

Supplementary Material

Phylogenomic Investigation of Phospholipid Synthesis in Archaea

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SUPPLEMENTARY TABLE 1: Species used in similarity searches

SUPPLEMENTARY FIGURE 1: Complete short-chain IPPS phylogeny.

SUPPLEMENTARY FIGURE 2: Complete long-chain IPPS phylogeny.

SUPPLEMENTARY FIGURE 3: GGGPS phylogeny.

SUPPLEMENTARY FIGURE 4: DGGGPS phylogeny.

SUPPLEMENTARY FIGURE 5: Phylogenetic tree of CDP alcohol phosphatidyltransferases probably related to serine transfer.

SUPPLEMENTARY FIGURE 6: Phylogenetic tree of CDP alcohol phosphatidyltransferases probably related to *myo*-inositol transfer.

SUPPLEMENTARY FIGURE 7: Phylogenetic tree of geranylgeranyl reductases (GGR).

SUPPLEMENTARY FIGURE 8: Phylogenetic tree of CDP diglyceride synthases (CdsA).

SUPPLEMENTARY TABLE 1: Species used in similarity searches

Bacteria	<i>Acaryochloris marina</i> MBIC11017 <i>Acholeplasma laidlawii</i> PG-8A <i>Acidimicrobium ferrooxidans</i> DSM 10331 <i>Acidithiobacillus ferrooxidans</i> ATCC 53993 <i>Acidobacterium capsulatum</i> ATCC 51196 <i>Acidovorax citrulli</i> AAC00-1 <i>Acinetobacter johnsonii</i> SH046 <i>Actinobacillus pleuropneumoniae</i> <i>Actinomyces coleocanis</i> DSM 15436 <i>Aeromonas hydrophila</i> <i>Akkermansia muciniphila</i> ATCC BAA-835 <i>Algoriphagus</i> sp. PR1 <i>Alicyclobacillus acidocaldarius</i> <i>Alkaliphilus metalliredigens</i> <i>Alteromonas macleodii</i> ATCC 27126 <i>Aminobacterium colombiense</i> DSM 12261 <i>Aminomonas paucivorans</i> <i>Anabaena variabilis</i> <i>Anaerobaculum hydrogeniformans</i> <i>Anaerolinea thermophila</i> <i>Anaplasma marginale</i> str. Florida <i>Aquifex aeolicus</i> VF5 <i>Arcobacter butzleri</i> RM4018 <i>Arthrospira maxima</i> <i>Atopobium parvum</i> DSM 20469 <i>Bacillus subtilis</i> BSn5 <i>Bacteroides uniformis</i> ATCC 8492 <i>Bdellovibrio bacteriovorus</i> HD100 <i>Bifidobacterium adolescentis</i> <i>Blastopirellula marina</i> DSM 3645 <i>Bordetella bronchiseptica</i> RB50 <i>Borrelia burgdorferi</i> 118a <i>Brachyspira murdochii</i> DSM 12563 <i>Brevibacterium linens</i> BL2 <i>Brevundimonas subvibrioides</i> ATCC 15264 <i>Burkholderia cenocepacia</i> HI2424 <i>Calditerrivibrio nitroreducens</i> <i>Caminiibacter mediatlanticus</i> TB-2 <i>Campylobacter gracilis</i> RM3268 <i>Candidatus Koribacter versatilis</i> Ellin345 <i>Candidatus Nitrospira defluvii</i> <i>Candidatus Phytoplasma australiense</i> <i>Candidatus Solibacter usitatus</i> Ellin6076 <i>Carboxydotherrmus hydrogenoformans</i> <i>Carnobacterium</i> sp. AT7 <i>Caulobacter crescentus</i> CB15 <i>Chlamydia trachomatis</i> 434/Bu <i>Chlamydophila pneumoniae</i> AR39 <i>Chlorobaculum parvum</i> <i>Chlorobium limicola</i> <i>Chlorobium luteolum</i> DSM 273 <i>Chlorobium tepidum</i> TLS <i>Chloroflexus aurantiacus</i> <i>Chloroherpeton thalassium</i> ATCC 35110 <i>Chthoniobacter flavus</i> Ellin428 <i>Collinsella aerofaciens</i> <i>Coprococcus eutactus</i> <i>Coralimargarita akajimensis</i> DSM 45221 <i>Crocospaera watsonii</i> <i>Cyanobium</i> sp.
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Cyanothece sp. ATCC 51142
Cytophaga hutchinsonii ATCC 33406
Dechloromonas aromatica
Deferribacter desulfuricans
Dehalococcoides ethenogenes 195
Dehalogenimonas lykanthroporepellens BL-DC-9
Deinococcus geothermalis
Deinococcus radiodurans
Denitrovibrio acetiphilus
Desulfarculus baarsii DSM 2075
Desulfatibacillum alkenivorans AK-01
Desulfococcus oleovorans Hxd3
Desulfohalobium retbaense DSM 5692
Desulfurispirillum indicum
Dethiosulfovibrio peptidovorans DSM 11002
Dictyoglomus thermophilum
Dictyoglomus turgidum DSM 6724
Dokdonia donghaensis MED134
Elusimicrobium minutum
Enterobacter sakazakii ATCC BAA-894
Enterococcus faecalis
Escherichia coli O157:H7 str. EC4024
Eubacterium dolichum
Fervidobacterium nodosum Rt17-B1
Fibrobacter succinogenes
Flavobacterium johnsoniae
Francisella tularensis
Frankia alni ACN14a
Fusobacterium nucleatum subsp. *nucleatum*
ATCC 23726
Gallionella capsiferriformans ES-2
Gemmata obscuriglobus UQM 2246
Gemmatimonas aurantiaca T-27
Geobacter metallireducens GS-15
Gloeobacter violaceus PCC 7421
Halomonas elongata DSM 2581
Helicobacter pylori B38
Heliobacterium modesticaldum
Herpetosiphon aurantiacus
Hydrogenivirga sp. 128-5-R1-1
Hydrogenobaculum sp. Y04AAS1
Ilyobacter polytropus DSM 2926
Isosphaera pallida ATCC 43644
Kosmotoga olearia TBF 19.5.1
Ktedonobacter racemifer DSM 44963
Lactococcus lactis subsp. *cremoris* MG1363
Lawsonia intracellularis PHE/MN1-00
Lentisphaera araneosa
Leptolyngbya valderiana BDU 20041
Leptospira interrogans
Leptospirillum ferrooxidans
Leptotrichia hofstadii
Magnetococcus sp. MC-1
Maricaulis maris MCS10
Marinitoga piezophila KA3
Mariprofundus ferrooxydans PV-1
Meiothermus ruber DSM 1279
Meiothermus silvanus DSM 9946
Mesoplasma florum L1
Methylibium petroleiphilum PM1
Methylobacillus flagellatus KT
Microscilla marina

Mitsuokella multacida
Moorella thermoacetica
Mycoplasma agalactiae PG2
Mycoplasma pneumoniae M129
Myxococcus xanthus DK 1622
Nautilia profundicola AmH
Neisseria elongata ATCC 29315
Nitratifractor salsuginis
Nitratiruptor sp. SB155-2
Nitrosomonas eutropha C91
Nostoc punctiforme PCC 73102
Oceanithermus profundus
Opitutus terrae PB90-1
Parachlamydia acanthamoebae str. Hall's coccus
Pasteurella multocida subsp. *multocida* str. Pm70
Pedobacter sp. BAL39
Persephonella marina
Petrogla mobilis SJ95
Photobacterium angustum S14
Pirellula staleyi DSM 6068
Planctomyces limnophilus DSM 3776
Porphyromonas gingivalis
Prevotella amnii CRIS 21A-A
Prochlorococcus marinus str. AS9601
Prosthecochloris aestuarii DSM 271
Pyramidobacter piscicola
Ralstonia eutropha H16
Rhizobium leguminosarum
Rhodobacter sphaeroides
Rhodopirellula baltica SH 1
Rhodospirillum rubrum ATCC 11170
Roseiflexus castenholzii DSM 13941
Rubrobacter xylanophilus DSM 9941
Salinibacter ruber DSM 13855
Seibaldella termitidis ATCC 33386
Solibacter usitatus Ellin6076
Sphingomonas wittichii RW1
Sphingopyxis alaskensis RB2256
Spirochaeta smaragdinae DSM 11293
Spiroplasma citri
Stenotrophomonas maltophilia K279a
Streptobacillus moniliformis DSM 12112
Streptococcus agalactiae
Sulfurihydrogenibium yellowstonense
Sulfurimonas denitrificans DSM 1251
Sulfurovum sp. NBC37-1
Syntrophobacter fumaroxidans MPOB
Syntrophus aciditrophicus SB
Terriglobus saanensis SP1PR4
Thermanaerovibrio acidaminovorans
Thermocrinis albus DSM 14484
Thermodesulfobacterium yellowstonii DSM 11347
Thermomicrobium roseum
Thermosipho africanus TCF52B
Thermotoga maritima MSB8
Thermovibrio ammonificans
Thermus thermophilus
Thiobacillus denitrificans ATCC 25259
Treponema brennaborensis DSM 12168
Treponema denticola ATCC 35405
Truepera radiovictrix
Ureaplasma parvum serovar 1 str. ATCC 27813

Verrucomicrobium spinosum DSM 4136
Victivallis vadensis
Waddlia chondrophila WSU 86-1044
Xanthobacter autotrophicus Py2
Xanthomonas oryzae

Archaea

Acidilobus saccharovorans 345-15
Aciduliprofundum boonei T469
Aeropyrum pernix K1
Archaeoglobus fulgidus DSM 4304
Archaeoglobus profundus DSM 5631
Caldivirga maquilingensis IC-167
Candidatus Caldiarchaeum subterraneum
Candidatus Korarchaeum cryptofilum OPF8
Candidatus Methanoregula boonei 6A8
Cenarchaeum symbiosum A
Desulfurococcus kamchatkensis 1221n
Ferroglobus placidus DSM 10642
Ferroplasma acidarmanus fer1
Halalkalicoccus jeotgali B3
Haloarcula marismortui ATCC 43049
Halobacterium salinarum
Haloferax volcanii DS2
Halogeometricum borinquense DSM 11551
Halomicrobium mukohataei DSM 12286
Haloquadratum walsbyi DSM 16790
Halorhabdus utahensis DSM 12940
Halorubrum lacusprofundi ATCC 49239
Haloterrigena turkmenica DSM 5511
Hyperthermus butylicus DSM 5456
Ignicoccus hospitalis KIN4/I
Ignisphaera aggregans DSM 17230
Metallosphaera sedula DSM 5348
Methanobrevibacter ruminantium M1
Methanobrevibacter smithii
Methanocaldococcus fervens AG86
Methanocaldococcus infernus ME
Methanocaldococcus jannaschii DSM 2661
Methanocaldococcus sp. FS406-22
Methanocaldococcus vulcanius M7
Methanocella paludicola SANAE
Methanococcoides burtonii DSM 6242
Methanococcoides burtonii DSM 6242
Methanococcus aeolicus Nankai-3
Methanococcus maripaludis
Methanococcus vannieli SB
Methanococcus voltae A3
Methanocorpusculum labreanum Z
Methanoculleus marisnigri JR1
Methanohalobium evestigatum Z-7303
Methanohalophilus mahii DSM 5219
Methanoplanus petrolearius DSM 11571
Methanopyrus kandleri AV19
Methanosaeta thermophila PT
Methanosarcina acetivorans C2A
Methanosarcina barkeri str. Fusaro
Methanosarcina mazei Go1
Methanosphaera stadtmanae DSM 3091
Methanosphaerula palustris E1-9c
Methanospirillum hungatei JF-1
Methanothermobacter marburgensis str. Marburg
Methanothermobacter thermautotrophicus Delta H
Methanothermococcus okinawensis IH1

