetivorans* and in rice field soil. *Applied and environmental microbiology*, **75**(9), 2605–12.
- Gorrell, A. and Ferry, J. G. (2008). NIH Public Access. **46**(49), 14170–14176.
- Grant, W. and Pinch, G. (1985). Polar lipids in methanogen taxonomy. *Journal of general Microbiology*, **131**, 3277–3286.
- Huber, H. *et al.* (1982). *Methanococcus Thermolithotrophicus*, a Novel Thermophilic Lithotrophic Methanogen. *Arch Microbiol*, **132**, 47–50.

- Iino, T. *et al.* (2010). *Methanospirillum lacunae* sp. nov., a methane-producing archaeon isolated from a puddly soil, and emended descriptions of the genus *Methanospirillum* and *Methanospirillum hungatei*. *International journal of systematic and evolutionary microbiology*, **60**(Pt 11), 2563–6.
- Iino, T. *et al.* (2013). *Candidatus Methanogranum caenicola*: a Novel Methanogen from the Anaerobic Digested Sludge, and Proposal of *Methanomassiliicoccaceae* fam. nov. and *Methanomassiliicoccales* ord. nov., for a Methanogenic Lineage of the Class *Thermoplasmata*. *Microbes and Environments*, **28**(2), 244–250.
- Imachi, H. *et al.* (2000). Cultivation and In Situ Detection of a Thermophilic Bacterium Capable of Oxidizing Propionate in Syntrophic Association with Hydrogenotrophic Methanogens in a Thermophilic Methanogenic Granular Sludge. *Applied and Environmental Microbiology*.
- Imachi, H. *et al.* (2006). Non-sulfate-reducing, syntrophic bacteria affiliated with *Desulfotomaculum* cluster I are widely distributed in methanogenic environments. *Applied and . . .*, **72**(3), 2080–2091.
- Imachi, H. *et al.* (2008). *Methanolinea tarda* gen. nov., sp. nov., a methane-producing archaeon isolated from a methanogenic digester sludge. *International journal of systematic and evolutionary microbiology*, **58**(Pt 1), 294–301.
- Imachi, H. *et al.* (2009). *Methanofollis ethanolicus* sp. nov., an ethanol-utilizing methanogen isolated from a lotus field. *International journal of systematic and evolutionary microbiology*, **59**(Pt 4), 800–5.
- Jablonski, P. E. and Ferry, J. G. (1991). Purification and properties of methyl coenzyme M methylreductase from acetate-grown *Methanosarcina thermophila*. *Journal of bacteriology*, **173**(8), 2481–7.
- Jain, M. K. *et al.* (1987). Speciation of *Methanobacterium* strain Ivanov as *Methanobacterium ivanovii*, sp. nov. *Systematic and Applied Microbiology*, **9**(12), 77–82.
- Jeanthon, C. *et al.* (1998). *Methanococcus infernus* sp. nov., a novel hyperthermophilic lithotrophic methanogen isolated from a deep-sea hydrothermal vent. *International Journal of Systematic Bacteriology*, **48**(3), 913–919.
- Jeanthon, C. *et al.* (1999a). *Methanococcus vulcanius* sp. nov., a novel hyperthermophilic methanogen isolated from East Pacific Rise, and identification of *Methanococcus* sp. DSM 4213T as *Methanococcus fervens* sp. nov. *International journal of systematic bacteriology*, **49** Pt 2(1999), 583–9.
- Jeanthon, C. *et al.* (1999b). *Methanococcus vulcanius* sp. nov., a novel hyperthermophilic methanogen isolated from East Pacific Rise, and identification of *Methanococcus* sp. DSM 4213T as *Methanococcus fervens* sp. nov. *International Journal of Systematic Bacteriology*, **49**(2), 583–589.
- Jetten, M. (1992). Methanogenesis from acetate: a comparison of the acetate metabolism in *Methanotheroxis soehngenii* and *Methanosarcina* spp. *FEMS Microbiology Letters*, **88**(3-4), 181–197.
- Jiang, B. *et al.* (2005). *Methanomethylovorans thermophila* sp. nov., a thermophilic, methylotrophic methanogen from an anaerobic reactor fed with methanol. *International journal of systematic and evolutionary microbiology*, **55**(Pt 6), 2465–70.
- Jiang, N. *et al.* (2010). Methanol as the primary methanogenic and acetogenic precursor in the cold Zoige wetland at Tibetan plateau. *Microbial Ecology*, **60**(1), 206–213.

- John Parkes, R. *et al.* (2012). Changes in methanogenic substrate utilization and communities with depth in a salt-marsh, creek sediment in southern England. *Estuarine, Coastal and Shelf Science*, **96**, 176.
- Jones, W. J. *et al.* (1983). *Methanococcus jannaschii* sp. nov., an extremely thermophilic methanogen from a submarine hydrothermal vent. *Archives of Microbiology*, **136**(4), 254–261.
- Jones, W. J., M. J. B. Paynter *et al.* (1983). Characterization of *Methanococcus maripaludis* sp. nov., a new methanogen isolated from salt marsh sediment. *Arch Microbiol*, **135**(2), 91–97.
- Joulain, C. *et al.* (1998). Phenotypic and phylogenetic characterization of dominant culturable methanogens isolated from ricefield soils. *FEMS Microbiology Ecology*, **25**(2), 135–145.
- Joulain, C. *et al.* (2000). *Methanobacterium oryzae* sp. nov., a novel methanogenic rod isolated from a Philippines ricefield. *International journal of systematic and evolutionary microbiology*, **50**(2), 525–8.
- Journal, B. (2012). Isolation and characterization of an. **45**(1), 441–448.
- Kadam, P. and Boone, D. (1995). Physiological characterization and emended description of *Methanlobus vulcani*. *International Journal of Systematic Bacteriology*, **45**(2), 400–402.
- Kadam, P. C. *et al.* (1994). Isolation and Characterization of *Methanlobus bombayensis* sp. nov., a Methylophilic Methanogen That Requires High Concentrations of Divalent Cations. *International Journal of Systematic Bacteriology*, **44**(4), 603–607.
- Kamagata, Y. and Mikami, E. (1991). Isolation and Characterization of a Novel Thermophilic. *International Journal of Systematic Bacteriology*, **41**(2), 191–196.
- Kamagata, Y. *et al.* (1992). Characterization of Three Thermophilic Strains of *Methanotherox* (*Methanosaeta*) *thermophila* sp. nov. and Rejection of *Methanotherox* (*Methanosaeta*) *thermoacetophila*. *International journal of systematic bacteriology*, **42**(3), 463–468.
- Katayama, T. *et al.* (2014). *Methanohalophilus levihalophilus* sp. nov., a slightly halophilic, methylophilic methanogen isolated from natural gas-bearing deep aquifers, and an emended description of the genus *Methanohalophilus*. *International Journal of Systematic and Evolutionary Microbiology*.
- Kendall, M. M. *et al.* (2006). *Methanococcus aeolicus* sp. nov., a mesophilic, methanogenic archaeon from shallow and deep marine sediments. *International journal of systematic and evolutionary microbiology*, **56**(Pt 7), 1525–9.
- Kendall, M. M. *et al.* (2007). Diversity of Archaea in marine sediments from Skan Bay, Alaska, including cultivated methanogens, and description of *Methanogenium boonei* sp. nov. *Applied and environmental microbiology*, **73**(2), 407–14.
- Kester, D. R. *et al.* (1967). Preparation of artificial seawater. *Limnology and Oceanography*, **12**(1), 176–179.
- Keswani, J. *et al.* (1996). Phylogeny and taxonomy of mesophilic *Methanococcus* spp. and comparison of rRNA, DNA hybridization, and phenotypic methods. *International journal of systematic bacteriology*, **46**(3), 727–35.

