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APPENDICES

APPENDIX A

BACTERIAL GROWTH MEDIA AND PLANT NUTRIENT SOLUTIONS

Preparation of all bacterial growth media and plant nutrient solutions are as described by Somasegaran and Hoben (1994) unless otherwise stated.

Yeast Extract Mannitol Broth (YMB)

Mannitol	10.0 g
K_2HPO_4	0.5 g
$MgSO_4.7H_2O$	0.2 g
NaCl	0.1 g
Yeast extract	0.5 g
Deionized water	1.0 g

pH of medium was adjusted to 6.8 with 0.1 N NaOH. The medium was autoclaved at 121°C for 15 min.

Yeast Extract Mannitol Agar (YMA)

YMB	1 liter
Agar	15 g

Agar was added to 1 liter of YMB. The solution was shaken to suspend the agar then autoclaved at 121°C for 15 min. After autoclaving, the medium was shaken to ensure even mixing of melted agar with medium before pouring onto petri dishes and left to solidify.

YMA with Congo Red

Congo Red stock solution: 250 mg of Congo Red dissolved in 100 ml of deionized water. 10 ml of Congo Red stock solution were added to 1 liter of YMA. The final Congo Red concentration was 25 $\mu g.ml^{-1}$. The medium was autoclaved at 121°C or 15 min.

YMA with Bromthymol Blue (BTB)

Bromthymol Blue stock solution: 0.5 g of Bromthymol Blue were dissolved in 100 ml of ethanol. 5 ml of Bromthymol Blue stock solution were added to 1 liter of YMA. The final Bromthymol Blue concentration was 25 $\mu g.ml^{-1}$. The medium was autoclaved at 121°C for 15 min.

N-free Nutrient Solution

Stock Solutions	Chemicals	g/liter
1	$CaCl_2.2H_2O$	294.1
2	KH_2PO_4	136.1
3	$FeC_6H_5O_7.3H_20$	6.7
	$MgSO_4.7H_2O$	123.3
	K_2SO_4	87.0
	$MnSO_4.H_2O$	0.338
4	H_3BO_3	0.247
	$ZnSO_4.7H_2O$	0.288
	$CuSO_4.5H_2O$	0.100
	$CoSO_4.7H_2O$	0.056
	$Na_2 MoO_2.7 H_2O$	0.048

Warm water was used to prepare stock solutions to get the ferric-citrate into solution. Ten liters of full-strength plant culture solution were prepared as follows:

- To 5 liters of water, add 5 ml of each stock solution and mix,
- Adjust pH to 6.8 with 1 N HCl,
- Dilute to 10 liters by adding water,

Tryptone-Yeast extract (TY) Medium

Tryptone	5.0 g
Yeast extract	3.0 g
$CaCl_2 \cdot H_2O$	0.87 g
Deionized water	1000 ml

pH of medium was adjusted to 6.8 with 0.1 N NaOH. The medium was autoclaved at 121°C for 15 min.

APPENDIX B

CHEMICALS AND SOLUTIONS

1. Solutions for DNA extraction

Saline-EDTA solution

15 mM NaCl, 10 mM EDTA, pH 8.0

0.9 g NaCl, 0.29 g EDTA

were added to distilled water. The final volume was made to 100 ml. 0.1 N NaOH was used to adjust pH to 8.0 before autoclaving at 121°C for 15 min.

DNAzol

DNAzol solution (Molecular Research Lab, MRL) was used according to the manufacturer's instruction.

2. Electrophoresis Buffer

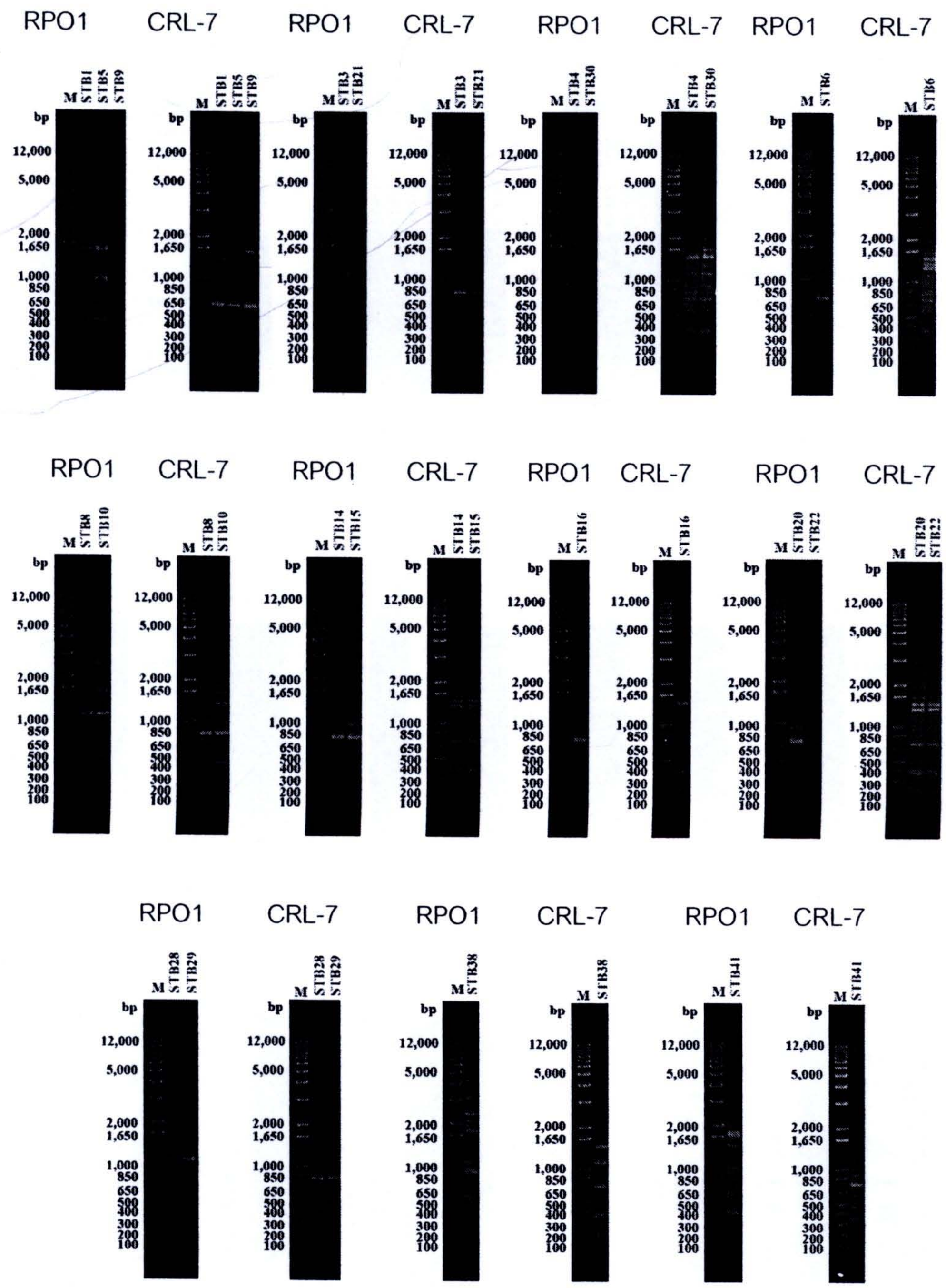
50X Tris Acetate Buffer (TAE buffer)