Methanothermus fervidus
Nanoarchaeum equitans Kin4-M
Natrialba magadii ATCC 43099
Natronomonas pharaonis DSM 2160
Nitrosopumilus maritimus SCM1
Picrophilus torridus DSM 9790
Pyrobaculum aerophilum str. IM2
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Pyrococcus abyssi GE5
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Pyrococcus horikoshii OT3
Staphylothermus hellenicus DSM 12710
Staphylothermus marinus F1
Sulfolobus acidocaldarius DSM 639
Sulfolobus solfataricus P2
Sulfolobus tokodaii str. 7
Thermococcus barophilus MP
Thermococcus gammatolerans EJ3
Thermococcus kodakarensis KOD1
Thermococcus onnurineus NA1
Thermococcus sibiricus MM 739
Thermococcus sp. AM4
Thermofilum pendens Hrk 5
Thermoplasma acidophilum DSM 1728
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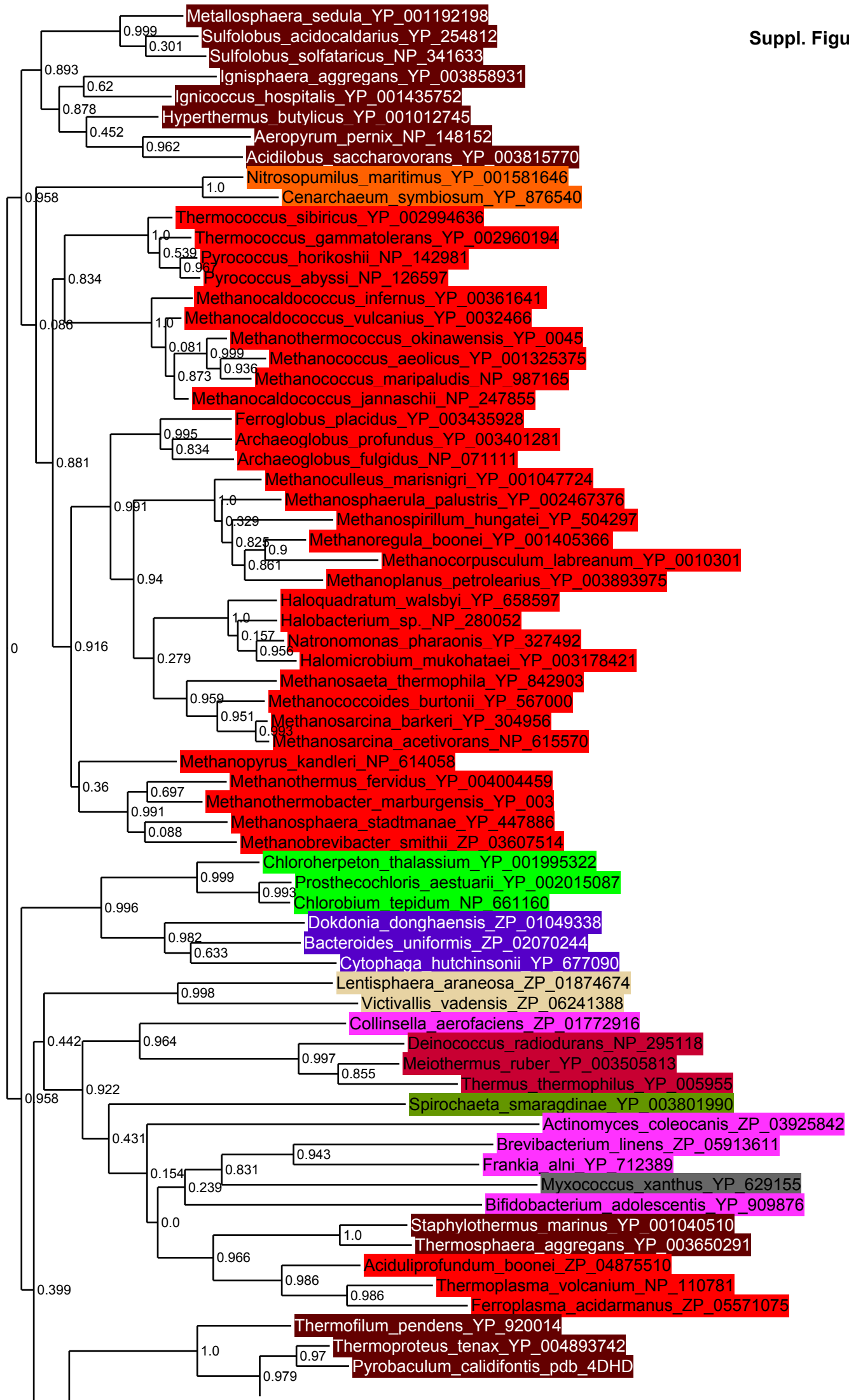
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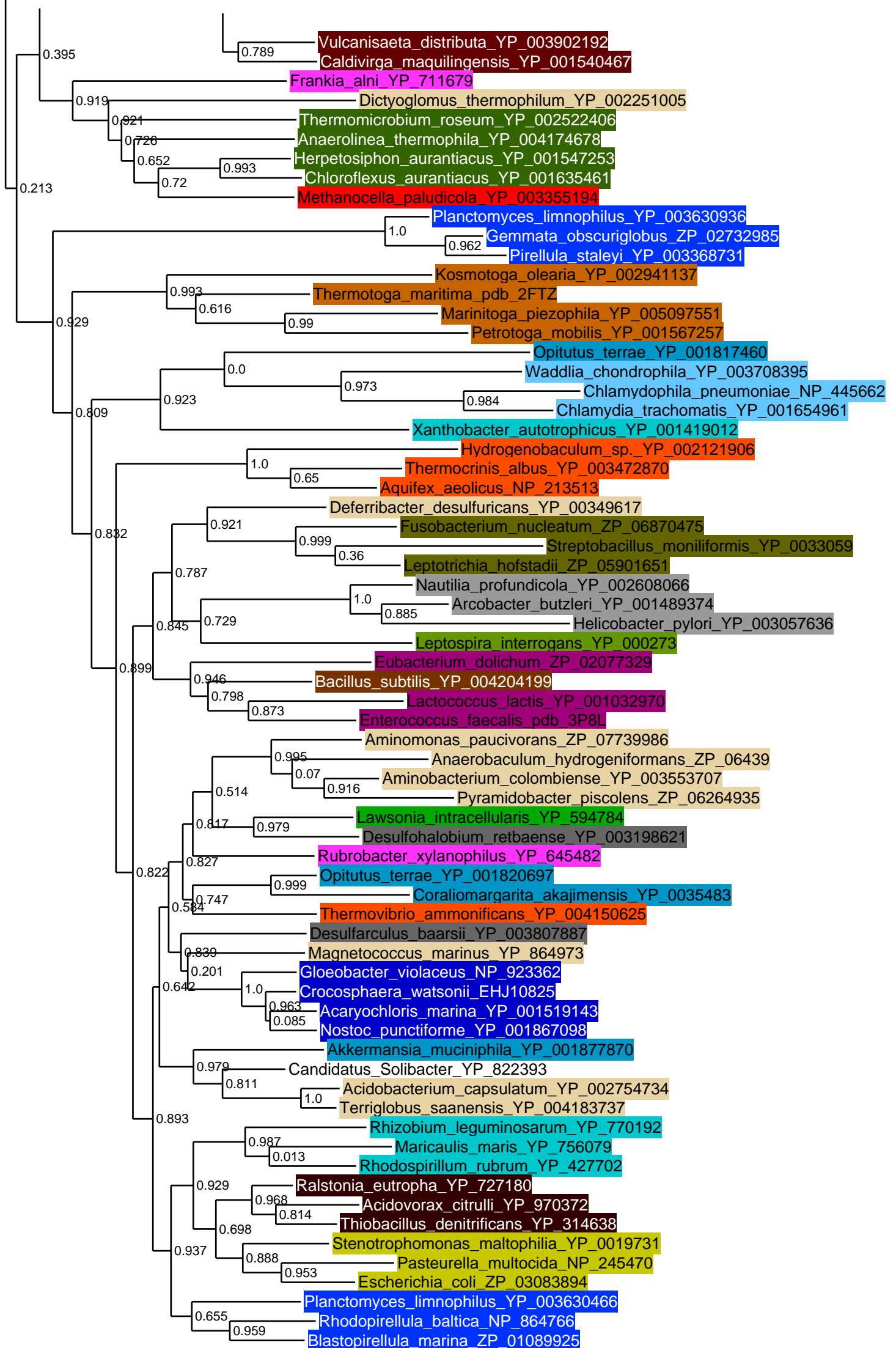
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Chlorella vulgaris
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Chromera velia
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Cryptococcus neoformans var. *grubii*
Cryptomonas paramecium
Cryptosporidium hominis TU502
Cyanidioschyzon merolae
Cyanophora paradoxa
Desmarestia viridis
Dictyostelium discoideum AX4
Durinskia baltica
Eimeria tenella str. Houghton
Emiliana huxleyi
Encephalitozoon cuniculi GB-M1
Entamoeba histolytica HM-1:IMSS
Euglena gracilis
Giardia intestinalis
Glaucocystis nostochinearum
Glomus irregulare
Gracilaria chilensis
Guillardia theta
Haemoproteus columbae