- Keyser, M. *et al.* (2006). PCR-based DGGE fingerprinting and identification of methanogens detected in three different types of UASB granules. *Systematic and applied microbiology*, **29**(1), 77–84.
- Kitamura, K. *et al.* (2011). *Methanobacterium kanagiense* sp. nov., a hydrogenotrophic methanogen, isolated from rice-field soil. *International journal of systematic and evolutionary microbiology*, **61**(Pt 6), 1246–52.
- Kobayashi, H. A. *et al.* (1988). Direct Characterization of Methanogens in Two High-Rate Anaerobic Biological Reactors. *Applied and Environmental Microbiology*, **54**(3), 693–698.
- König, H. (1984). Isolation and characterization of *Methanobacterium uliginosum* sp. nov. from a marshy soil. *Can. J. Microbiol.*, **König, H.**(12), 1477–1481.
- König, H. and Stetter, K. O. (1982a). Isolation and characterization of *Methanolobus tindarius*, sp. nov., a coccoid methanogen growing only on methanol and methylamines. *Zentralblatt für Bakteriologie Mikrobiologie und Hygiene: I. Abt. Originale C: Allgemeine, angewandte und ökologische Mikrobiologie*, **3**(4), 478–490.
- König, H. and Stetter, K. O. (1982b). Isolation and characterization of *Methanolobus tindarius*, sp. nov., a coccoid methanogen growing only on methanol and methylamines. *Zentralblatt für Bakteriologie Mikrobiologie und Hygiene: I. Abt. Originale C: Allgemeine, angewandte und ökologische Mikrobiologie*, **3**(4), 478–490.
- Koons, B. W. *et al.* (2001). Investigation of cell exudates active in carbon tetrachloride and chloroform degradation. *Biotechnology and bioengineering*, **74**(1), 12–7.
- Kotelnikova, S. V. *et al.* (1993a). *Methanobacterium thermoflexum* sp. nov. and *Methanobacterium defluvii* sp. nov., Thermophilic Rod-Shaped Methanogens Isolated from Anaerobic Digester Sludge. *Systematic and Applied Microbiology*, **16**(3), 427–435.
- Kotelnikova, S. V. *et al.* (1993b). *Methanobacterium thermoflexum* sp. nov. and *Methanobacterium defluvii* sp. nov., Thermophilic Rod-Shaped Methanogens Isolated from Anaerobic Digester Sludge. *Systematic and Applied Microbiology*, **16**(3), 427–435.
- Kotelnikova, S. V. *et al.* (1993c). Taxonomic Analysis of Thermophilic Strains of the Genus *Methanobacterium* : Reclassification of *Methanobacterium thermoalcaliphilum* as a Synonym of *Methanobacterium thermoautotrophicum*. (July), 591–596.
- Kotelnikova, S., Macario, J.L., P. K. (1998). *Methanobacterium subterraneum* sp. nov., a new alkaliphilic, eurythermic and halotolerant methanogen isolated from deep granitic groundwater. *International Journal of Systematic Bacteriology*, **48**(2), 357–367.
- Krivushin, K. V. *et al.* (2010). *Methanobacterium veterum* sp. nov., from ancient Siberian permafrost. *International journal of systematic and evolutionary microbiology*, **60**(Pt 2), 455–9.
- Kurr, M. *et al.* (1991). *Methanopyrus kandleri*, gen. and sp. nov. represents a novel group of hyperthermophilic methanogens, growing at 110 °C. *Archives of Microbiology*, **156**(4), 239–247.
- Lai, M. C. and Chen, S. C. (2001). *Methanofollis aquaemaris* sp. nov., a methanogen isolated from an aquaculture fish pond. *International journal of systematic and evolutionary microbiology*, **51**(Pt 5), 1873–80.

- Lai, M.-c. *et al.* (2002). *Methanocalculus taiwanensis* sp. nov., isolated from an estuarine environment. *International Journal of Systematic and Evolutionary Microbiology*, **52**(5), 1799–1806.
- Lai, M.-C. *et al.* (2004). *Methanocalculus chunghsingensis* sp. nov., isolated from an estuary and a marine fishpond in Taiwan. *International Journal of Systematic and Evolutionary Microbiology*, **54**(1), 183–189.
- Lauerer, G. *et al.* (1986). *Methanothermus sociabilis* sp. nov., a Second Species within the Methanothermaceae Growing at 97°C. *Systematic and Applied Microbiology*, **8**(12), 100–105.
- Laurinavichus, K.S., Kotelnikova, S.V., and Obraztsova, A. (1988). A new species of the thermophilic methane-forming bacterium *Methanobacterium thermophilum*. *Mikrobiologiya*, **57**, 1035–1041.
- Leadbetter, J. R. and Breznak, J. A. (1996). Physiological Ecology of *Methanobrevibacter cuticularis* sp. nov. and *Methanobrevibacter curvatus* sp. nov., Isolated from the Hindgut of the Termite *Reticulitermes flavipes*. *Applied and Environmental Microbiology*, **62**(10), 3620–3631.
- Leadbetter, J. R. *et al.* (1998). *Methanobrevibacter filiformis* sp. nov., a filamentous methanogen from termite hindguts. *Arch. Microbiol.*, **169**(4), 287–292.
- Lee, J.-H. *et al.* (2013). *Methanobrevibacter boviskoreani* sp. nov., isolated from the rumen of Korean native cattle. *International Journal of Systematic and Evolutionary Microbiology*, **63**(Pt 11), 4196–4201.
- Lessner, D. J. and Ferry, J. G. (2007). The archaeon *Methanosarcina acetivorans* contains a protein disulfide reductase with an iron-sulfur cluster. *Journal of bacteriology*, **189**(20), 7475–84.
- L’Haridon, S. *et al.* (2003). *Methanocaldococcus indicus* sp. nov., a novel hyperthermophilic methanogen isolated from the Central Indian Ridge. *International Journal of Systematic and Evolutionary Microbiology*, **53**(6), 1931–1935.
- L’Haridon, S. *et al.* (2014). *Methanococcoides vulcani* sp. nov., a novel marine methylotrophic methanogen; using betaine, choline and N,N-dimethylethanolamine for methanogenesis, isolated from the Napoli Mud Volcano in the Eastern Mediterranean Sea; and emendation of the genus *Meth.* *International Journal of Systematic and Evolutionary Microbiology*.
- Lira-Silva, E. *et al.* (2012). Activation of methanogenesis by cadmium in the marine archaeon *Methanosarcina acetivorans*. *PloS one*, **7**(11), e48779.
- Liu, Y. *et al.* (1990). *Methanohalophilus oregonense* sp. nov., a Methylotrophic Methanogen from an Alkaline, Saline Aquifer. *International Journal of Systematic Bacteriology*, **40**(2), 111–116.
- Lobo, a. L. and Zinder, S. H. (1988). Diazotrophy and Nitrogenase Activity in the Archaeobacterium *Methanosarcina barkeri* 227. *Applied and environmental microbiology*, **54**(7), 1656–61.
- Lomans, B. P. *et al.* (1999). Isolation and characterization of *Methanomethylovorans hollandica* gen. nov., sp. nov., isolated from freshwater sediment, a methylotrophic methanogen able to grow on dimethyl sulfide and methanethiol. *Applied and environmental microbiology*, **65**(8), 3641–50.
- Lü, Z. and Lu, Y. (2012a). Complete genome sequence of a thermophilic methanogen, *Methanocella conradii* HZ254, isolated from Chinese rice field soil. *Journal of bacteriology*, **194**(9), 2398–9.
- Lü, Z. and Lu, Y. (2012b). *Methanocella conradii* sp. nov., a thermophilic, obligate hydrogenotrophic methanogen, isolated from chinese rice field soil. *PLoS ONE*, **7**(4).