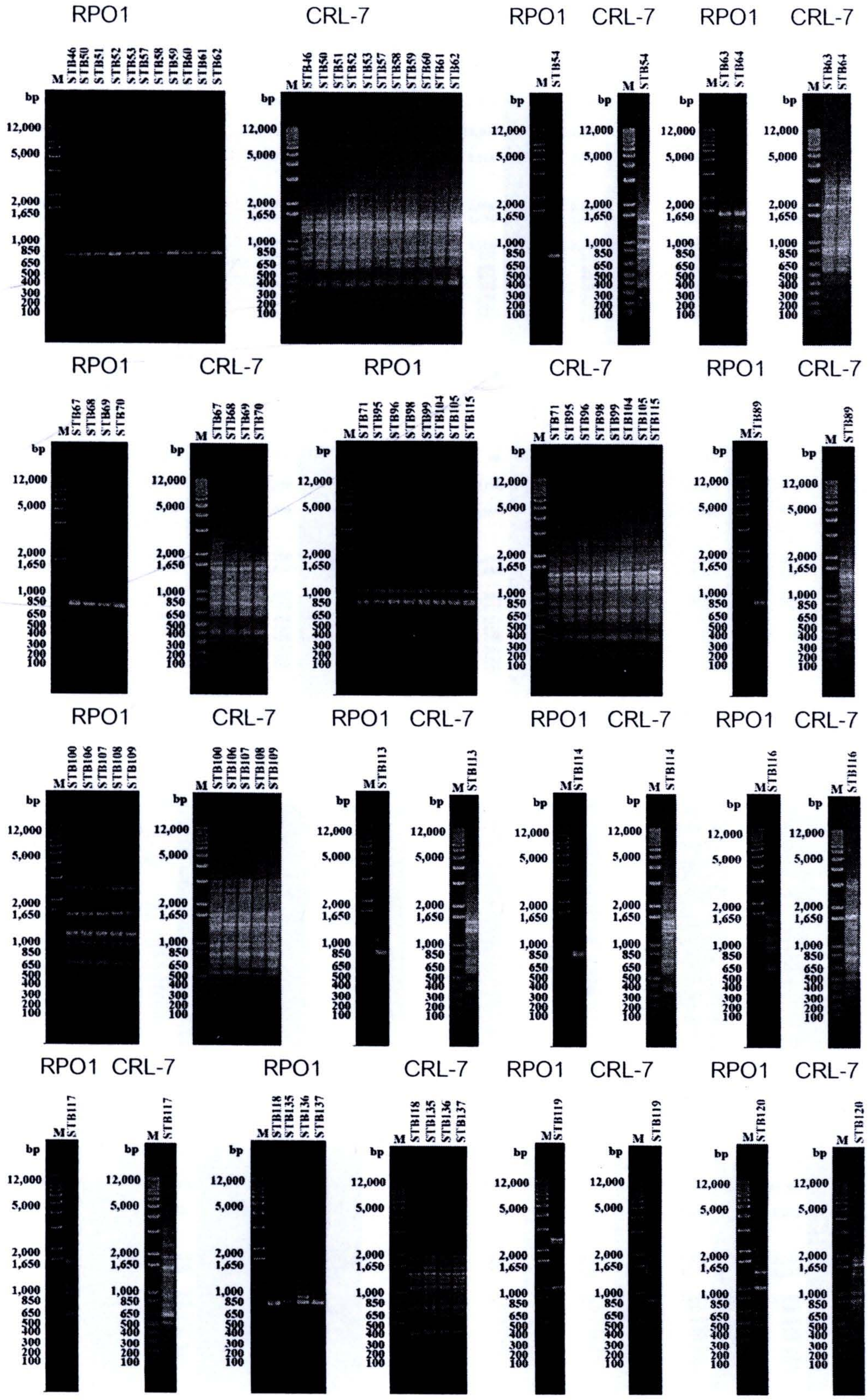
Tris base	242	g.
glacial acetic acid	57.1	ml
0.5 M EDTA pH 8.0	100	ml

were added to double distilled water. 6 N HCl was used to adjust pH to 8.0. The final volume was added to 1000 ml.