Hartmannella vermiformis
Hemiselmis andersenii
Igernella notabilis
Kryptoperidinium foliaceum
Leishmania major
Leucocytozoon majoris
Malawimonas jakobiformis
Mesostigma viride
Micromonas pusilla CCMP1545
Monosiga brevicollis ATCC 50154
Naegleria gruberi
Nephroselmis olivacea
Ochromonas danica
Odontella sinensis
Pan troglodytes verus
Parahaemoproteus vireonis
Paramecium tetraurelia strain d4-2
Paulinella chromatophora
Perkinsus marinus
Phakopsora pachyrhizi
Physarum polycephalum
Phytophthora infestans T30-4
Plasmodium falciparum 3D7
Porphyra purpurea
Reclinomonas americana
Rhodomonas salina
Saccharomyces cerevisiae A364A
Schizosaccharomyces pombe 972h
Staurostrum punctulatum
Synedra acus Cafeteria roenbergensis
Talaromyces stipitatus ATCC 10500
Tetrahymena thermophila
Thalassiosira oceanica CCMP1005
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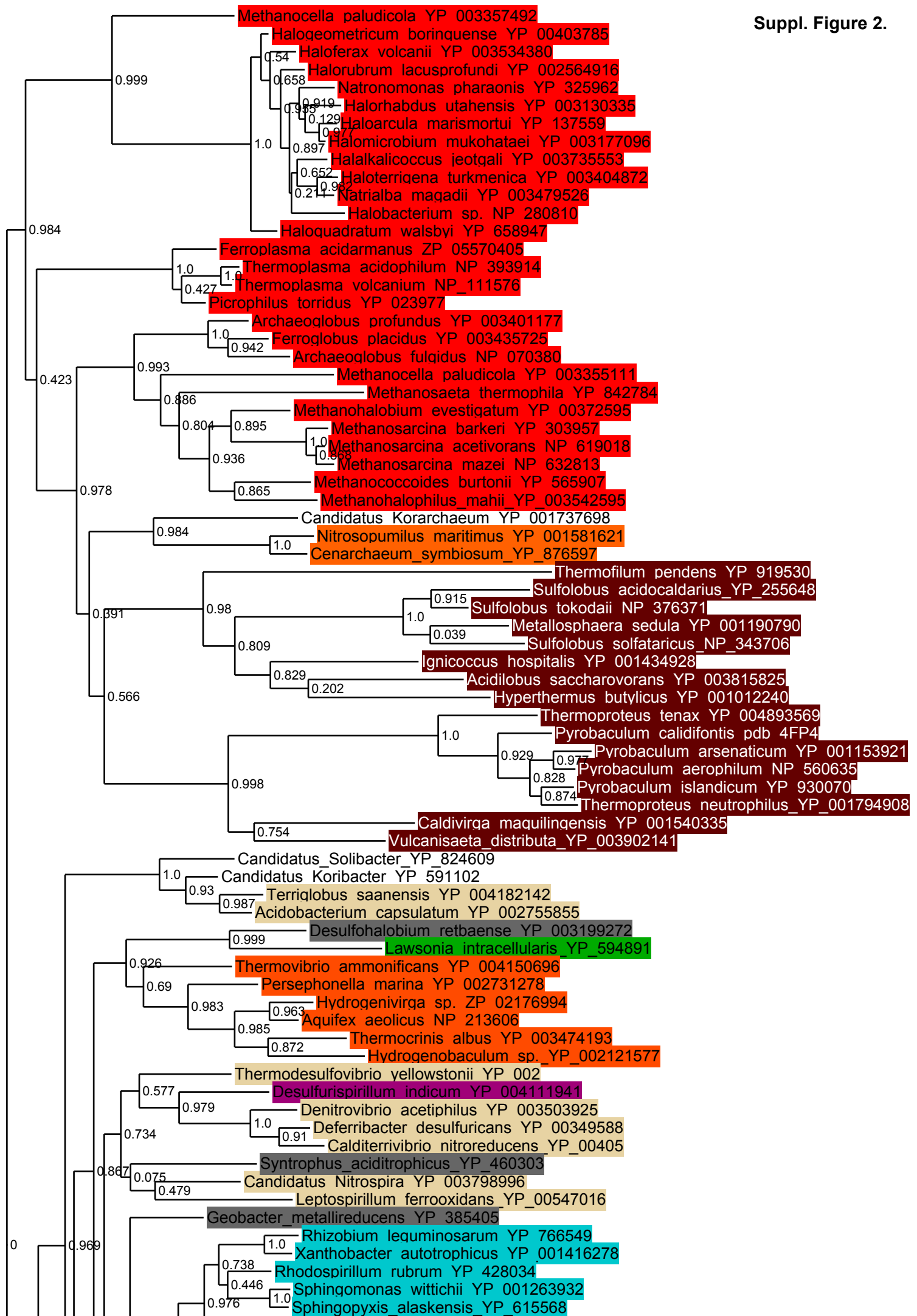
SUPPLEMENTARY FIGURE 1: Complete short-chain IPPS phylogeny reconstructed using 136 representative sequences and 244 conserved sites.

Suppl. Figure 1.

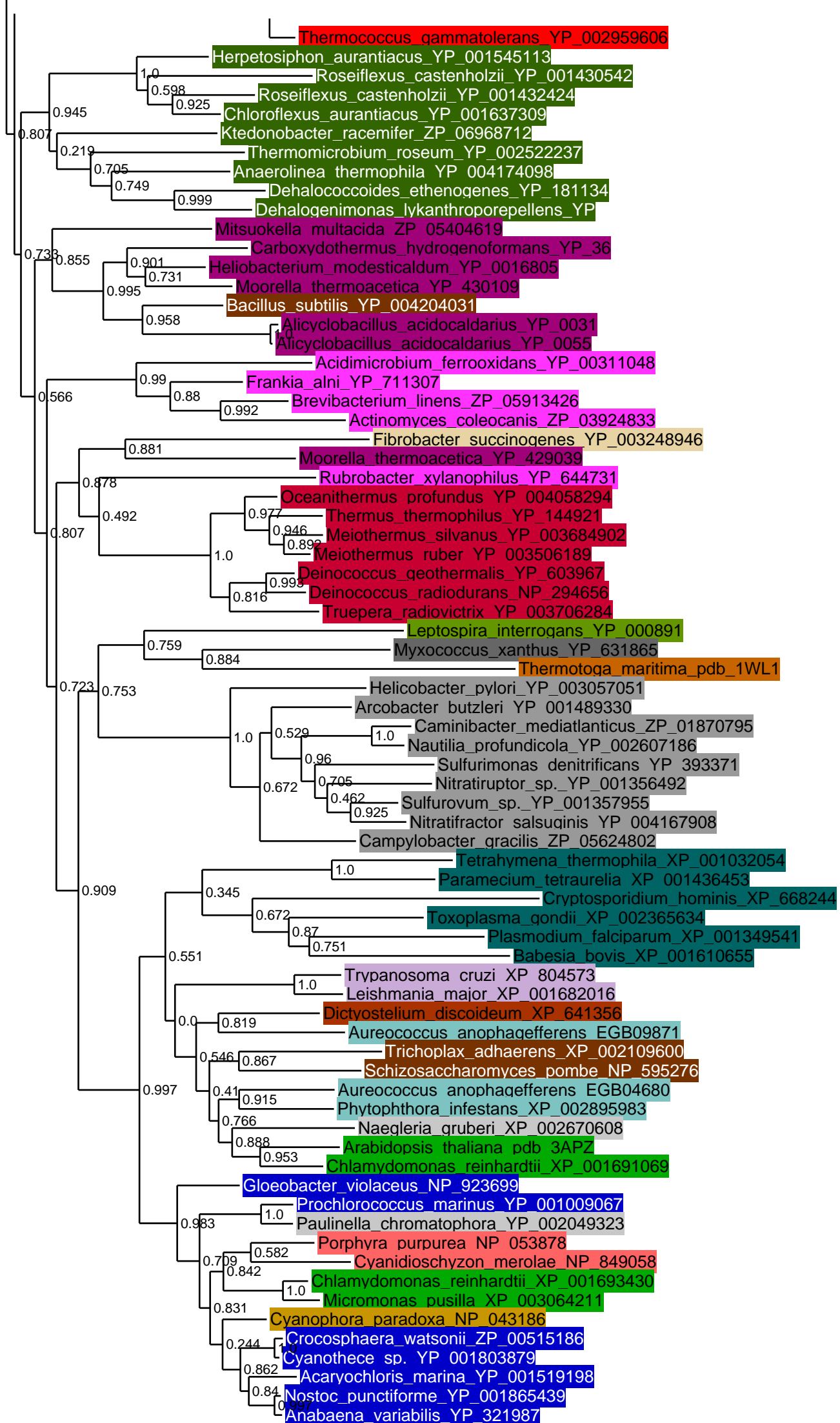




SUPPLEMENTARY FIGURE 2: Complete long-chain IPPS phylogeny reconstructed using 218 representative sequences and 241 conserved sites.