- Lyimo, T. J. *et al.* (2000). Methanosarcina semesiae sp. nov., a dimethylsulfide-utilizing methanogen from mangrove sediment. *International journal of systematic and evolutionary microbiology*, **50** Pt 1, 171–8.
- Ma, K. *et al.* (2005). Methanobacterium beijingense sp. nov., a novel methanogen isolated from anaerobic digesters. *International journal of systematic and evolutionary microbiology*, **55**(Pt 1), 325–9.
- Ma, K. *et al.* (2006). Methanosaeta harundinacea sp. nov., a novel acetate-scavenging methanogen isolated from a UASB reactor. *International journal of systematic and evolutionary microbiology*, **56**(Pt 1), 127–31.
- Maeder, D. L. *et al.* (2006). The Methanosarcina barkeri genome: comparative analysis with Methanosarcina acetivorans and Methanosarcina mazei reveals extensive rearrangement within methanosarcinal genomes. *Journal of bacteriology*, **188**(22), 7922–31.
- Maestrojuan, G. M. *et al.* (1992). Taxonomy and Halotolerance of Mesophilic Methanosarcina Strains, Assignment of Strains to Species, and Synonymy of Methanosarcina mazei and Methanosarcina frisia. *International Journal of Systematic Bacteriology*, **42**(4), 561–567.
- Mah, R. (1980). Isolation and characterization of Methanococcus mazei. *Current Microbiology*, **3**(6), 321–326.
- Martin, D. D. *et al.* (1999). Osmoadaptation in Archaea MINIREVIEW Osmoadaptation in Archaea. *Applied and Environmental Microbiology*, **65**(5), 1815–1825.
- Mathrani, I. M. *et al.* (1988). Methanohalophilus zhilinae sp. nov., an Alkaliphilic, Halophilic, Methylophilic Methanogen. *International Journal of Systematic Bacteriology*, **38**(2), 139–142.
- Meastrojuan, G. M. and Boone, D. R. (1991). Characterization of Methanosarcina barkeri MST and 227, Methanosarcina mazei S-6T, and Methanosarcina vacuolata Z-761T. *International Journal of Systematic Bacteriology*, **41**(2), 267–274.
- Menaia, J. A. G. F. *et al.* (1999). Osmotic adaptation of moderately halophilic methanogenic Archaeobacteria, and detection of cytosolic N, N-dimethylglycine. *Experientia*, **49**, 1047–1054.
- Mikucki, J. A. *et al.* (2003). Isolation of a Methanogen from Deep Marine Sediments That Contain Methane Hydrates, and Description of. *Applied and Environmental Microbiology*, **69**(6), 3311–3316.
- Miller, T. L. and Lin, C. (2002a). Description of Methanobrevibacter gottschalkii sp. nov., Methanobrevibacter thaueri sp. nov., Methanobrevibacter woesei sp. nov. and Methanobrevibacter wolnii sp. nov.. *International Journal of Systematic and Evolutionary Microbiology*, **52**(3), 819–822.
- Miller, T. L. and Lin, C. (2002b). Description of Methanobrevibacter gottschalkii sp. nov., Methanobrevibacter thaueri sp. nov., Methanobrevibacter woesei sp. nov. and Methanobrevibacter wolnii sp. nov.. *International Journal of Systematic and Evolutionary Microbiology*, **52**(3), 819–822.
- Miller, T. L. and Lin, C. (2002c). Description of Methanobrevibacter gottschalkii sp. nov., Methanobrevibacter thaueri sp. nov., Methanobrevibacter woesei sp. nov. and Methanobrevibacter wolnii sp. nov.. *International Journal of Systematic and Evolutionary Microbiology*, **52**(3), 819–822.