APPENDIX C

RAPD-PCR FINGERPRINTS OF 202 SLOW-GROWING SOYBEAN RHIZOBIUM ISOLATES GROUPED AS THE SAME STRAINS




RPO1
CRL-7
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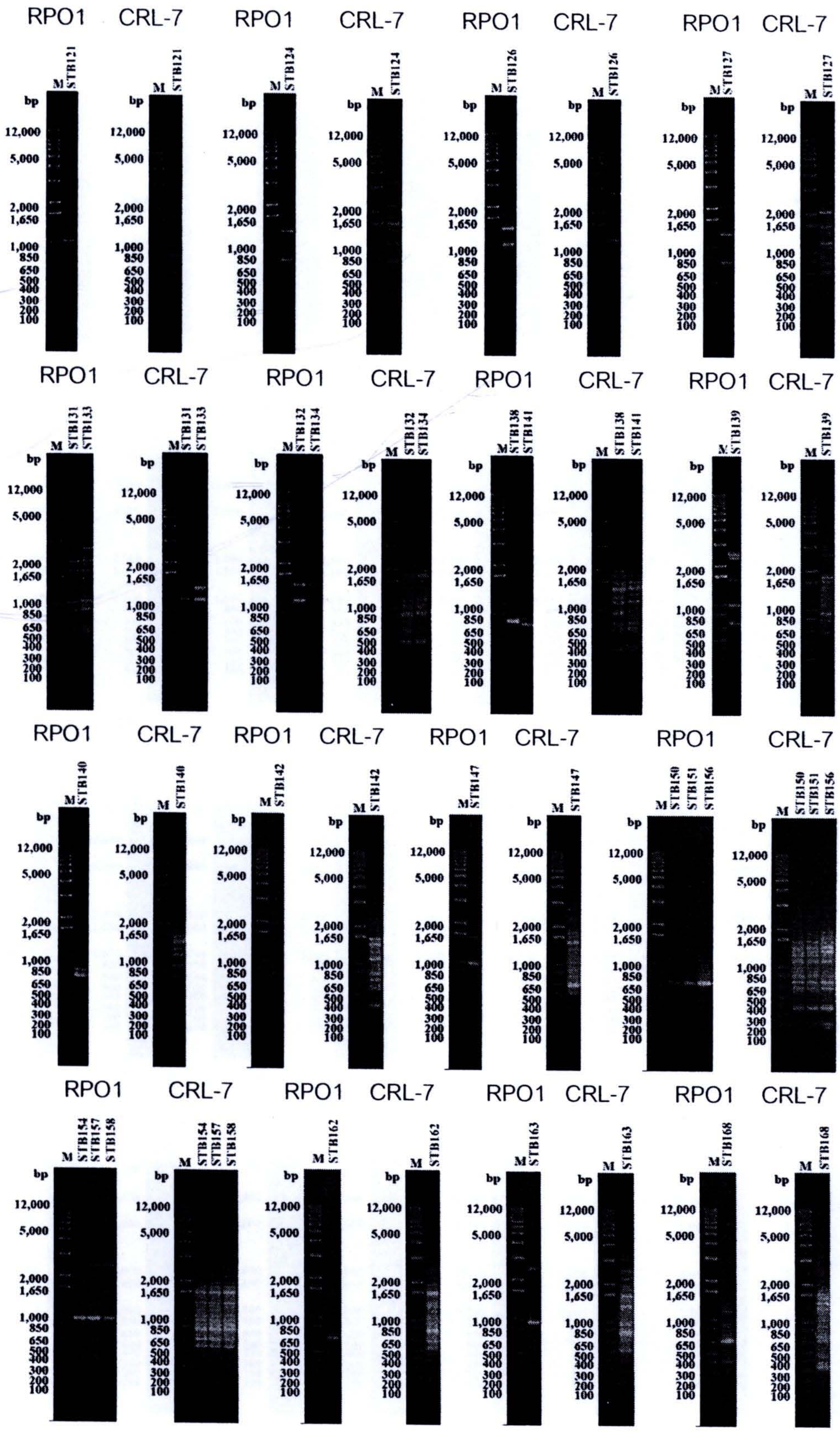
CRL-7
RPO1
CRL-7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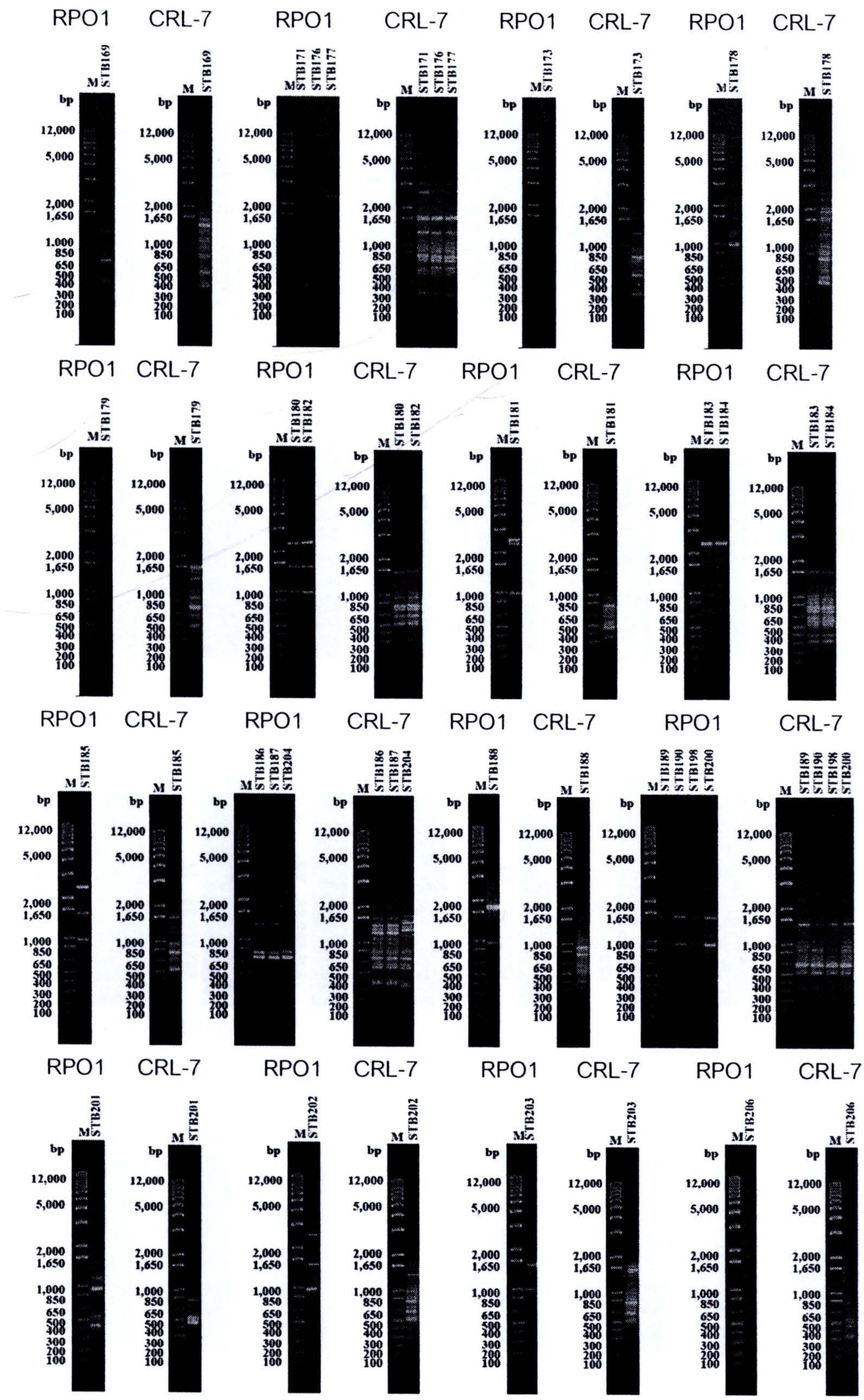
200
100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M STB169
CRL-7
M STB169
RPO1
M STB171 STB176 STB177
CRL-7
M STB171 STB176 STB177
RPO1
M STB173
CRL-7
M STB173
RPO1
M STB178
CRL-7
M STB178
RPO1
M STB179
CRL-7
M STB179
RPO1
M STB180 STB182
CRL-7
M STB180 STB182
RPO1
M STB181
CRL-7
M STB181
RPO1
M STB183 STB184
CRL-7
M STB183 STB184
RPO1
M STB185
CRL-7
M STB185
RPO1
M STB186 STB187 STB204
CRL-7
M STB186 STB187 STB204
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M STB188
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M STB188
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M STB189 STB190 STB198 STB200
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CRL-7