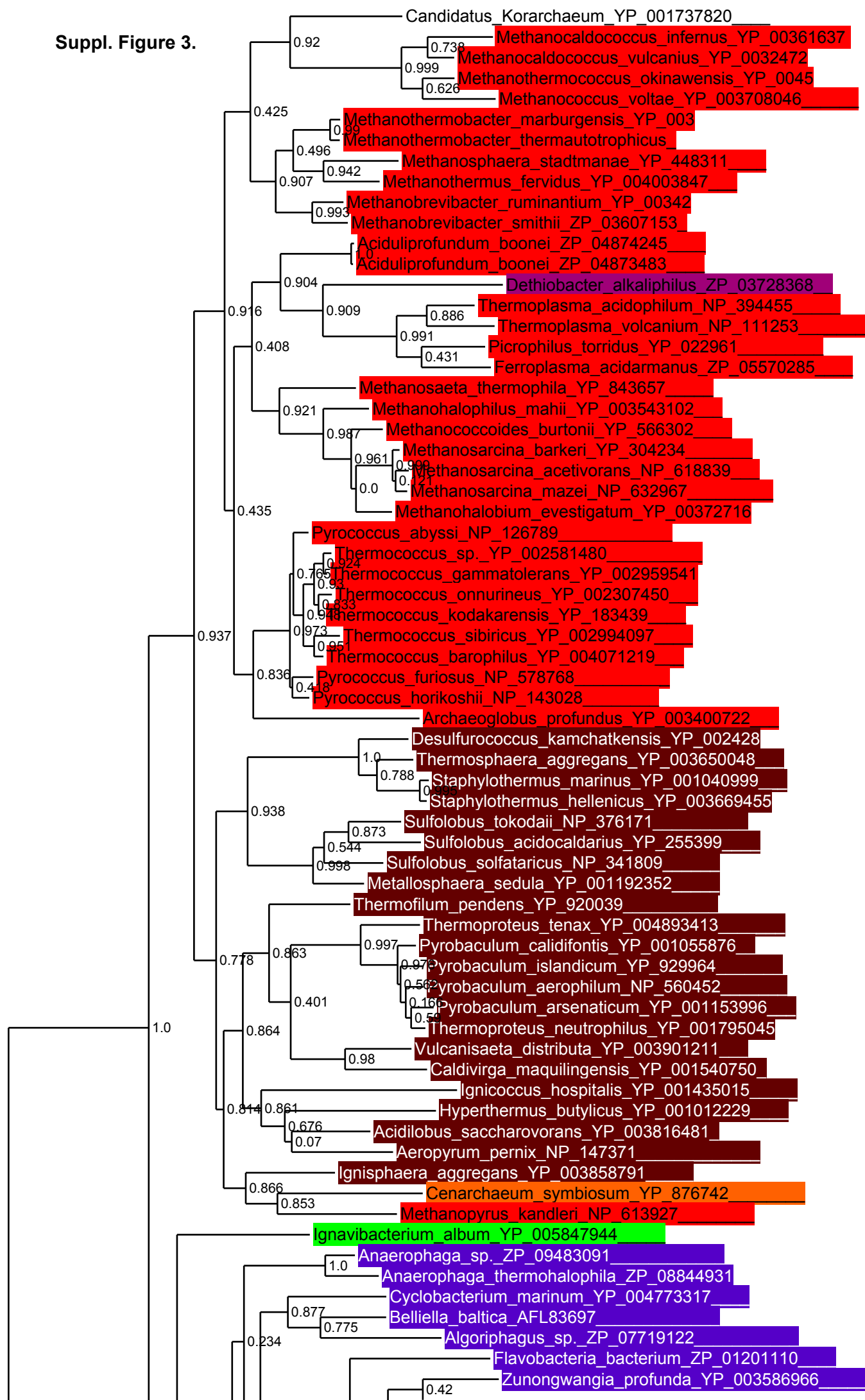


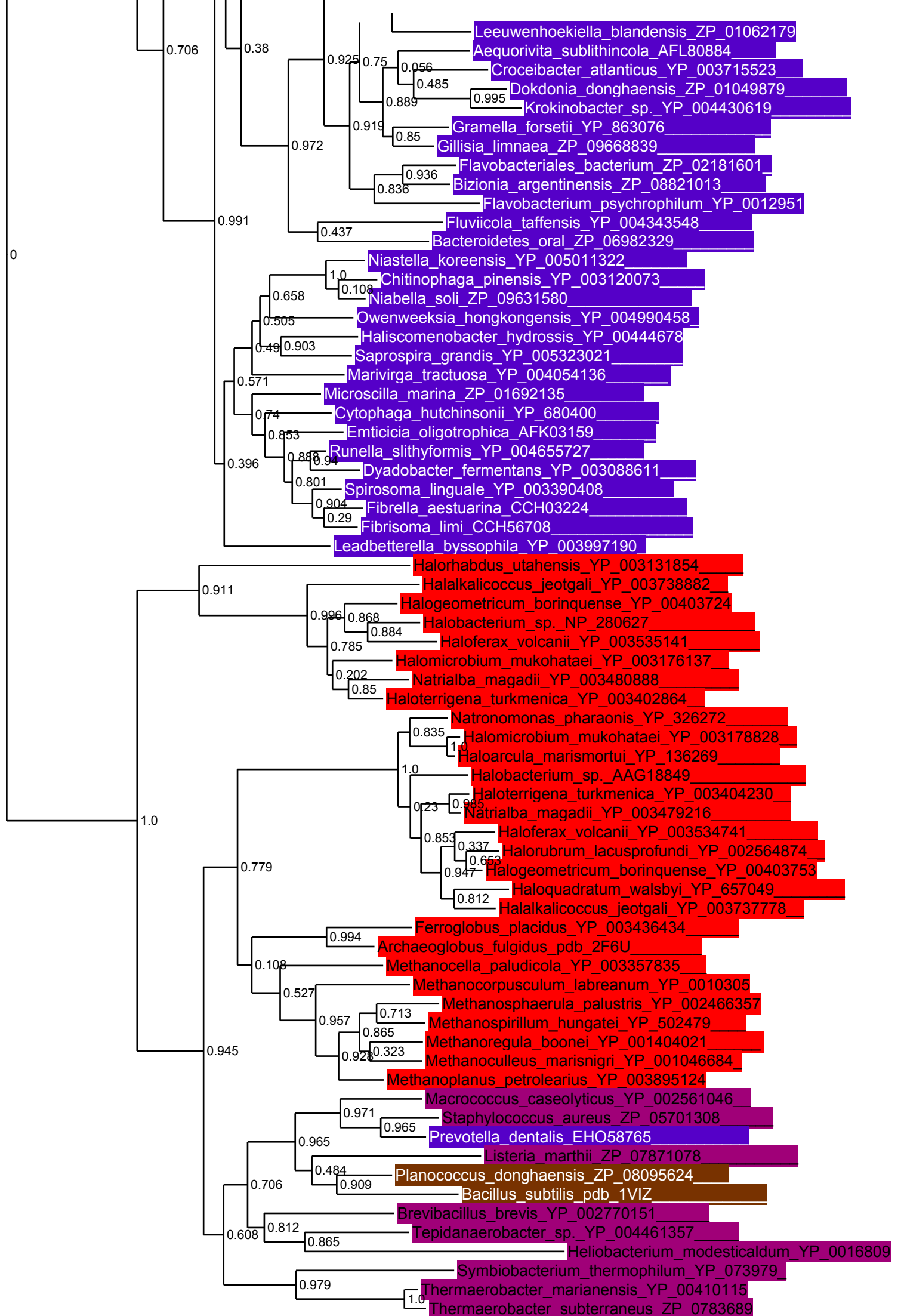




SUPPLEMENTARY FIGURE 3: GGGPS phylogeny reconstructed using 135 representative sequences and 176 conserved sites.

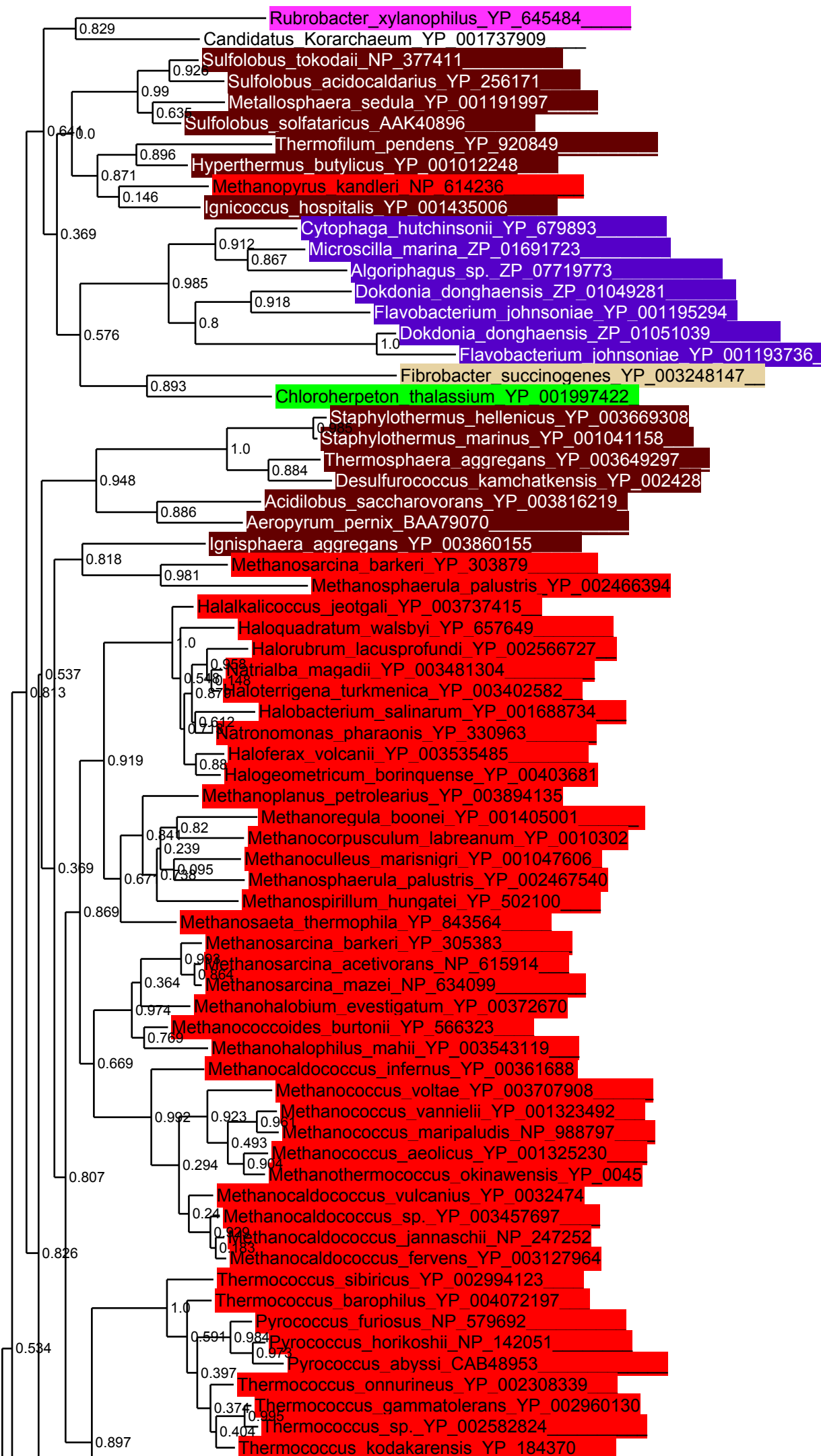
Suppl. Figure 3.