- Miller, T. L. and Lin, C. (2002d). Description of *Methanobrevibacter gottschalkii* sp. nov., *Methanobrevibacter thaueri* sp. nov., *Methanobrevibacter woesei* sp. nov. and *Methanobrevibacter wolinii* sp. nov.. *International Journal of Systematic and Evolutionary Microbiology*, **52**(3), 819–822.
- Miller, T. L. and Wolin, M. J. (1985). *Methanosphaera stadtmaniae* gen. nov., sp. nov.: a species that forms methane by reducing methanol with hydrogen. *Arch Microbiol*, **141**, 116–122.
- Miller, T. L. *et al.* (1986). Isolation and characterization of methanogens from animal feces. *Systematic and Applied Microbiology*, **8**(3), 234–238.
- Mladenovska, Z. and Ahring, B. K. (2000). Growth kinetics of thermophilic *Methanosarcina* spp. isolated from full-scale biogas plants treating animal manures. *FEMS Microbiology Ecology*, **31**(3), 225–229.
- Mochimaru, H. *et al.* (2009). *Methanolobus profundus* sp. nov., a methylotrophic methanogen isolated from deep subsurface sediments in a natural gas field. *International journal of systematic and evolutionary microbiology*, **59**(Pt 4), 714–8.
- Mochimaru, H. *et al.* (2016). *Methanomicrobium antiquum* sp. nov., a hydrogenotrophic methanogen isolated from deep sedimentary aquifers in a natural gas field. *International Journal of Systematic and Evolutionary Microbiology*, **66**(11), 4873–4877.
- Mori, K. and Harayama, S. (2011). *Methanobacterium petrolearium* sp. nov. and *Methanobacterium ferruginis* sp. nov., mesophilic methanogens isolated from salty environments. *International journal of systematic and evolutionary microbiology*, **61**(Pt 1), 138–43.
- Mori, K. *et al.* (2000). *Methanocalculus pumilus* sp. nov., a heavy-metal-tolerant methanogen isolated from a waste-disposal site. *International journal of systematic and evolutionary microbiology*, **50 Pt 5**, 1723–9.
- Mori, K. *et al.* (2012). Aceticlastic and NaCl-requiring methanogen "Methanosaeta pelagica" sp. nov., isolated from marine tidal flat sediment. *Applied and environmental microbiology*, **78**(9), 3416–23.
- MORII, H. *et al.* (1983). Isolation, Characterization and Physiology of a New Formate-assimilable Methanogenic Strain (A2) of *Methanobrevibacter arboriphilus*. *Agricultural and Biological Chemistry*, **47**(12), 2781–2789.
- Murray, P. a. and Zinder, S. H. (1985). Nutritional Requirements of *Methanosarcina* sp. Strain TM-1. *Applied and environmental microbiology*, **50**(1), 49–55.
- Nakamura, K. *et al.* (2013). *Methanothermobacter tenebrarum* sp. nov., a hydrogenotrophic, thermophilic methanogen isolated from gas-associated formation water of a natural gas field. *International journal of systematic and evolutionary microbiology*, **63**(Pt 2), 715–22.
- Narihiro, T. *et al.* (2009). Quantitative detection of culturable methanogenic archaea abundance in anaerobic treatment systems using the sequence-specific rRNA cleavage method. *The ISME journal*, **3**(5), 522–35.
- Nelson, K E; Paulsen, I T; Heidelberg, J F; Fraser, C. M. (2000). Status of genome projects for nonpathogenic bacteria and archaea. *Nature biotechnology*, **18**(10), 1049–54.

- Ni, S. and Boone, D. R. (1991). Isolation and Characterization of a Dimethyl Sulfide-Degrading Methanogen, *Methanolobus siciliae* HI350, from an Oil Well, Characterization of *M. siciliae* T4/MT, and Emendation of *M. siciliae*. *International Journal of Systematic Bacteriology*, **41**(3), 410–416.
- NI, S. *et al.* (1994). NOTES: Transfer of *Methanolobus siciliae* to the Genus *Methanosarcina*, Naming It *Methanosarcina siciliae*, and Emendation of the Genus *Methanosarcina*. *International Journal of Systematic Bacteriology*, **44**(2), 357–359.
- Oelgeschläger, E. and Rother, M. (2009). Influence of carbon monoxide on metabolite formation in *Methanosarcina acetivorans*. *FEMS microbiology letters*, **292**(2), 254–60.
- Ollivier, B. and Fardeau, M. (1998). *Methanocalculus halotolerans* gen. nov., sp. nov., isolated from an oil-producing well. *International journal of systematic Bacteriology*, **48**, 823–824.
- Ollivier, B. and Mah, R. (1986). Isolation and Characterization of *Methanogenium bourgense* sp. nov. *International Journal of Systematic Bacteriology*, **36**(2), 297–301.
- Ollivier, B. *et al.* (1997). *Methanoplanus Petrolearius* sp. nov., a novel methanogenic bacterium from an oil-producing well. *FEMS Microbiology Letters*, **147**, 51–56.
- Ollivier, B. M. *et al.* (1985). Isolation and Characterization of *Methanogenium aggregans* sp. nov. *International Journal of Systematic Bacteriology*, **35**(2), 127–130.
- Oremland, R. S. and Boone, D. R. (1994). NOTES: *Methanolobus taylorii* sp. nov., a New Methy-lotrophic, Estuarine Methanogen. *International Journal of Systematic Bacteriology*, **44**(3), 573–575.
- Oremland, R. S. *et al.* (1989). Description of an estuarine methylotrophic methanogen which grows on dimethyl sulfide. *Applied and environmental microbiology*, **55**(4), 994–1002.
- Parshina, S. N. *et al.* (2014). *Methanospirillum stamsii* sp. nov., a psychrotolerant, hydrogenotrophic, methanogenic archaeon isolated from an anaerobic expanded granular sludge bed bioreactor operated at low temperature. *International Journal of Systematic and Evolutionary Microbiology*, **64**(Pt 1), 180–186.
- Patel, G. *et al.* (1990). Isolation and characterization of *Methanobacterium espanolae* sp. nov., a mesophilic, moderately acidiphilic methanogen. *International Journal of Systematic Bacteriology*, **40**(1), 12–18.
- Patel, G. B. and Sprott, G. D. (1990a). *Methanosaeta concilii* gen. nov., sp. nov. ("Methanothrix concilii") and *Methanosaeta thermoacetophila* nom. rev., comb. nov. *International Journal of Systematic Bacteriology*, **40**(1), 79–82.
- Patel, G. B. and Sprott, G. D. (1990b). *Methanosaeta concilii* gen. nov., sp. nov. ("Methanothrix concilii") and *Methanosaeta thermoacetophila* nom. rev., comb. nov. *International Journal of Systematic Bacteriology*, **40**(1), 79–82.
- Patel, G. B. *et al.* (1988). Nutritional requirements for growth of *Methanothrix concilii*. *Canadian Journal of Microbiology*, **34**(1), 73–77.
- Paterek, J. R. and Smith, P. H. (1988). *Methanohalophilus mahii* gen. nov., sp. nov., a Methy-lotrophic Halophilic Methanogen. *International Journal of Systematic Bacteriology*, **38**(1), 122–123.