M STB203
RPO1
M STB206
CRL-7
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200
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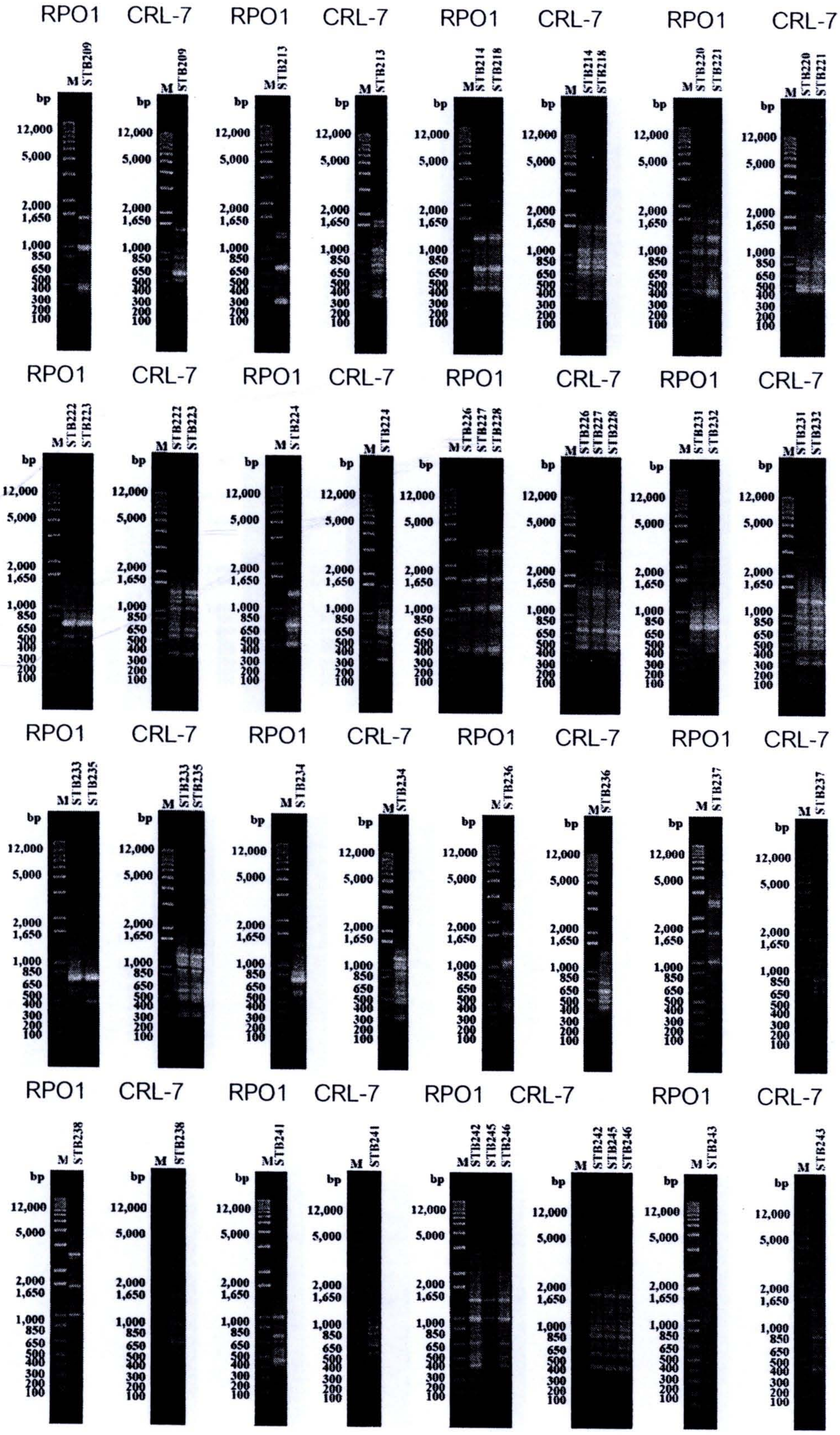
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CRL-7
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M STB214 STB218
M STB214 STB218
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M STB220 STB221
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CRL-7
RPO1
CRL-7
RPO1
CRL-7
RPO1
CRL-7
M STB222 STB223
M STB222 STB223
M STB224
M STB224
M STB226 STB227 STB228
M STB226 STB227 STB228
M STB231 STB232
M STB231 STB232
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CRL-7
RPO1
CRL-7
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CRL-7
RPO1
CRL-7
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M STB237
M STB237
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CRL-7
RPO1
CRL-7
RPO1
CRL-7
RPO1
CRL-7
M STB238
M STB238
M STB241
M STB241
M STB242 STB245 STB246
M STB242 STB245 STB246