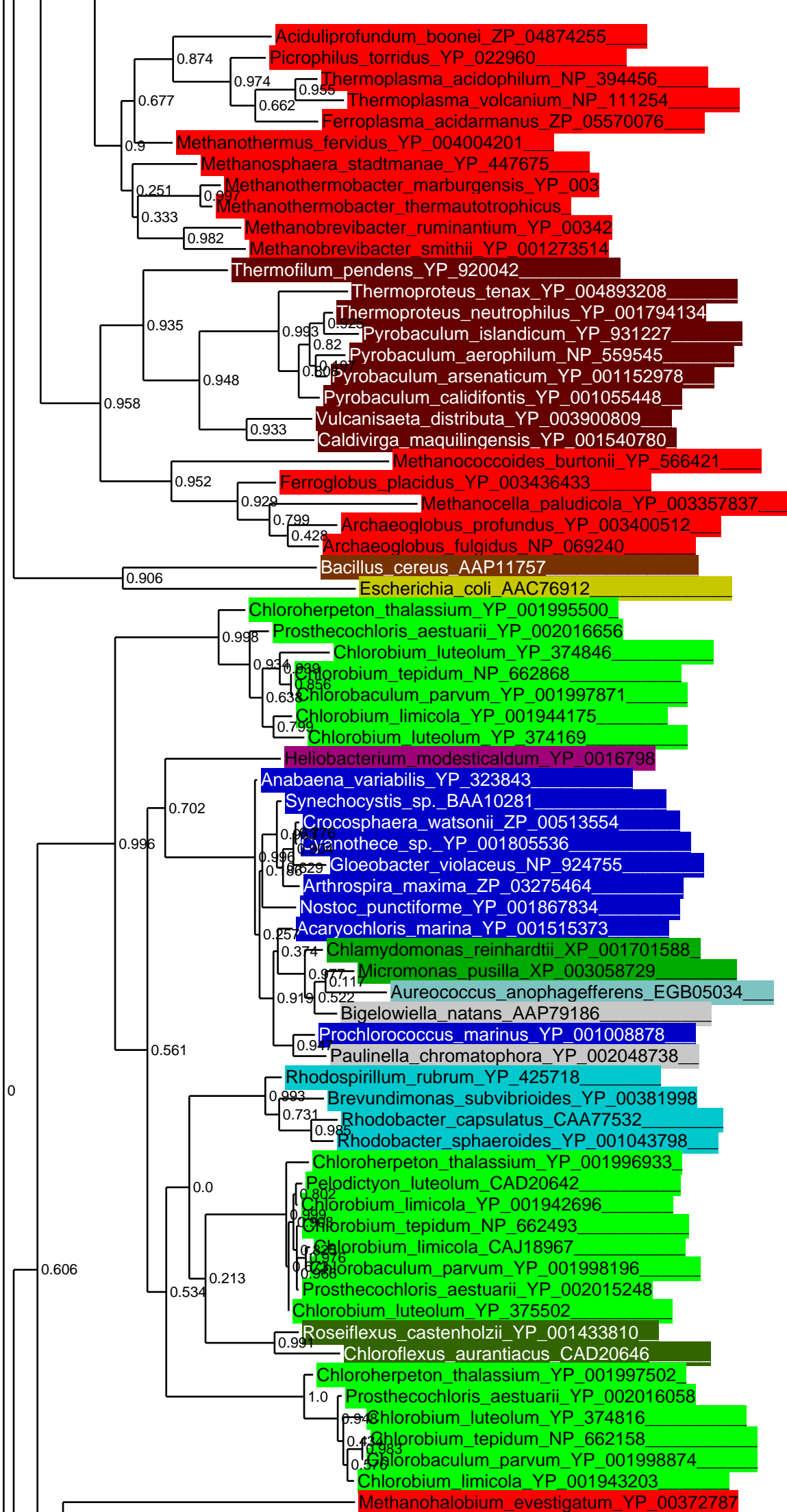


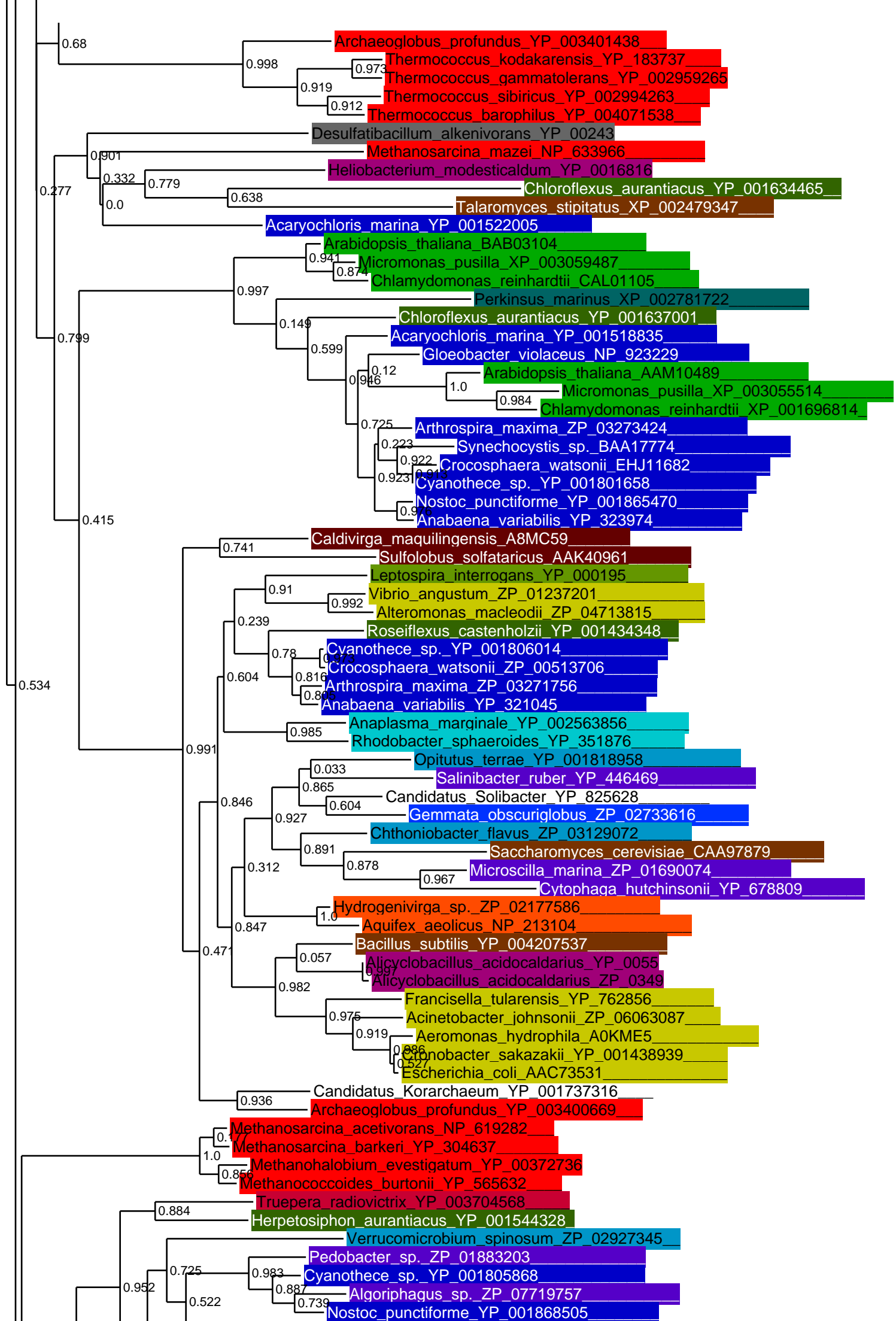


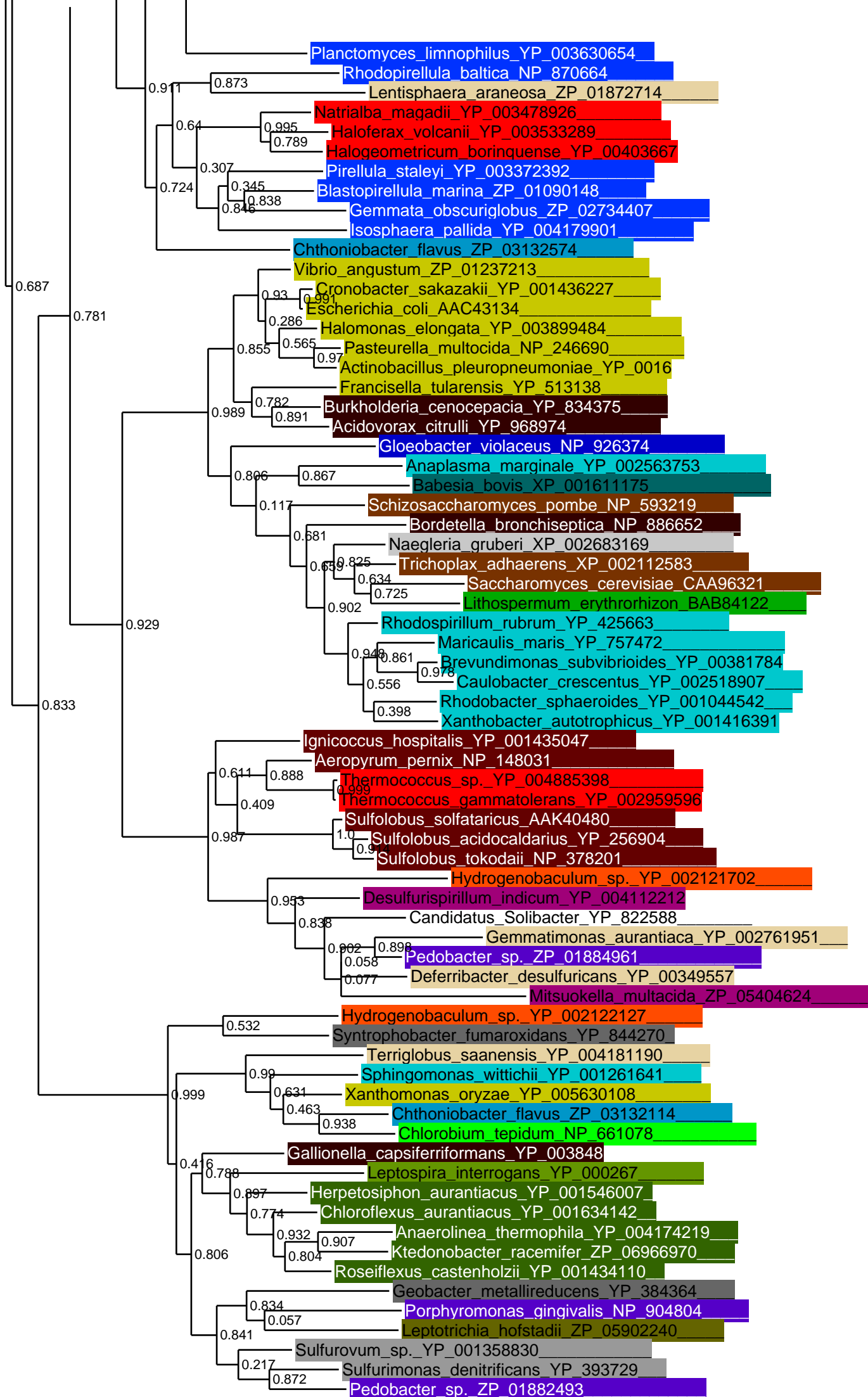
SUPPLEMENTARY FIGURE 4: DGGGPS phylogeny reconstructed using 278 representative sequences and 114 conserved sites.

Suppl. Figure 4.