- Pavlov, N. a. *et al.* (2002). Identification, cloning and characterization of a new DNA-binding protein from the hyperthermophilic methanogen *Methanopyrus kandleri*. *Nucleic acids research*, **30**(3), 685–94.
- Paynter, M. J. and Hungate, R. E. (1968a). Characterization of *Methanobacterium mobilis*, sp. n., isolated from the bovine rumen. *Journal of bacteriology*, **95**(5), 1943–51.
- Paynter, M. J. and Hungate, R. E. (1968b). Characterization of *Methanobacterium mobilis*, sp. n., isolated from the bovine rumen. *Journal of bacteriology*, **95**(5), 1943–51.
- Purdy, K. J. *et al.* (2003). Analysis of the Sulfate-Reducing Bacterial and Methanogenic Archaeal Populations in Contrasting Antarctic Sediments. *Appl. Envir. Microbiol.*, **69**(6), 3181–3191.
- Raemakers-Franken, P. C. *et al.* (1990). Methanogenesis involving a novel carrier of C1 compounds in *Methanogenium tationis*. *Journal of bacteriology*, **172**(2), 1157–9.
- Raskin, L. *et al.* (1994). Group-specific 16S rRNA hybridization probes to describe natural communities of methanogens. *Applied and environmental microbiology*, **60**(4), 1232–40.
- Raskin, L; Stromley, J M Rittmann, B E Stahl, D. a. (1994). Group-specific 16S rRNA hybridization probes to describe natural communities of methanogens. *Applied and environmental microbiology*, **60**(4), 1232–40.
- Rea, S. *et al.* (2007). *Methanobrevibacter millerae* sp. nov. and *Methanobrevibacter olleyae* sp. nov., methanogens from the ovine and bovine rumen that can utilize formate for growth. *International journal of systematic and evolutionary microbiology*, **57**(Pt 3), 450–6.
- Rivard, C. J. and Smith, P. H. (1982). Isolation and Characterization of a Thermophilic Marine Methanogenic Bacterium, *Methanogenium thermophilicum* sp. nov. *International Journal of Systematic Bacteriology*, **32**(4), 430–436.
- Rivard, C. J. *et al.* (1983). Isolation and Characterization of *Methanomicrobium paynteri* sp. nov., a Mesophilic Methanogen Isolated from Marine Sediments. *Applied and environmental microbiology*, **46**(2), 484–90.
- Rivkina, E. *et al.* (2007). Biogeochemistry of methane and methanogenic archaea in permafrost. *FEMS Microbiology Ecology*, **61**(1), 1–15.
- Roberts, M. F. *et al.* (1992). Biosynthetic pathways of the osmolytes N epsilon-acetyl-beta-lysine, beta-glutamine, and betaine in *Methanohalophilus* strain FDF1 suggested by nuclear magnetic resonance analyses. *Journal of bacteriology*, **174**(20), 6688–93.
- Robertson, D. E. *et al.* (1990). Detection of the osmoregulator betaine in methanogens. *Applied and environmental microbiology*, **56**(2), 563–5.
- Robertson, D. E. *et al.* (1992). Free Amino Acid Dynamics in Marine Methanogens. *The Journal of Biological Chemistry*, **267**, 14893–14901.
- Robertson, D E; Roberts, M F; Belay, N; Stetter, K O; Boone, D. R. (1990). Occurrence of beta-glutamate, a novel osmolyte, in marine methanogenic bacteria. *Applied and environmental microbiology*, **56**(5), 1504–8.

- Rocheleau, S. *et al.* (1999). Differentiation of methanosaeta concilii and methanosarcina barkeri in anaerobic mesophilic granular sludge by fluorescent In situ hybridization and confocal scanning laser microscopy. *Applied and environmental microbiology*, **65**(5), 2222–9.
- Rohlin, L. and Gunsalus, R. P. (2010). Carbon-dependent control of electron transfer and central carbon pathway genes for methane biosynthesis in the Archaeon, Methanosarcina acetivorans strain C2A. *BMC microbiology*, **10**, 62.
- Romesser, J. A. *et al.* (1979). Methanogenium, a New Genus of Marine Methanogenic Bacteria, and Characterization of Methanogenium cariaci sp. nov. and Methanogenium marisnigri sp. nov. *Arch. Microbiol.*, **121**, 147–153.
- Rother, M. and Metcalf, W. W. (2004). Anaerobic growth of Methanosarcina acetivorans C2A on carbon monoxide: an unusual way of life for a methanogenic archaeon. *Proceedings of the National Academy of Sciences of the United States of America*, **101**(48), 16929–34.
- Sakai, S. *et al.* (2008). Methanocella paludicola gen. nov., sp. nov., a methane-producing archaeon, the first isolate of the lineage ‘Rice Cluster I’, and proposal of the new archaeal order Methanocellales ord. nov. *International journal of systematic and evolutionary microbiology*, **58**(Pt 4), 929–36.
- Sakai, S. *et al.* (2010). Methanocella arvoryzae sp. nov., a hydrogenotrophic methanogen isolated from rice field soil. *International journal of systematic and evolutionary microbiology*, **60**(Pt 12), 2918–23.
- Sakai, S. *et al.* (2012). Methanolinea mesophila sp. nov., a hydrogenotrophic methanogen isolated from rice field soil, and proposal of the archaeal family Methanoregulaceae fam. nov. within the order. *International Journal of Systematic and Evolutionary Microbiology*, **62**(Pt 6), 1389–1395.
- Saunders, N. F. W. *et al.* (2003). Mechanisms of thermal adaptation revealed from the genomes of the Antarctic Archaea Methanogenium frigidum and Methanococcoides burtonii. *Genome research*, **13**(7), 1580–8.
- Savant, D. V. *et al.* (2002). Methanobrevibacter acididurans sp. nov., a novel methanogen from a sour anaerobic digester. *International journal of systematic and evolutionary microbiology*, **52**(Pt 4), 1081–7.
- Schirmack, J. *et al.* (2014). Methanobacterium movilense sp. nov., a hydrogenotrophic, secondary-alcohol-utilizing methanogen from the anoxic sediment of a subsurface lake. *International journal of systematic and evolutionary microbiology*, **64**(Pt 2), 522–7.
- Schmid, K. *et al.* (1984a). Three new restriction endonucleases MaeI, MaeII and MaeIII from Methanococcus aeolicus. *Nucleic Acids Research*, **12**(6), 2619–2628.
- Schmid, K. *et al.* (1984b). Three new restriction endonucleases MaeI, MaeII and MaeIII from Methanococcus aeolicus. *Nucleic Acids Research*, **12**(6), 2619–2628.
- Schönheit, P. *et al.* (1979). Nickel, cobalt, and molybdenum requirement for growth of Methanobacterium thermoautotrophicum. *Archives of Microbiology*, **123**(1), 105–107.
- Schönheit, P. *et al.* (1980). Growth parameters (Ks, μ_{\max} , Ys) of Methanobacterium thermoautotrophicum. *Archives of Microbiology*, **127**(1), 59–65.