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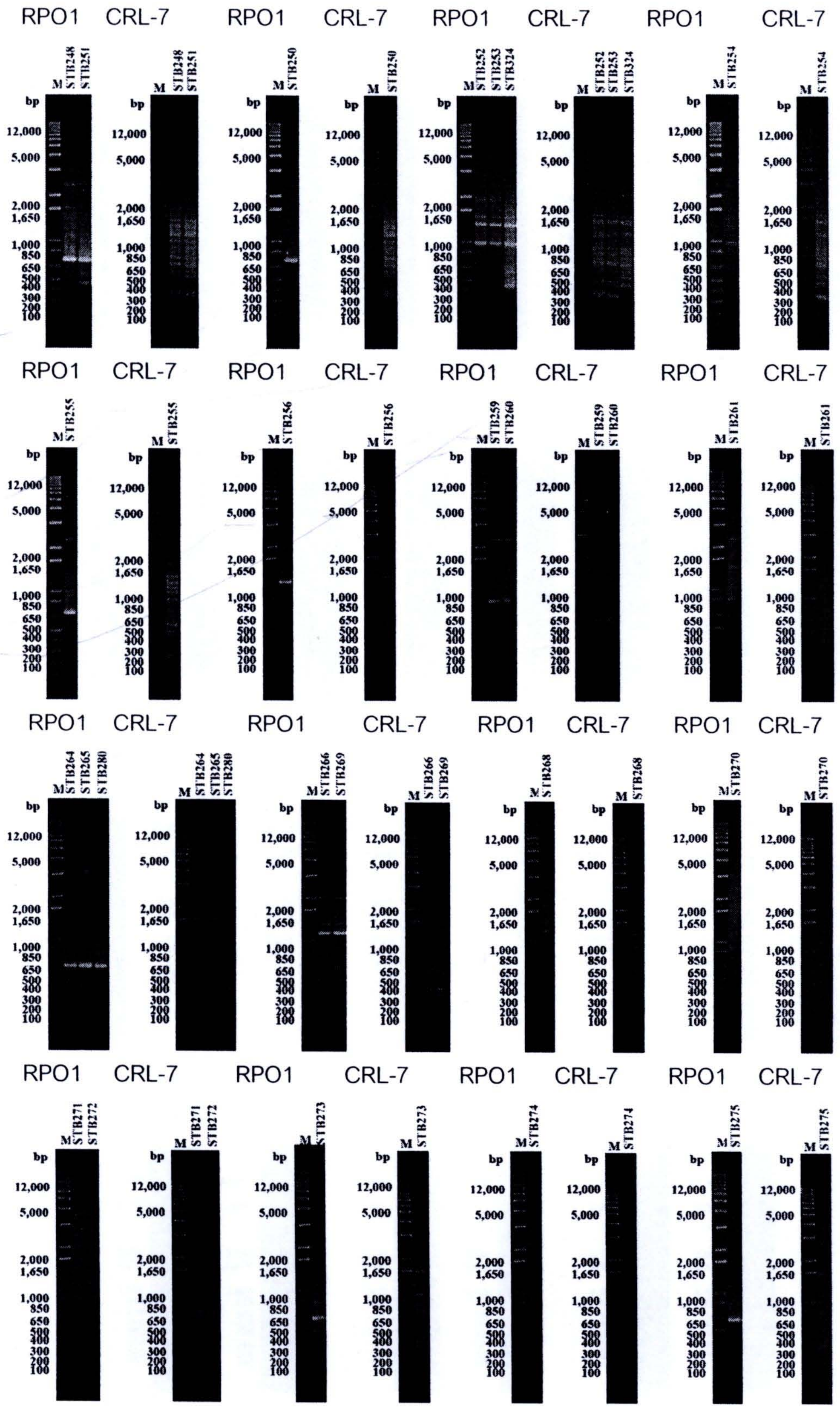
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M STB248 STB251
M STB250
M STB250
M STB252 STB253 STB324
M STB252 STB253 STB324
M STB254
M STB254
bp
12,000
5,000
2,000
1,650
1,000
850
650
500
400
300
200
100
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M STB255
M STB255
M STB256
M STB256
M STB259 STB260
M STB259 STB260
M STB261
M STB261
RPO1 CRL-7 RPO1 CRL-7 RPO1 CRL-7 RPO1 CRL-7
M STB264 STB265 STB280
M STB264 STB265 STB280
M STB266 STB269
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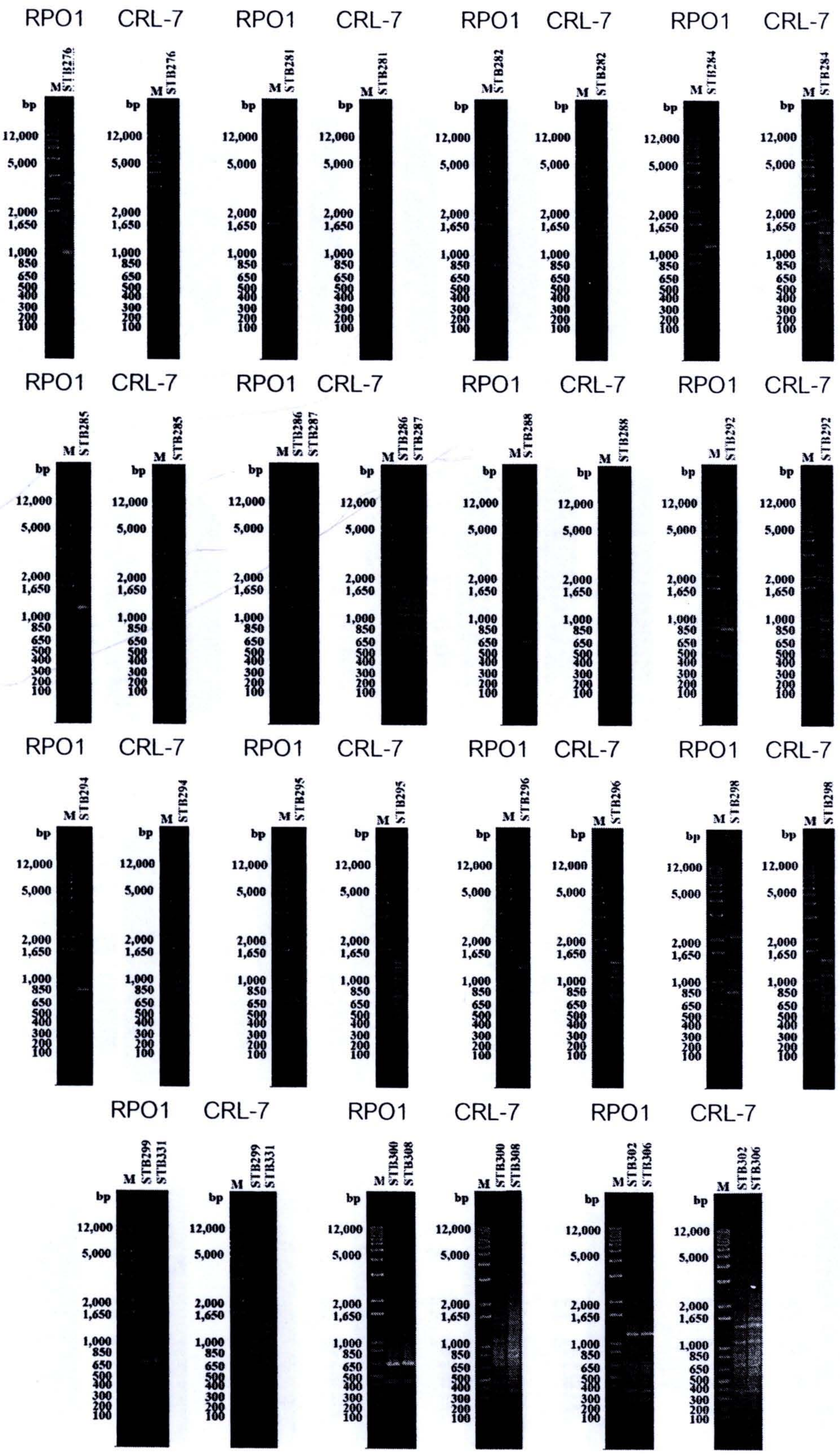
M STB275
M STB275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M STB282
M STB284
M STB285
M STB286 STB287
M STB288
M STB292
M STB294
M STB295
M STB296
M STB298
M STB299 STB331
M STB300 STB308
M STB302 STB306
bp
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200
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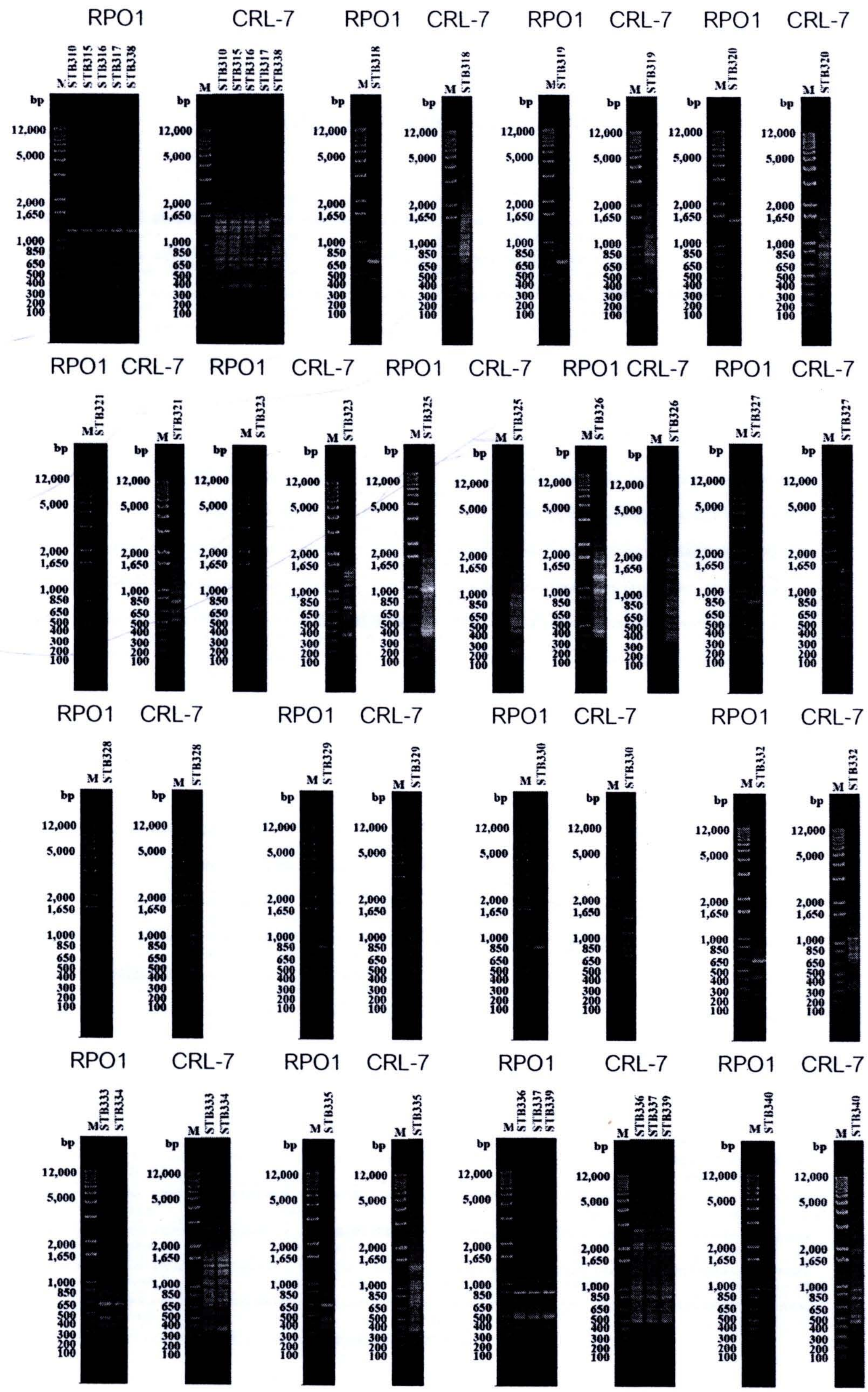