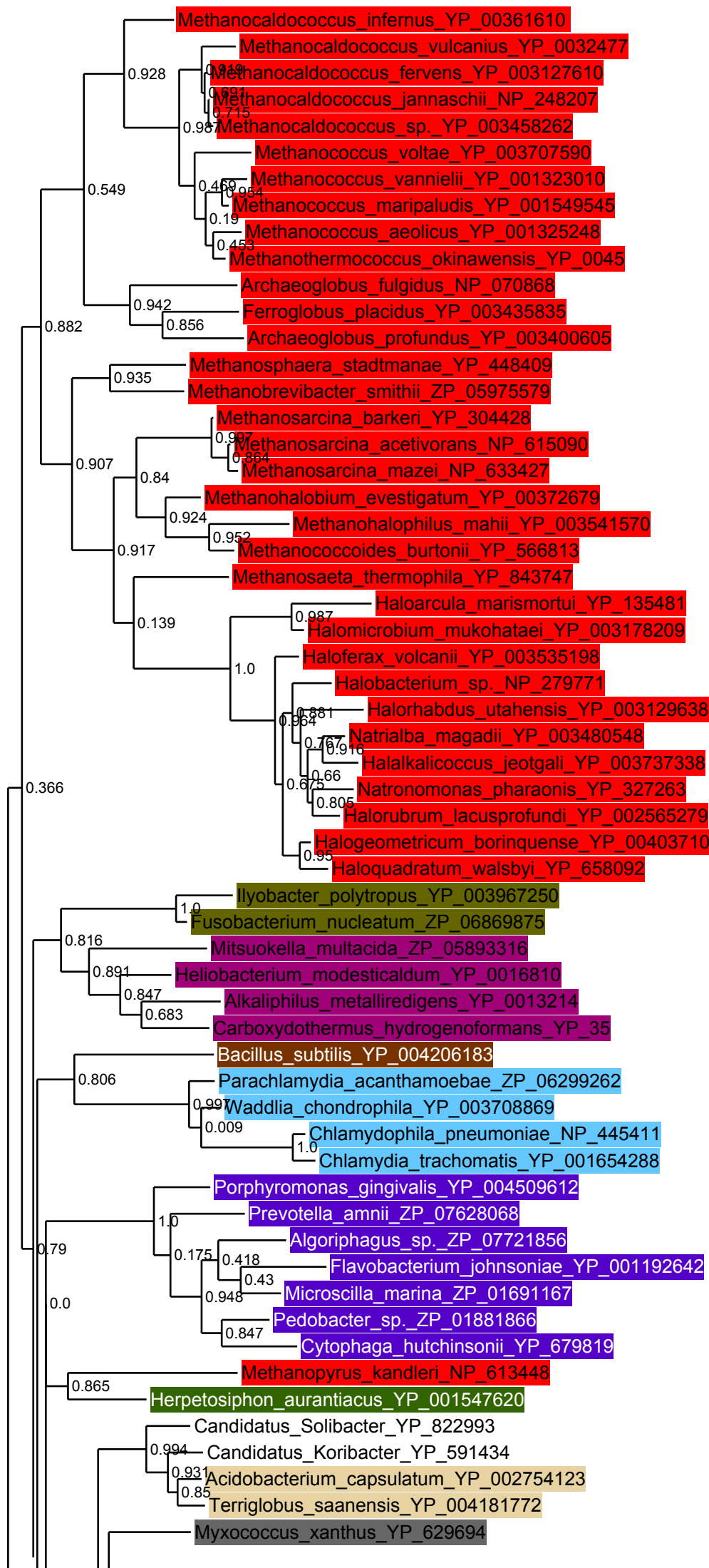


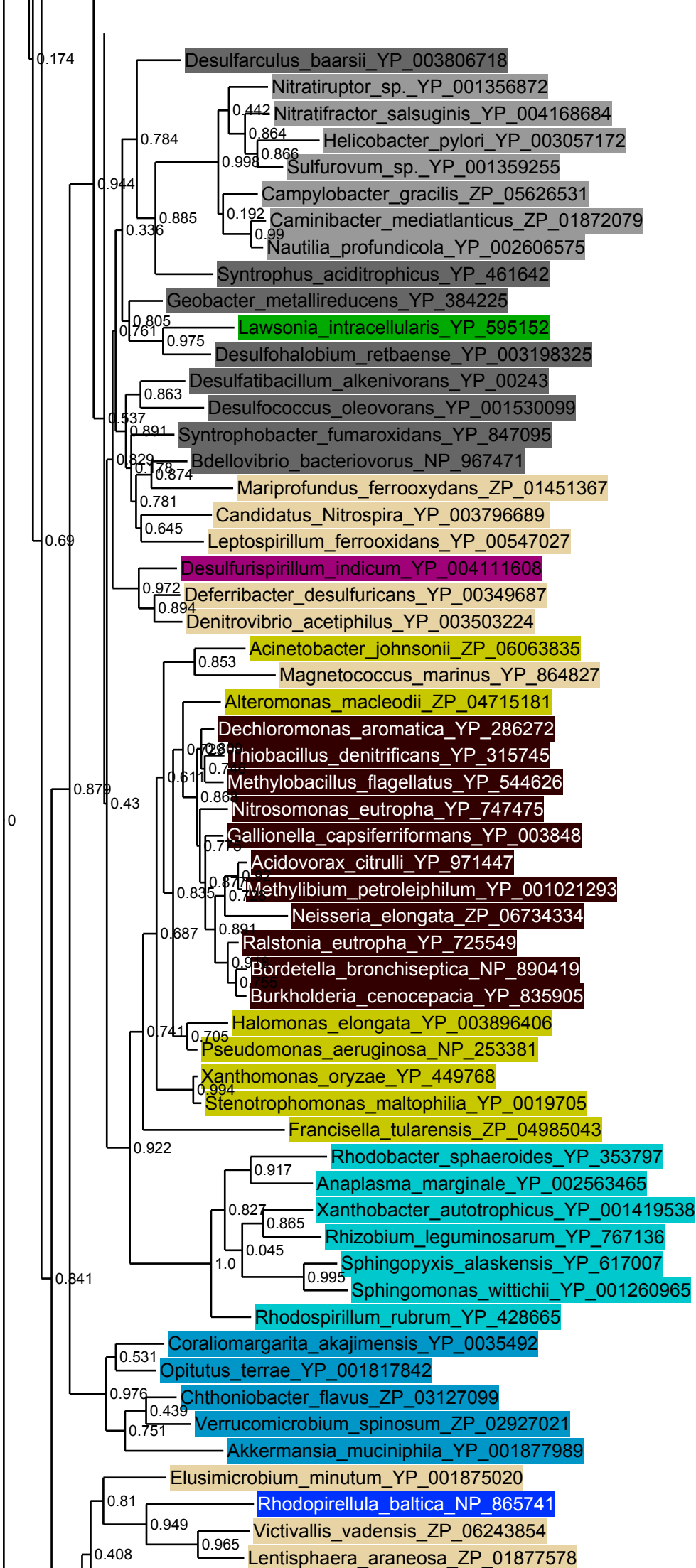


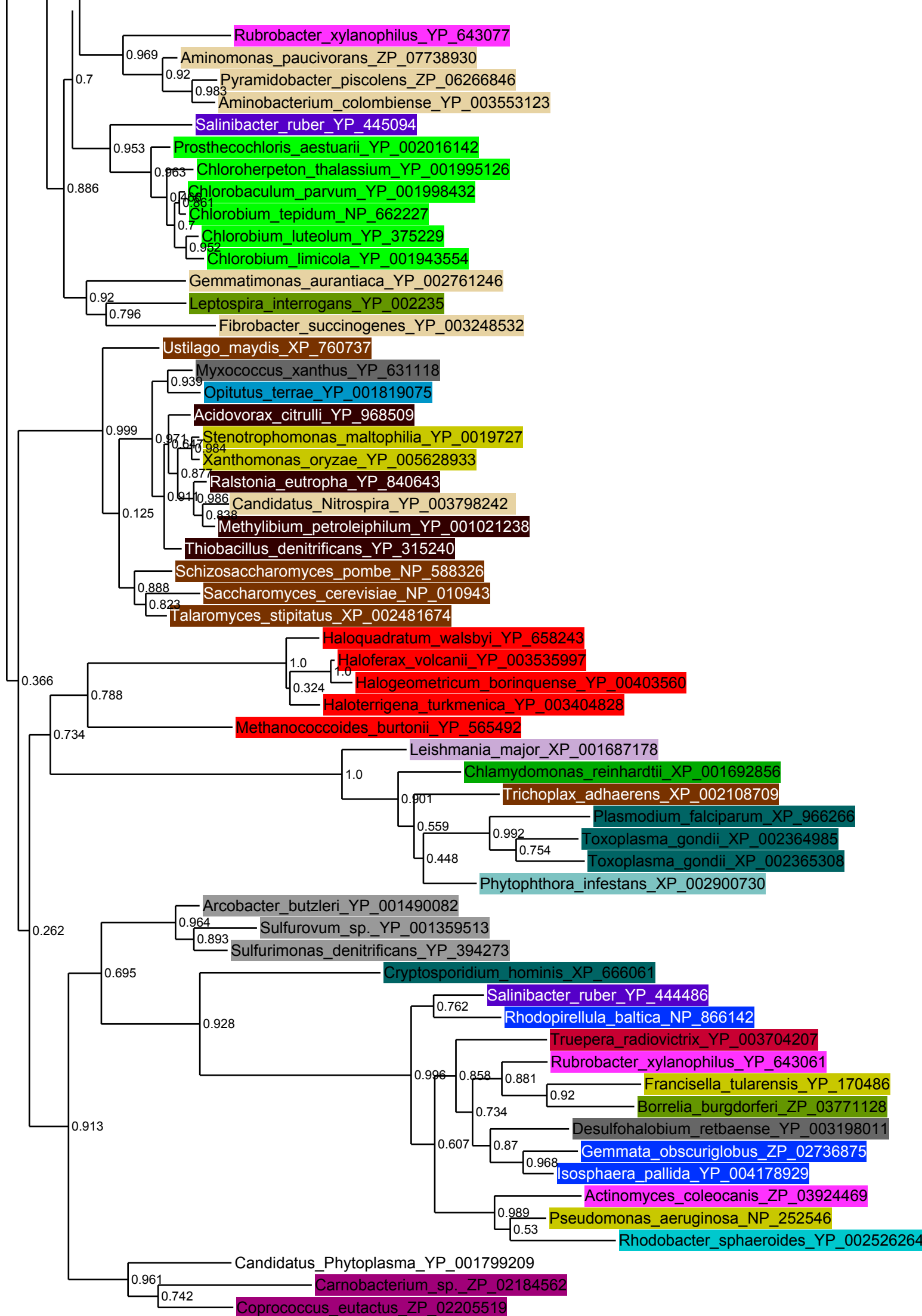


SUPPLEMENTARY FIGURE 5: Phylogenetic tree of CDP alcohol phosphatidyltransferases probably related to serine transfer. This tree was reconstructed using 173 representative sequences and 132 conserved sites.

Suppl. Figure 5.