- Shcherbakova, V. *et al.* (2011). Methanobacterium arcticum sp. nov., a methanogenic archaeon from Holocene Arctic permafrost. *International Journal of Systematic and Evolutionary Microbiology*, **61**(1), 144–147.
- Shimizu, S. *et al.* (2011). Methanosarcina horonobensis sp. nov., a methanogenic archaeon isolated from a deep subsurface Miocene formation. *International journal of systematic and evolutionary microbiology*, **61**(Pt 10), 2503–7.
- Shimizu, S. *et al.* (2013). Methanoculleus horonobensis sp. nov., a methanogenic archaeon isolated from a deep diatomaceous shale formation. *International journal of systematic and evolutionary microbiology*, **63**(Pt 11), 4320–3.
- Shlimon, A. *et al.* (2004). Methanobacterium aarhusense sp. nov., a novel methanogen isolated from a marine sediment (Aarhus Bay, Denmark). *International Journal of Systematic and Evolutionary Microbiology*, **54**(3), 759–763.
- Siddiqui, K. *et al.* (2005). The active site is the least stable structure in the unfolding pathway of a multidomain cold-adapted \hat{I} -amylase. *Journal of bacteriology*, pages 6197–6205.
- Simankova, M. V. *et al.* (2001). Methanosarcina lacustris sp. nov., a new psychrotolerant methanogenic archaeon from anoxic lake sediments. *Systematic and applied microbiology*, **24**(3), 362–7.
- Simankova, M. V. *et al.* (2003). Isolation and characterization of new strains of methanogens from cold terrestrial habitats. *Systematic and applied microbiology*, **26**(2), 312–8.
- Singh, N. *et al.* (2005a). Isolation and characterization of methylotrophic methanogens from anoxic marine sediments in Skan Bay, Alaska: description of Methanococcoides alaskense sp. nov., and emended description of Methanosarcina baltica. *International journal of systematic and evolutionary microbiology*, **55**(Pt 6), 2531–8.
- Singh, N. *et al.* (2005b). Isolation and characterization of methylotrophic methanogens from anoxic marine sediments in Skan Bay, Alaska: description of Methanococcoides alaskense sp. nov., and emended description of Methanosarcina baltica. *International journal of systematic and evolutionary microbiology*, **55**(Pt 6), 2531–8.
- Slesarev, A. I. *et al.* (2002). The complete genome of hyperthermophile Methanopyrus kandleri AV19 and monophyly of archaeal methanogens. *Proceedings of the National Academy of Sciences of the United States of America*, **99**(7), 4644–9.
- Smith, P. and Hungate, R. (1958). Isolation and characterization of Methanobacterium ruminantium n. sp. *Journal of bacteriology*, **75**(6), 713.
- Sowers, K. R. and Ferry, J. G. (1983). Isolation and Characterization of a Methylotrophic Marine Methanogen , Methanococcoides methylutens gen . nov ., sp . *Applied and Enviromental Microbiology*, **45**(2), 684–690.
- Sowers, K. R. and Gunsalus, R. P. (1988). Plasmid DNA from the acetotrophic methanogen Methanosarcina acetivorans. *Journal of bacteriology*, **170**(10), 4979–82.
- Sowers, K. R. and Gunsalus, R. P. (1995). Halotolerance in Methanosarcina spp .: Role of N (sup (epsilon)) -Acetyl- (beta) -Lysine , (alpha) -Glutamate , Glycine Betaine , and K (sup +) as Compatible Solutes for Osmotic Halotolerance in Methanosarcina spp .: Role of N ϵ -Acetyl-Lysin.

- Sowers, K. R. *et al.* (1984a). *Methanosarcina acetivorans* sp. nov., an Acetotrophic Methane-Producing Bacterium Isolated from Marine Sediments. *Applied and Environmental Microbiology*, **47**(5), 971–978.
- Sowers, K. R. *et al.* (1984b). *Methanosarcina acetivorans* sp. nov., an Acetotrophic Methane-Producing Bacterium Isolated from Marine Sediments. *Applied and environmental microbiology*, **47**(5), 971–8.
- Sowers, K. R. *et al.* (1990). N6-Acetyl-, 8-lysine : An osmolyte synthesized by methanogenic archaeobacteria. *Proc. Natl. Acad. Sci. USA*, **87**(December), 9083–9087.
- Sprenger, W. W. *et al.* (2000). *Methanomicrococcus blatticola* gen. nov., sp. nov., a methanol- and methylamine-reducing methanogen from the hindgut of the cockroach *Periplaneta americana*. *International journal of systematic and evolutionary microbiology*, **50**(6), 1989–1999.
- Stadtman, T. C. and Barker, H. A. (1951). STUDIES ON THE METHANE FERMENTATION X . : A New Bacterium , *Methanococcus vannielii*. *J. Bacteriol.*, **62**(3), 269.
- Steinhaus, B. *et al.* (2007). A portable anaerobic microbioreactor reveals optimum growth conditions for the methanogen *Methanosaeta concilii*. *Applied and environmental microbiology*, **73**(5), 1653–8.
- Stetter KO, Thomm M, Winter J, Wildgruber G, Huber H, Zillig W, Jané-Covic D, König H, Palm P, W. S. (1981). *Methanothermobacter fervidus* , sp . nov . , a Novel Extremely Thermophilic Methanogen Isolated from an Icelandic Hot Spring. *Zentralbl. Mikrobiol.*, **178**, 166–178.
- Tabatabaei, M. *et al.* (2009). PCR-based DGGE and FISH analysis of methanogens in an anaerobic closed digester tank for treating palm oil mill effluent. *Electronic Journal of Biotechnology*, **12**(3).
- Takai, K. *et al.* (2002). *Methanothermococcus okinawensis* sp . nov . , a thermophilic , methane-producing archaeon isolated from a Western Pacific deep-sea hydrothermal vent system. *International Journal of Systematic and Evolutionary Microbiology*, **52**, 1089–1095.
- Takai, K. *et al.* (2004). *Methanoterris formicicus* sp. nov., a novel extremely thermophilic, methane-producing archaeon isolated from a black smoker chimney in the Central Indian Ridge. *International journal of systematic and evolutionary microbiology*, **54**(Pt 4), 1095–100.
- Takai, K. *et al.* (2008). Cell proliferation at 122°C and isotopically heavy CH₄ production by a hyperthermophilic methanogen under high-pressure cultivation. *Proceedings of the National Academy of Sciences*, **105**(31), 10949–10954.
- Tang, Y.-Q. *et al.* (2007). Anaerobic treatment performance and microbial population of thermophilic upflow anaerobic filter reactor treating awamori distillery wastewater. *Journal of bioscience and bioengineering*, **104**(4), 281–7.
- Tang, Y.-Q. *et al.* (2008). Effect of temperature on microbial community of a glucose-degrading methanogenic consortium under hyperthermophilic chemostat cultivation. *Journal of bioscience and bioengineering*, **106**(2), 180–7.
- Terlesky, K. C. and Ferry, J. G. (1988). Ferredoxin requirement for electron transport from the carbon monoxide dehydrogenase complex to a membrane-bound hydrogenase in acetate-grown *Methanosarcina thermophila*. *The Journal of biological chemistry*, **263**(9), 4075–9.