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CRL-7
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STB315
STB316
STB317
STB338
STB318
STB319
STB320
STB321
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STB326
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STB333
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STB336
STB337
STB339
STB340
bp
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5,000
2,000
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1,000
850
650
500
400
300
200
100

APPENDIX D

16S rDNA AND *nodY* SEQUENCES

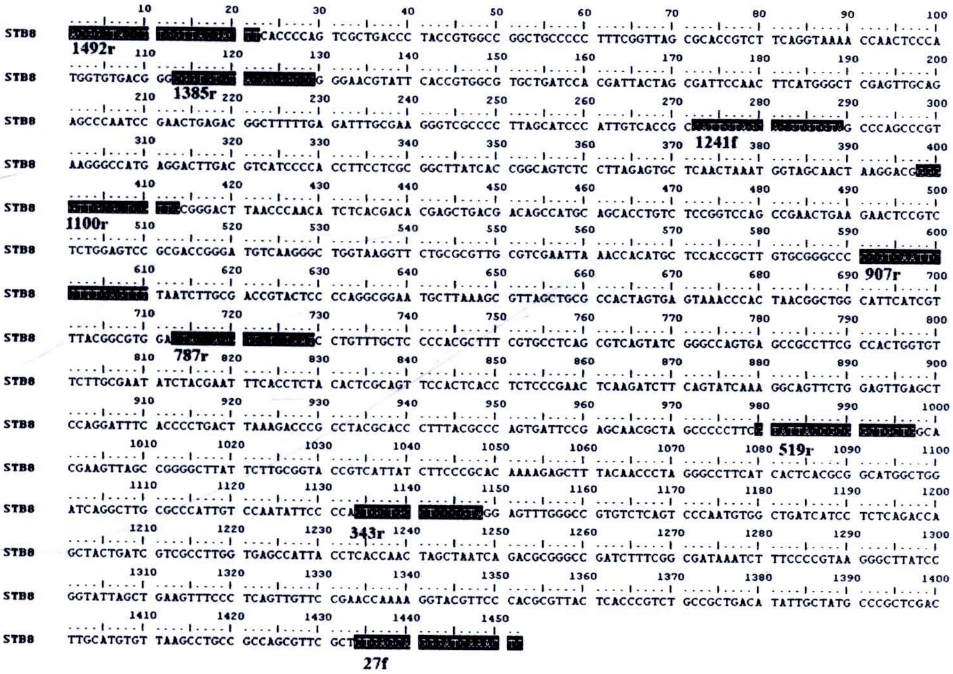

Figure G.1 16S rDNA sequence of *B. elkanii* STB8 with sequences of primers in boxes.

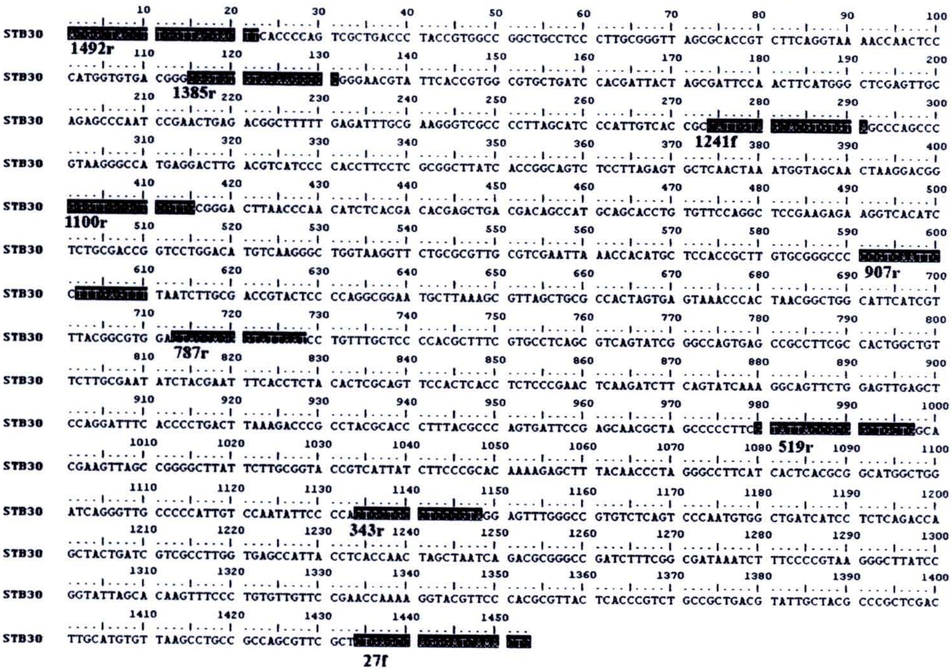

Figure G.2 16S rDNA sequence of *B. japonicum* STB30. Primer sequences in boxes.