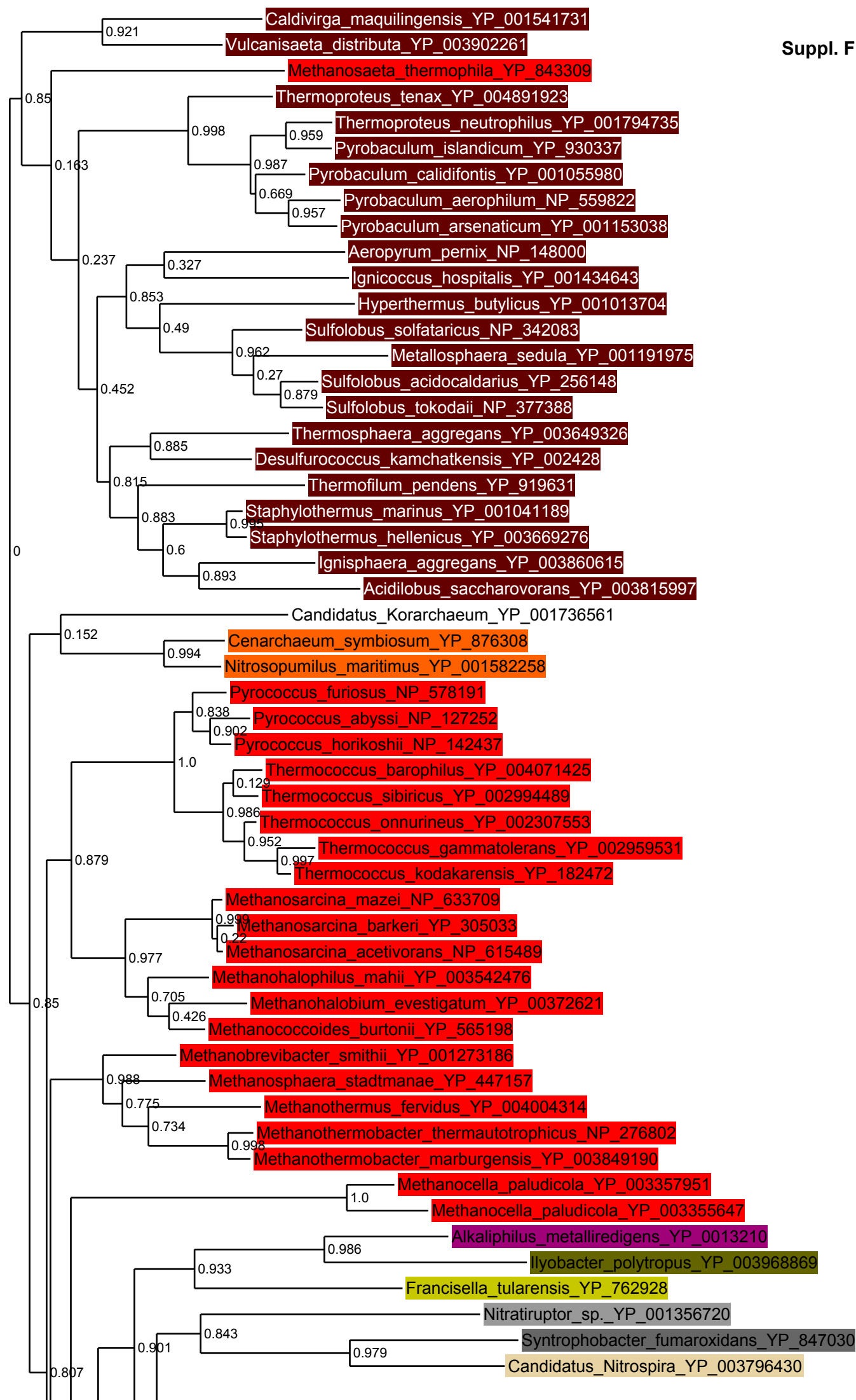




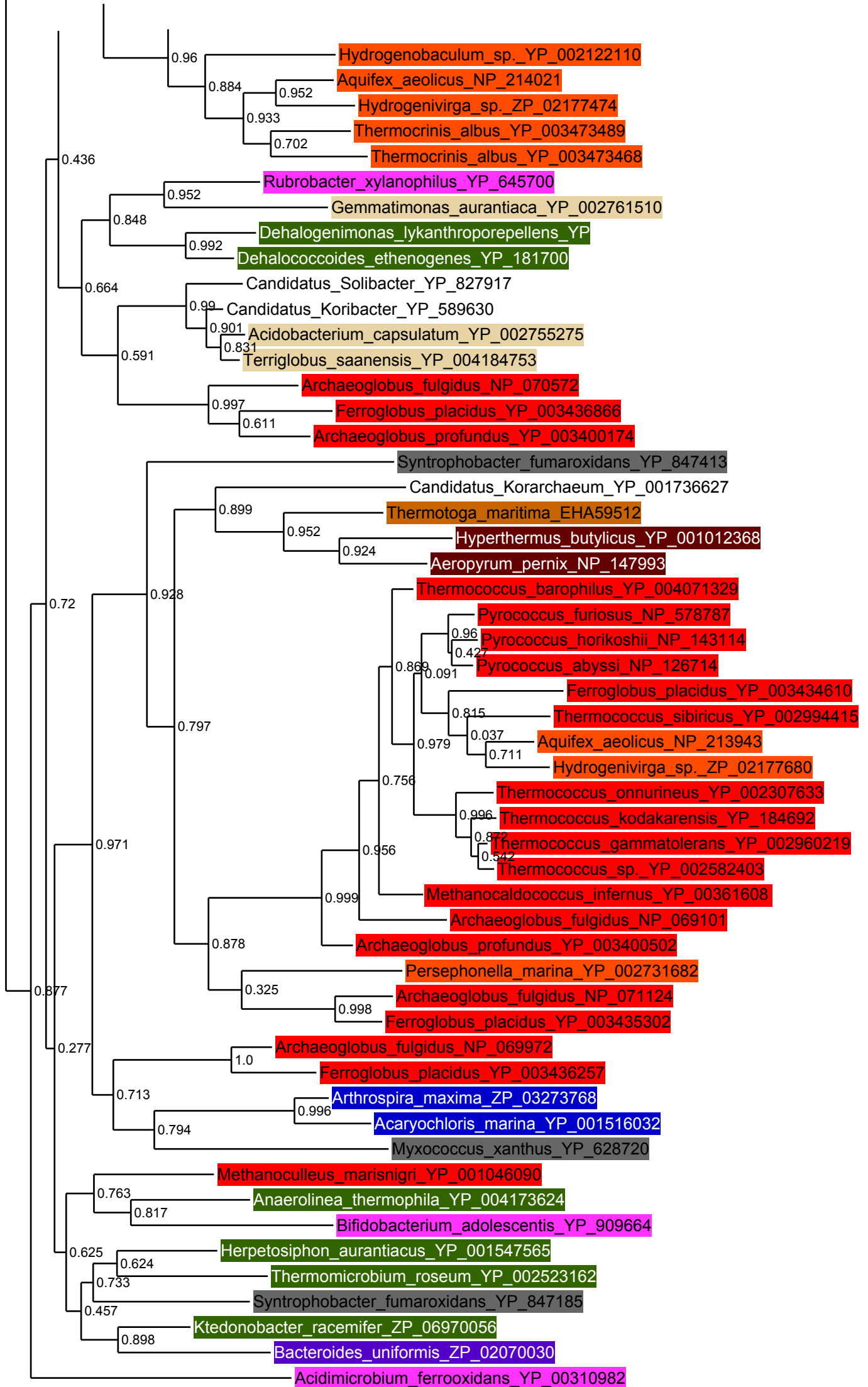


SUPPLEMENTARY FIGURE 6: Phylogenetic tree of CDP alcohol phosphatidyltransferases probably related to *myo*-inositol transfer. This tree was reconstructed using 160 representative sequences and 159 conserved sites.

Suppl. Figure 6.