- Terlesky, K. C. *et al.* (1986). Isolation of an enzyme complex with carbon monoxide dehydrogenase activity containing corrinoid and nickel from acetate-grown *Methanosarcina thermophila*. *Journal of bacteriology*, **168**(3), 1053–8.
- Thummes, K. *et al.* (2007a). Temporal change of composition and potential activity of the thermophilic archaeal community during the composting of organic material. *Systematic and applied microbiology*, **30**(5), 418–29.
- Thummes, K. *et al.* (2007b). Thermophilic methanogenic Archaea in compost material: occurrence, persistence and possible mechanisms for their distribution to other environments. *Systematic and applied microbiology*, **30**(8), 634–43.
- Tian, J. *et al.* (2010). *Methanoculleus hydrogenitrophicus* sp. nov., a methanogenic archaeon isolated from wetland soil. *International journal of systematic and evolutionary microbiology*, **60**(Pt 9), 2165–9.
- Touzel, J. and Albagnac, G. (1983). Isolation and characterization of *Methanococcus mazei* strain MC 3. *FEMS Microbiology Letters*, **16**(2-3), 241–245.
- Touzel, J. P. *et al.* (1988). Description of a New Strain of *Methanothrix soehngenii* and Rejection of *Methanothrix concilii* as a Synonym of *Methanothrix soehngenii*. *International journal of systematic bacteriology*, **Jan**, **1988**(80120), 30–36.
- Touzel, J. P. *et al.* (1992). DNA Relatedness among Some Thermophilic Members of the Genus *Methanobacterium* : Emendation of the Species *Methanobacterium thermoautotrophicum* and Rejection of *Methanobacterium thennoformicicum* as a Synonym of *Methanobacterium thermoautotrophicum*. (July), 408–411.
- van Bruggen, J. J. A. *et al.* (1984). *Methanobacterium formicicum*, an endosymbiont of the anaerobic ciliate *Metopus striatus* McMurrich. *Archives of Microbiology*, **139**(1), 1–7.
- Visser, F. A. *et al.* (1991). Diversity and Population Dynamics of Methanogenic Bacteria in a Granular Consortium Diversity and Population Dynamics of Methanogenic Bacteria in a Granular Consortium. *Applied and Environmental Microbiology*, **57**(6), 1728–1734.
- von Klein, D. *et al.* (2002). *Methanosarcina baltica*, sp. nov., a novel methanogen isolated from the Gotland Deep of the Baltic Sea. *Extremophiles : life under extreme conditions*, **6**(2), 103–10.
- Wagner, D. *et al.* (2013). *Methanosarcina soligelidi* sp. nov., a desiccation- and freeze-thaw-resistant methanogenic archaeon from a Siberian permafrost-affected soil. *International Journal of Systematic and Evolutionary Microbiology*, **63**(Pt 8), 2986–2991.
- Wang, M. *et al.* (2011). Electron transport in acetate-grown *Methanosarcina acetivorans*. *BMC microbiology*, **11**(1), 165.
- Ward, J. M. *et al.* (1989). Emended Description of Strain PS (= OGC 70 = ATCC 33273 = DSM 1537), the Type Strain of *Methanococcus voltae*. *International Journal of Systematic Bacteriology*, **39**(4), 493–494.
- Wasserfallen, a. *et al.* (2000). Phylogenetic analysis of 18 thermophilic *Methanobacterium* isolates supports the proposals to create a new genus, *Methanothermobacter* gen. nov., and to reclassify several isolates in three species, *Methanothermobacter thermotrophicus* comb. nov., *Methano.* *International Journal of Systematic and Evolutionary Microbiology*, **50**(1), 43–53.

- Whitman, W. B. *et al.* (1982). Nutrition and carbon metabolism of *Methanococcus-Voltae*. *Journal of Bacteriology*, **149**(3), 852–863.
- Widdel, F. and Pfennig, N. (1981). Studies on dissimilatory sulfate-reducing bacteria that decompose fatty acids - I. Isolation of new sulfate-reducing bacteria enriched with acetate from saline environments. Description of *Desulfobacter postgatei* gen. nov., sp. nov. *Archives of Microbiology*, **129**(5), 395–400.
- Widdel, F. *et al.* (1988). Classification of secondary alcohol-utilizing methanogens including a new thermophilic isolate. *Arch Microbiol*, **150**, 477–481.
- Wildgruber, G. *et al.* (1982). *Methanoplanus limicola*, a Plate-Shaped Methanogen Representing a Novel Family, the Methanoplanaceae. *Arch Microbiol*, **132**, 31–36.
- Wilhelm, T. *et al.* (1991a). DNA-DNA Hybridization of Methylophilic Halophilic Methanogenic Bacteria and Transfer of *Methanococcus halophilus* to the Genus *Methanohalophilus* as *Methanohalophilus halophilus* comb. nov. *International Journal of Systematic Bacteriology*, **41**(4), 558–562.
- Wilhelm, T. *et al.* (1991b). DNA-DNA Hybridization of Methylophilic Halophilic Methanogenic Bacteria and Transfer of *Methanococcus halophilus* to the Genus *Methanohalophilus* as *Methanohalophilus halophilus* comb. nov. *International journal of ...*, **41**(4), 558–562.
- Winter, J. (1983). Maintenance of stock cultures of methanogens in the laboratory. *System Appl. Microbiol.*, **4**(4), 558–563.
- Winter, J. *et al.* (1984). *Methanobacterium wolfei*, sp. nov., a New Tungsten-Requiring, Thermophilic, Autotrophic Methanogen. *Systematic and Applied Microbiology*, **5**(4), 457–466.
- Wolin, E. A. *et al.* (1963). Formation of methane from bacterial extracts. *Journal of the Franklin Institute*, **238**(8), 2882–2886.
- Wolin, E. A., Wolin, M. J. & Wolfe, R. S. (1963). Formation of methane by bacterial extracts. *J Biol Chem*, **238**(8), 2882–2886.
- Worakit, S. *et al.* (1986). *Methanobacterium alcaliphilum* sp. nov., an H₂-Utilizing Methanogen That Grows at High pH Values. *International Journal of Systematic Bacteriology*, **36**(3), 380–382.
- Wu, S.-Y. *et al.* (2005). *Methanofollis formosanus* sp. nov., isolated from a fish pond. *International journal of systematic and evolutionary microbiology*, **55**(Pt 2), 837–42.
- Yanagita, K. and Kamagata, Y. (2000). Phylogenetic analysis of methanogens in sheep rumen ecosystem and detection of *Methanomicrobium mobile* By fluorescence in situ hybridization. *Bioscience, ...*, **64**(8), 1737–1742.
- Yashiro, Y. *et al.* (2011). *Methanoregula formicica* sp. nov., a methane-producing archaeon isolated from methanogenic sludge. *International journal of systematic and evolutionary microbiology*, **61**(Pt 1), 53–9.
- Zabel, H. P. *et al.* (1984). Isolation and characterization of a new coccoid methanogen, *Methanogenium tatii* spec. nov. from a sulfataric field on Mount Tatío. *Arch Microbiol*, **37**, 308–315.