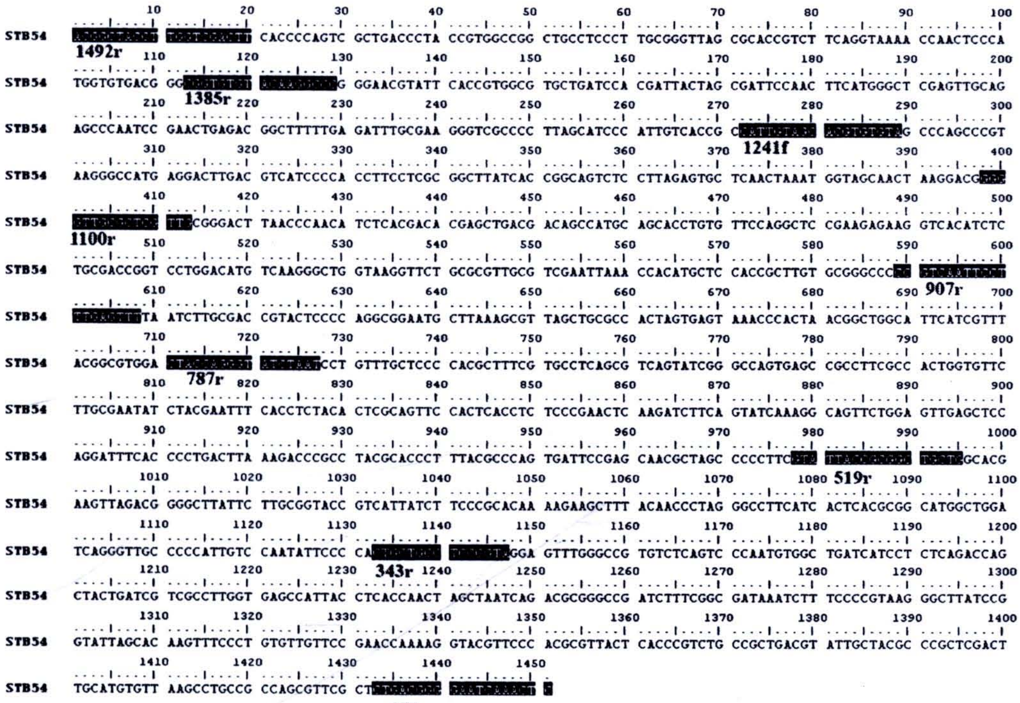

Figure G.3 16S rDNA sequence of *B. japonicum* STB54. Sequences of primers are in boxes.

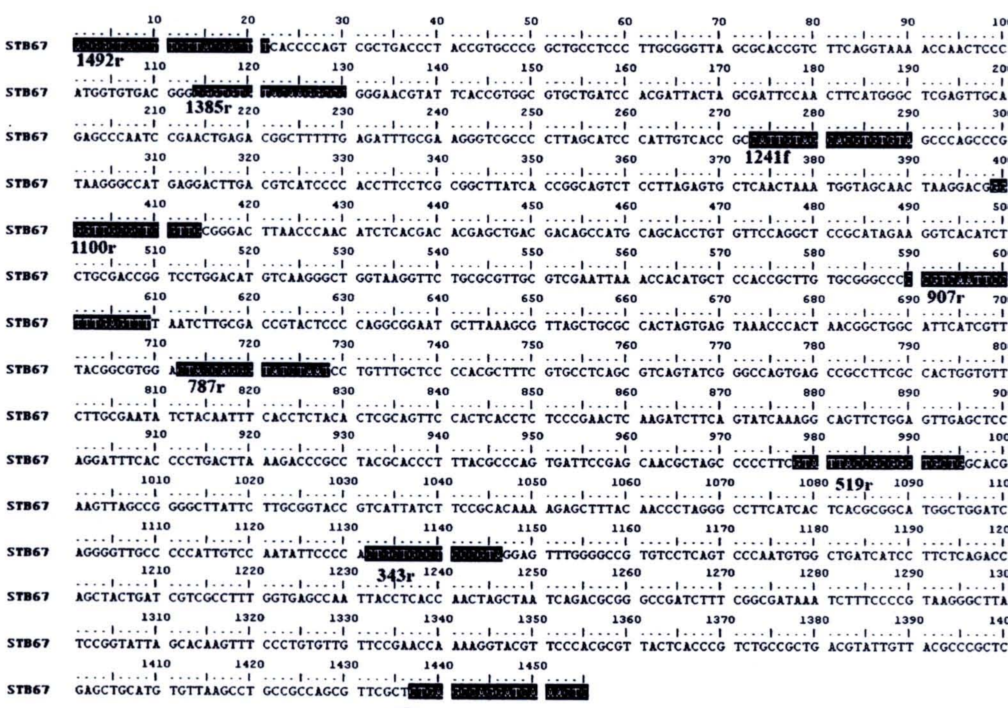

Figure G.4 16S rDNA sequence of *B. japonicum* STB67. Sequences of primers are in boxes.

```
STB96  [illegible] [illegible] [illegible]CACCCCAGT CGCTGACCCT ACCGTGGCCG GCTGCCTCCC TTGCGGGTTA GCGCACCGTC TTCAGGTAAA ACCAACTCCC
       1492r
STB96  ATGGTGTGAC GGG[illegible] [illegible] GGGAACGTAT TCACCGTGGC GTGCTGATCC ACGATTACTA GCGATTCCAA CTTCATGGGC TCGAGTTGCA
                     1385r
STB96  GAGCCCAATC CGAACTGAGA CGGCTTTTTG AGATTTGCGA AGGGTCGCCC CTTAGCATCC CATTGTCACC GC[illegible] [illegible] GCCCAGCCCG
                                                                                  1241f
STB96  TAAGGGCCAT GAGGACTTGA CGTCATCCCC ACCTTCCTCG CGGCTTATCA CCGGCAGTCT CCTTAGAGTG CTCAACTAAA TGGTAGCAAC TAAGGACG[illegible]
STB96  [illegible] [illegible]CGGGAC TTAACCCAAC ATCTCACGAC ACGAGCTGAC GACAGCCATG CAGCACCTGT GTTCCAGGCT CCGAAGAGAA GGTCACATCT
       1100r
STB96  CTGCGACCGG TCCTGGACAT GTCAAGGGCT GGTAAGGTTC TGCGCGTTGC GTCGAATTAA ACCACATGCT CCACCGCTTG TGCGGGCCC[illegible] [illegible]
                                                                                                        907r
STB96  [illegible]T AATCTTGCGA CCGTACTCCC CAGGCGGAAT GCTTAAAGCG TTAGCTGCGC CACTAGTGAG TAAACCCACT AACGGCTGGA TTCATCGTTT
STB96  ACGGCGTGGA [illegible] [illegible]CCT GTTTGCTCCC CACGCTTTCG TGCCTCAGCG TCAGTATCGG GCCAGTGAGC CGCCTTCGCC ACTGGTGTTC
                787r
STB96  TTGCGAATAT CTACGAATTT CACCTCTACA CTCGCAGTTC CACTCACCTC TCCCGAACTC AAGATCTTCA GTATCAAAGG CAGTTCTGGA GTTGAGCTCC
STB96  AGGATTTCAC CCCTGACTTA AAGACCCGCC TACGCACCCT TTACGCCCAG TGATTCCGAG CAACGCTAGC CCCCTTC[illegible] [illegible] [illegible]GCACG
                                                                                                519r
STB96  AAGTTAGCCG GGGCTTATTC TTGCGGTACC GTCATTATCT TCCCGCACAA AAGAGCTTTA CAACCCTAGG GCCTTCATCA CTCACGCGGC ATGGCTGGAT
STB96  CAGGGTTGCC CCCATTGTCC AATATTCCCC A[illegible] [illegible]GGAG TTTGGGCCGT GTCTCAGTCC CAATGTGGCT GATCATCCTC TCAGACCAGC
                                         343r
STB96  TACTGATCGT CGCCTTGGTG AGCCATTACC TCACCAACTA GCTAATCAGA CGCGGGCCGA TCTTTCGGCG ATAAATCTTT CCCCGTAAGG GCTTATCCGG
STB96  TATTAGCACA AGTTTCCCTG TGTTGTTCCG AACCAAAAGG TACGTTCCCA CGCGTTACTC ACCCGTCTGC CGCTGACGTA TTGCTACGCC CGCTCGACTT
STB96  GCATGTGTTA AGCCTGCCGC CAGCGTTCGC T[illegible] [illegible] [illegible]
                                         27f
```