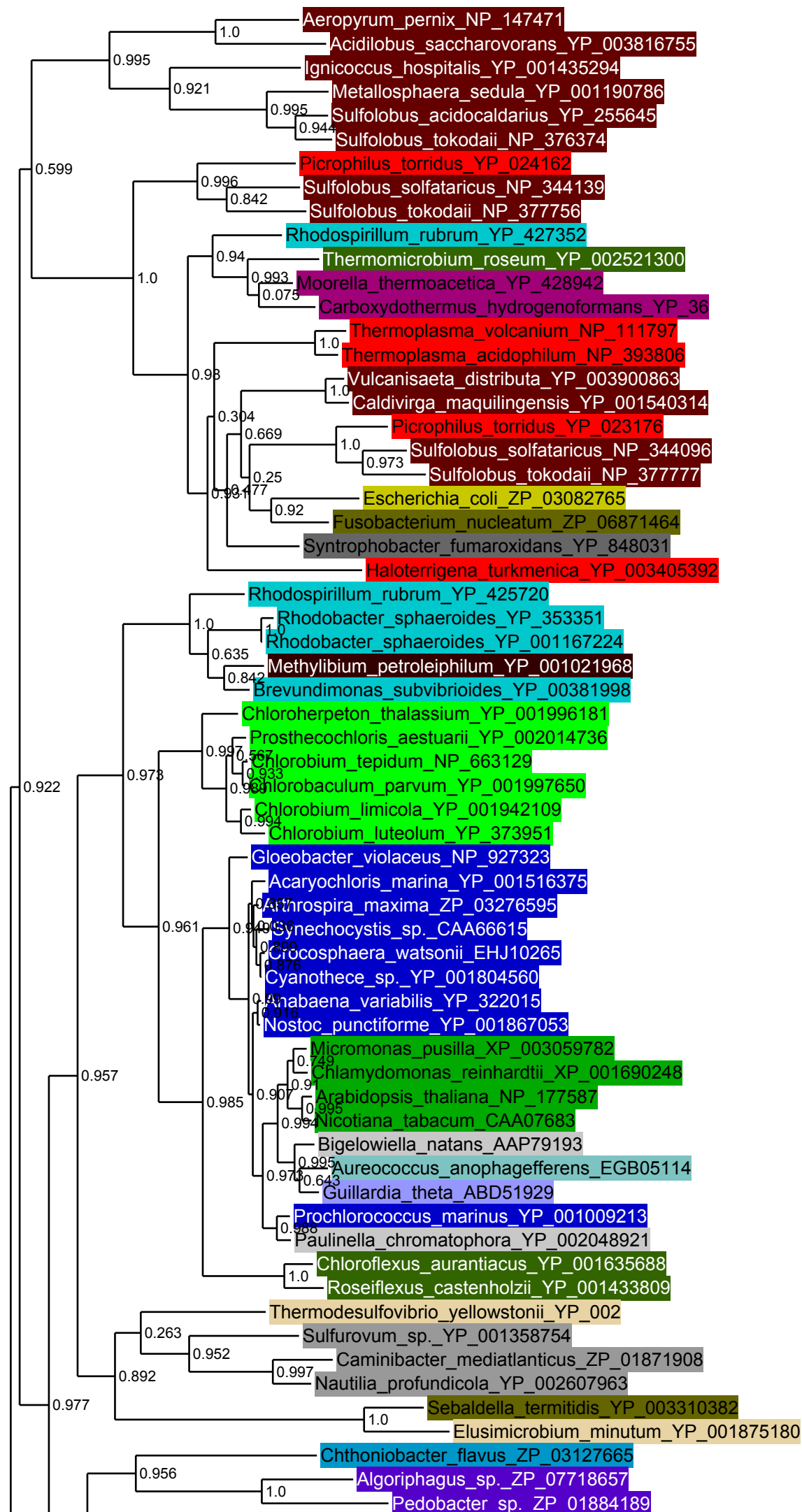


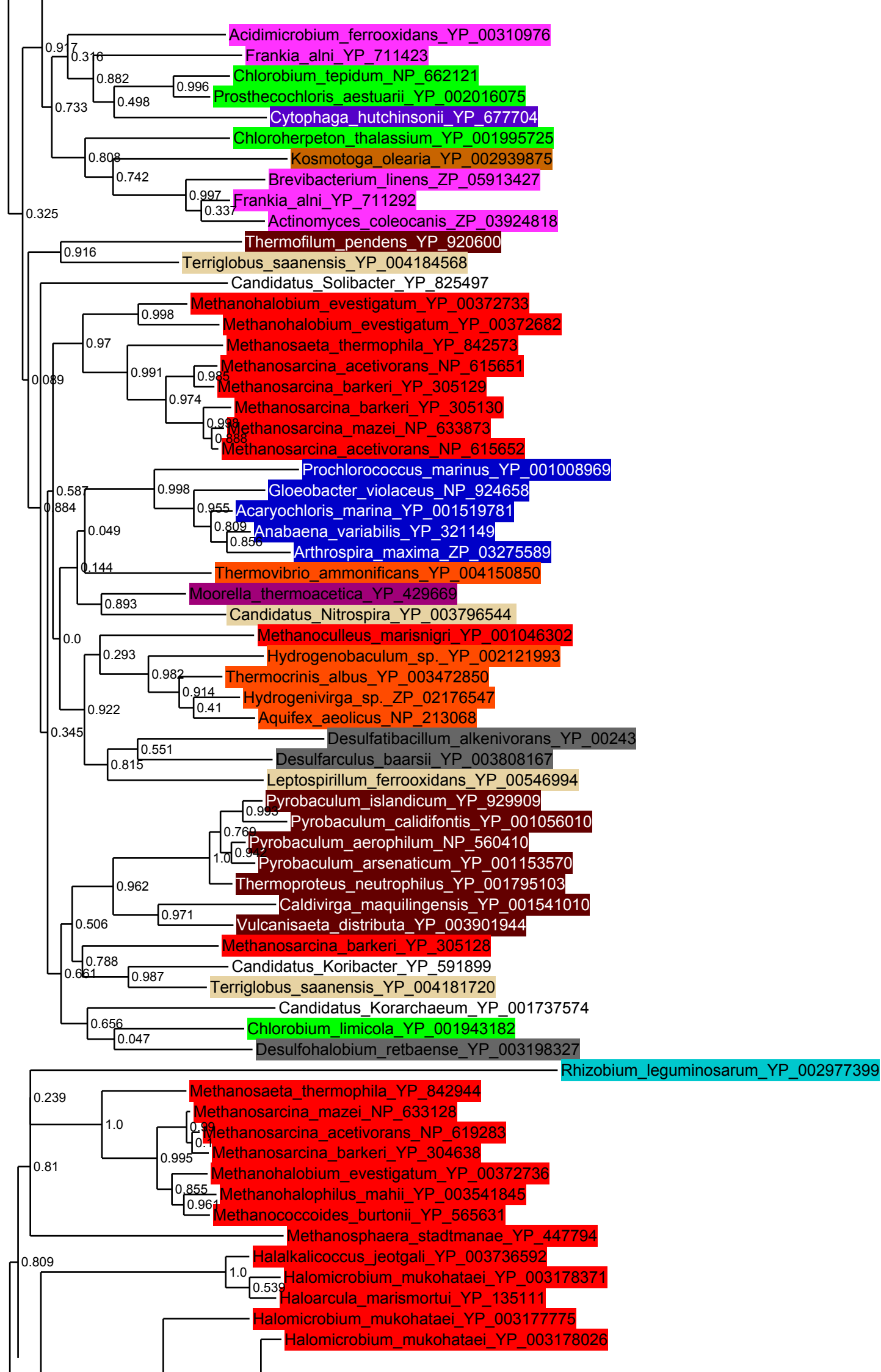


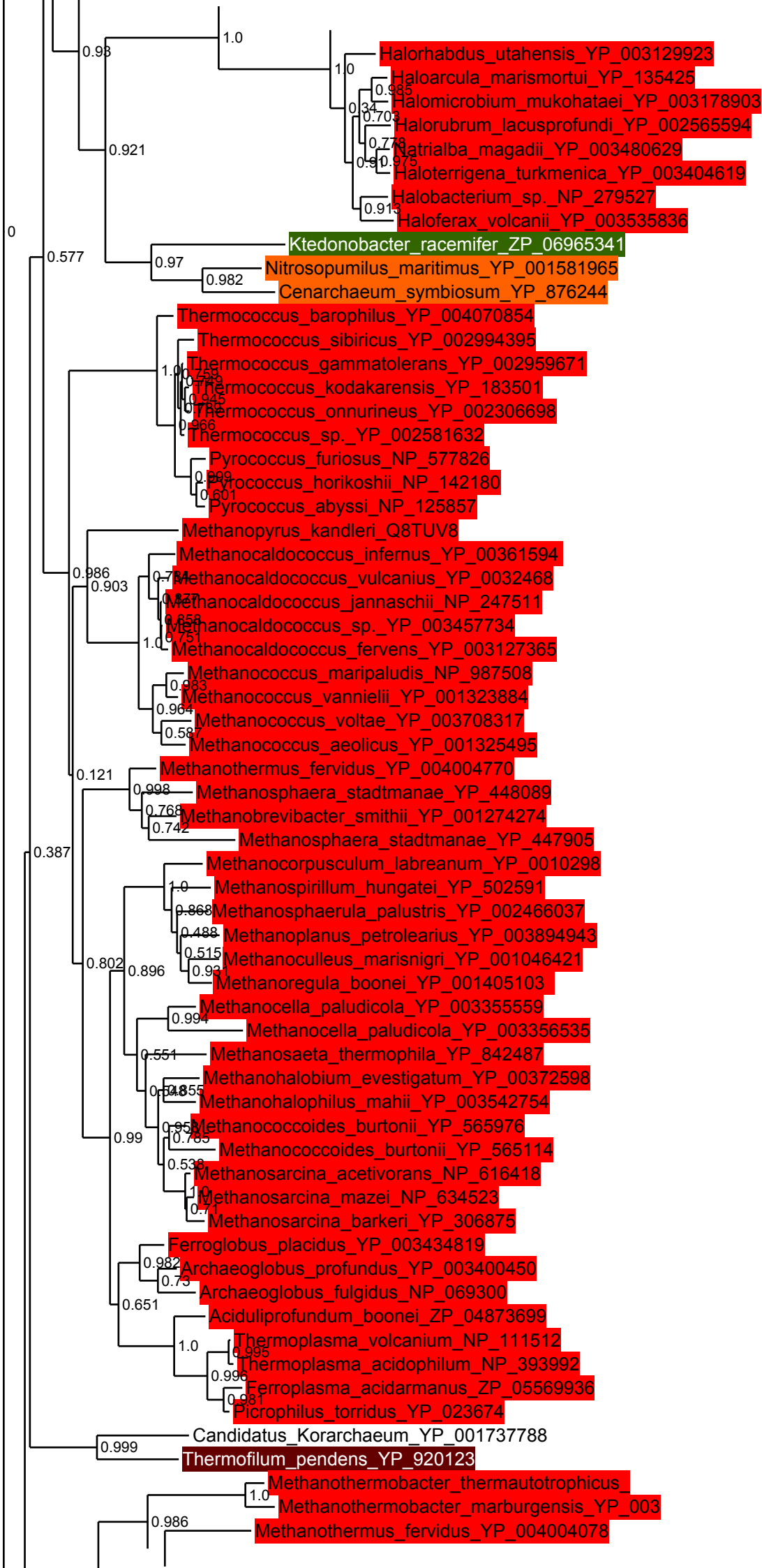
SUPPLEMENTARY FIGURE 7: Phylogenetic tree of geranylgeranyl reductases (GGR).

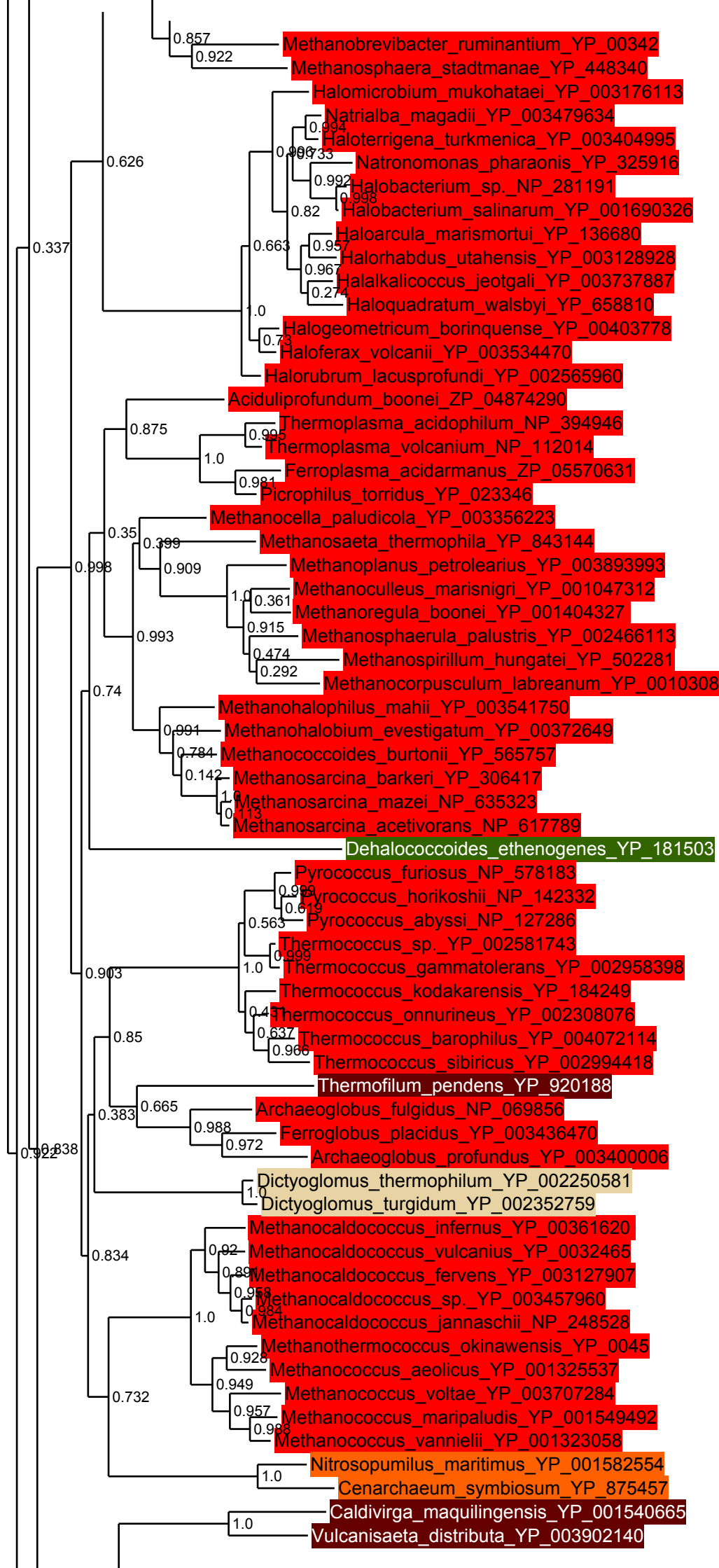
This tree was reconstructed using 317 representative sequences and 266 conserved sites.

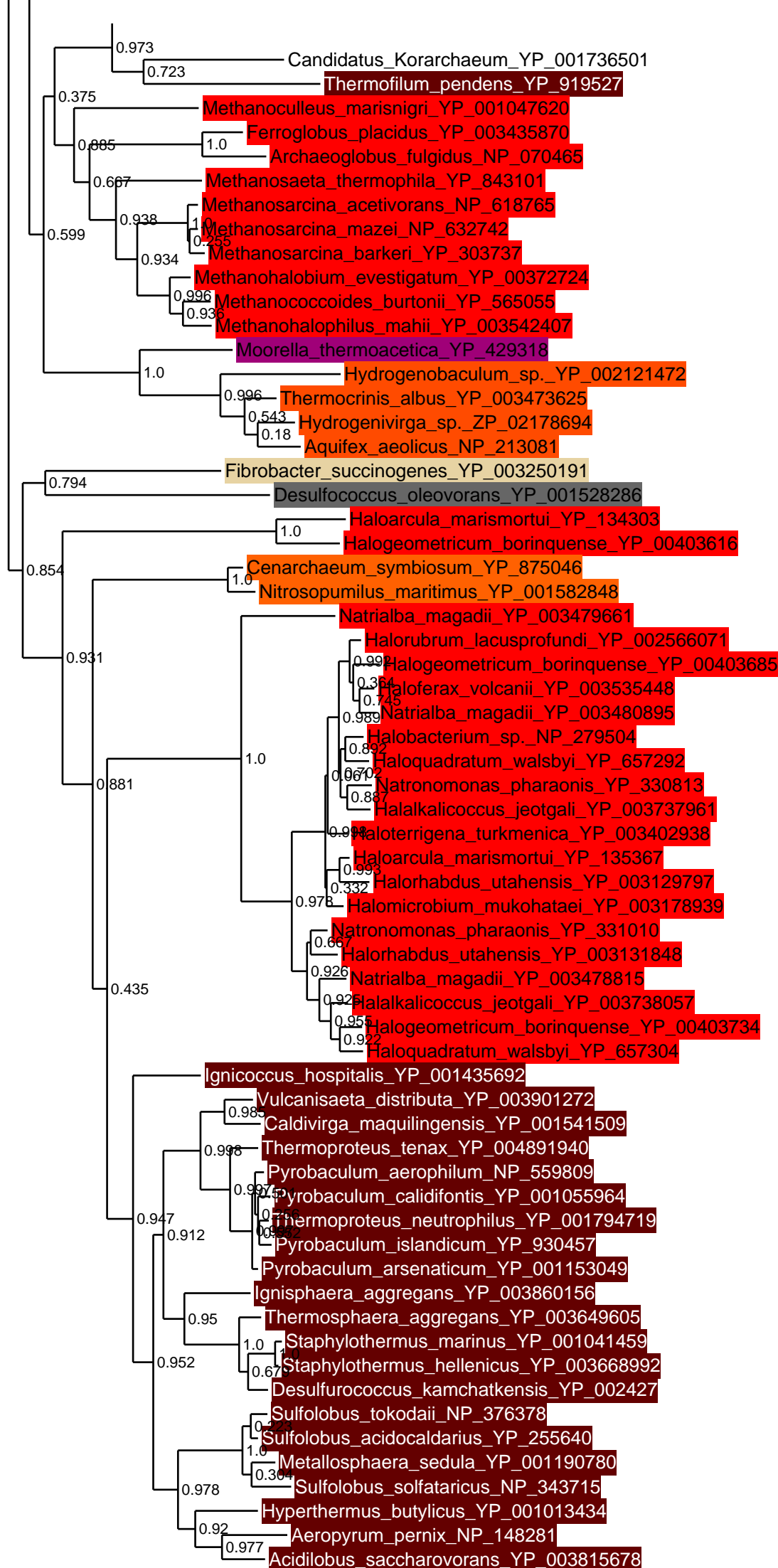
Suppl. Figure 7.











SUPPLEMENTARY FIGURE 8: Phylogenetic tree of CDP diglyceride synthases (CdsA).
This tree was reconstructed using 133 representative sequences and 87 conserved sites.

Suppl. Figure 8.