- Zanaroli, G. *et al.* (2010). Characterization of the microbial community from the marine sediment of the Venice lagoon capable of reductive dechlorination of coplanar polychlorinated biphenyls (PCBs). *Journal of hazardous materials*, **178**(1-3), 417–26.
- Zehnder, A. J. B. and Wuhrmann, K. (1977). Physiology of a Methanobacterium strain AZ. *Archives of Microbiology*, **111**(3), 199–205.
- Zeikus, J. and Wolee, R. (1972a). Methanobacterium thermoautotrophicus sp. n., an anaerobic, autotrophic, extreme thermophile. *Journal of Bacteriology*, **109**(2), 707–713.
- Zeikus, J. G. (1977). The biology of methanogenic bacteria. *Bacteriological reviews*, **41**(2), 514–41.
- Zeikus, J. G. and Wolee, R. S. (1972b). Methanobacterium thermoautotrophicum sp. n., an Anaerobic, Autotrophic, Extreme Thermophile. *Journal of bacterio*, **109**(2), 707–713.
- Zeikus, J. G. *et al.* (1975). Methanobacterium arbophilicum sp.nov. An obligate anaerobe isolated from wetwood of living trees. *Antonie van Leeuwenhoek*, **41**, 543–552.
- Zellner, G. and Messner, P. (1998). Methanoculleus palmolei sp. nov., an irregularly coccoid methanogen from an anaerobic digester treating wastewater of a palm oil plant in North-Sumatra, Indonesia. *International Journal of Systematic Bacteriology*, **48**(4), 1111–1117.
- Zellner, G. *et al.* (1988). Characterization of a new mesophilic, secondary alcohol-utilizing methanogen, Methanobacterium palustre spec. nov. from a peat bog. *Archives of Microbiology*, **151**(1), 1–9.
- Zellner, G. *et al.* (1989). Methanocorpusculaceae fam. nov., represented by Methanocorpusculum parvum, Methanocorpusculum sinense spec. nov. and Methanocorpusculum bavaricum spec. nov. *Arch. Microbiol.*, **151**(151), 381–390.
- Zellner, G. *et al.* (1999). Reclassification of Methanogenium tationis and Methanogenium liminatans as Methanofollis tationis gen. nov., comb. nov. and Methanofollis liminatans comb. nov. and description of a new strain of Methanofollis liminatans. *Int J Syst Bacteriol*, (1 999), 250–255.
- Zellner G., C.Alten, Winter, J. (1987). Isolation and characterization of Methanocorpusculum parvum, gen. nov., spec. nov., a new tungsten requiring, coccoid methanogen. *Archives of microbiology*, **147**(1), 13–20.
- Zellner, G., Sleytr, U. B., Messner, P., Kneifel, H. & Winter, J. (1990). Methanogenium liminatans spec. nov., a new coccoid, mesophilic methanogen able to oxidize secondary alcohols. *Arch Microbioll*, **153**, 287–288.
- Zhang, G. *et al.* (2008). Methanogenesis from methanol at low temperatures by a novel psychrophilic methanogen, "Methanolobus psychrophilus" sp. nov., prevalent in Zoige wetland of the Tibetan plateau. *Applied and environmental microbiology*, **74**(19), 6114–20.
- Zhang, J. *et al.* (2011). Performance and spatial community succession of an anaerobic baffled reactor treating acetone-butanol-ethanol fermentation wastewater. *Bioresource technology*, **102**(16), 7407–14.
- Zhao, H. *et al.* (1988). An extremely thermophilic Methanococcus from a deep sea hydrothermal vent and its plasmid. *Archives of Microbiology*, **150**(2), 178–183.

- Zhao, Y. *et al.* (1989). Isolation and Characterization of *Methanocorpusculum labreanum* sp. nov. from the LaBrea Tar Pits. *International Journal of systematic and evolutionary microbiology*, **39**(1), 10–13.
- Zhilina, T. and Zavarzin, G. (1987a). *Methanohalobium evestigatus*, n. gen., n. sp. The extremely halophilic methanogenic Archaeobacterium. *Dokl. Akad. Nauk SSSR*, **293**, 464–468.
- Zhilina, T. N. (1983). A new obligate halophilic methane-producing bacterium. *Mikrobiologiya*, **52**, 375–382.
- Zhilina, T. N. and Zavarzin, G. A. (1987b). NOTES: *Methanosarcina vacuolata* sp. nov., a Vacuolated *Methanosarcina*. *International Journal of Systematic Bacteriology*, **37**(3), 281–283.
- Zhilina, T. N. *et al.* (2014). *Methanocalculus natronophilus* sp. nov., a new alkaliphilic hydrogenotrophic methanogenic archaeon from a soda lake, and proposal of the new family Methanocalculaceae. *Microbiology*, **82**(6), 698–706.
- Zhou, L. *et al.* (2014a). *Methanospirillum psychrodurum* sp. 1. Zhou L, Liu X, Dong X. *Methanospirillum psychrodurum* sp. nov., isolated from the wetland soil of Qinghai-Tibetan Plateau, China. *Int. J. Syst. Evol. Microbiol.* [Internet]. 2014;64:638. Available from: <http://ijs.sgmjournals.org/>. *International Journal of Systematic and Evolutionary Microbiology*, **64**, 638.
- Zhou, L. *et al.* (2014b). *Methanospirillum psychrodurum* sp. nov., isolated from wetland soil. *International Journal of Systematic and Evolutionary Microbiology*, **64**(PART 2), 638–641.
- Zhu, C. *et al.* (2011a). Diversity of methanogenic archaea in a biogas reactor fed with swine feces as the mono-substrate by *mcrA* analysis. *Microbiological research*, **166**(1), 27–35.
- Zhu, J. *et al.* (2011b). *Methanobacterium movens* sp. nov. and *Methanobacterium flexile* sp. nov., isolated from lake sediment. *International journal of systematic and evolutionary microbiology*, **61**(Pt 12), 2974–8.
- Zielińska, M. *et al.* (2013). Impact of temperature, microwave radiation and organic loading rate on methanogenic community and biogas production during fermentation of dairy wastewater. *Bioresource technology*, **129**, 308–14.
- Zinder, S. H. and Mah, R. a. (1979). Isolation and Characterization of a Thermophilic Strain of *Methanosarcina* Unable to Use H₂-CO₂ for Methanogenesis. *Applied and environmental microbiology*, **38**(5), 996–1008.
- Zinder, S. H. *et al.* (1985). NOTES: *Methanosarcina thermophila* sp. nov., a Thermophilic, Acetotrophic, Methane-Producing Bacterium. *International Journal of Systematic Bacteriology*, **35**(4), 522–523.