Figure G.5 16S rDNA sequence of *B. japonicum* STB96. Sequences of primers are in boxes.

```
STB119 [illegible] [illegible] [illegible]CACCCCAGT CGCTGACCCT ACCGTGGCCG GCTGCCCCCT TTCGGTTAGC GCACCGTCTT CAGGCAAAAC CAACTCCCAT
       1492r
STB119 GGTGTGACGG G[illegible] [illegible]GG GAACGTATTC ACCGTGGCGT GCTGATCCAC GATTACTAGC GATTCCAACT TCATGGGCTC GAGTTGCAGA
                     1385r
STB119 GCCCAATCCG AACTGAGACG GCTTTTTGAG ATTTGCGAAG GGTCGCCCCT TAGCATCCCA TTGTCACCGC [illegible] [illegible]GC CCAGCCCGTA
                                                                                  1241f
STB119 AGGGCCATGA GGACTTGACG TCATCCCCAC CTTCCTCGCG GCTTATCACC GGCAGTCTCC TTAGAGTGCT CAACTAAATG GTAGCAACTA AGGACG[illegible]
STB119 [illegible] [illegible]CGGGACTT AACCCAACAT CTCACGACAC GAGCTGACGA CAGCCATGCA GCACCTGTCT CCGGTCCAGC CGAACTGAAG AACTCCGTCT
       1100r
STB119 CTGGAGTCCG CGACCGGGAT GTCAAGGGCT GGTAAGGTTC TGCGCGTTGC GTCGAATTAA ACCACATGCT CCACCGCTTG TGCGGGCCC[illegible] [illegible]
                                                                                                        907r
STB119 [illegible]T AATCTTGCGA CCGTACTCCC CAGGCGGAAT GCTTAAAGCG TTAGCTGCGC CACTAGTGAG TAAACCCACT AACGGCTGGC ATTCATCGTT
STB119 TACGGCGTGG A[illegible] [illegible]CC TGTTTGCTCC CCACGCTTTC GTGCCTCAGC GTCAGTATCG GGCCAGTGAG CCGCCTTCGC CACTGGTGTT
                787r
STB119 CTTGCGAATA TCTACGAATT TCACCTCTAC ACTCGCAGTT CCACTCACCT CTCCCGAACT CAAGATCTTC AGTATCAAAG GCAGTTCTGG AGTTGAGCTC
STB119 CAGGATTTCA CCCCTGACTT AAAGACCCGC CTACGCACCC TTTACGCCCA GTGATTCCGA GCAACGCTAG CCCCCTTC[illegible] [illegible] [illegible]GCAC
                                                                                                519r
STB119 GAAGTTAGCC GGGGCTTATT CTTGCGGTAC CGTCATTATC TTCCCGCACA AAAGAGCTTT ACAACCCTAG GGCCTTCATC ACTCACGCGG CATGGCTGGA
STB119 TCAGGCTTGC GCCCATTGTC CAATATTCCC CA[illegible] [illegible]GGA GTTTGGGCCG TGTCTCAGTC CCAATGTGGC TGATCATCCT CTCAGACCAG
                                         343r
STB119 CTACTGATCG TCGCCTTGGT GAGCCATTAC CTCACCAACT AGCTAATCAG ACGCGGGCCG ATCTTTCGGC GATAAATCTT TCCCCGTAAG GGCTTATCCG
STB119 GTATTAGCTG AAGTTTCCCT CAGTTGTTCC GAACCAAAAG GTACGTTCCC ACGCGTTACT CACCCGTCTG CCGCTGACAT ATTGCTATGC CCGCTCGACT
STB119 TGCATGTGTT AAGCCTGCCG CCAGCGTTCG CT[illegible] [illegible] [illegible]
                                         27f
```

Figure G.6 16S rDNA sequence of *B. elkanii* STB119 with sequences of primers in boxes.

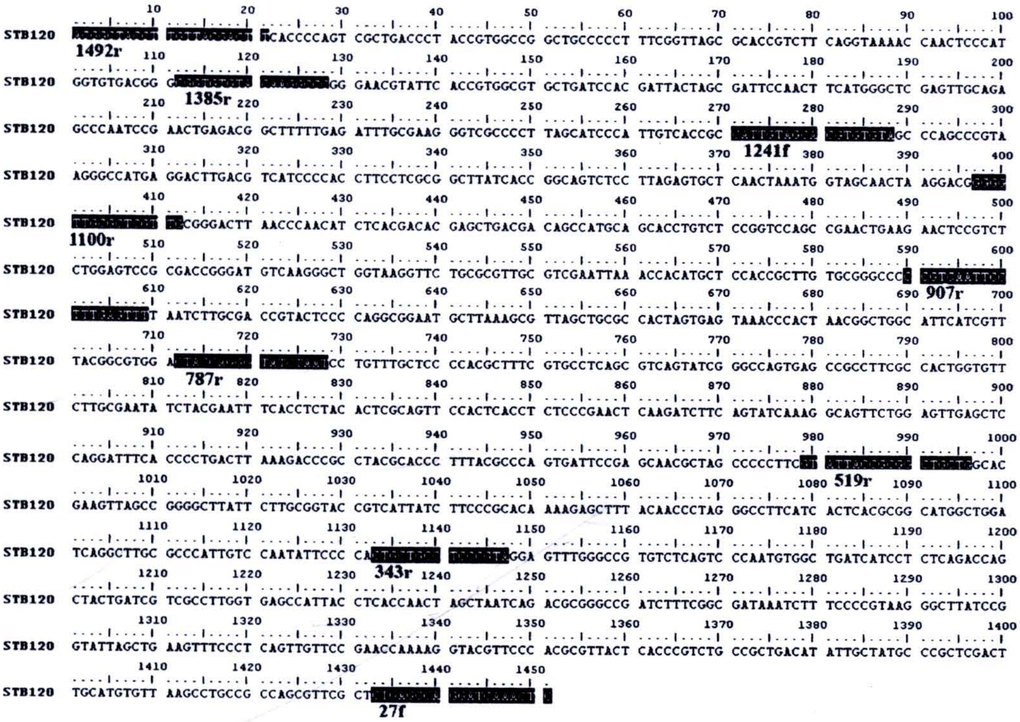

Figure G.7 16S rDNA sequence of *B. elkanii* STB120 with sequences of primers in boxes.

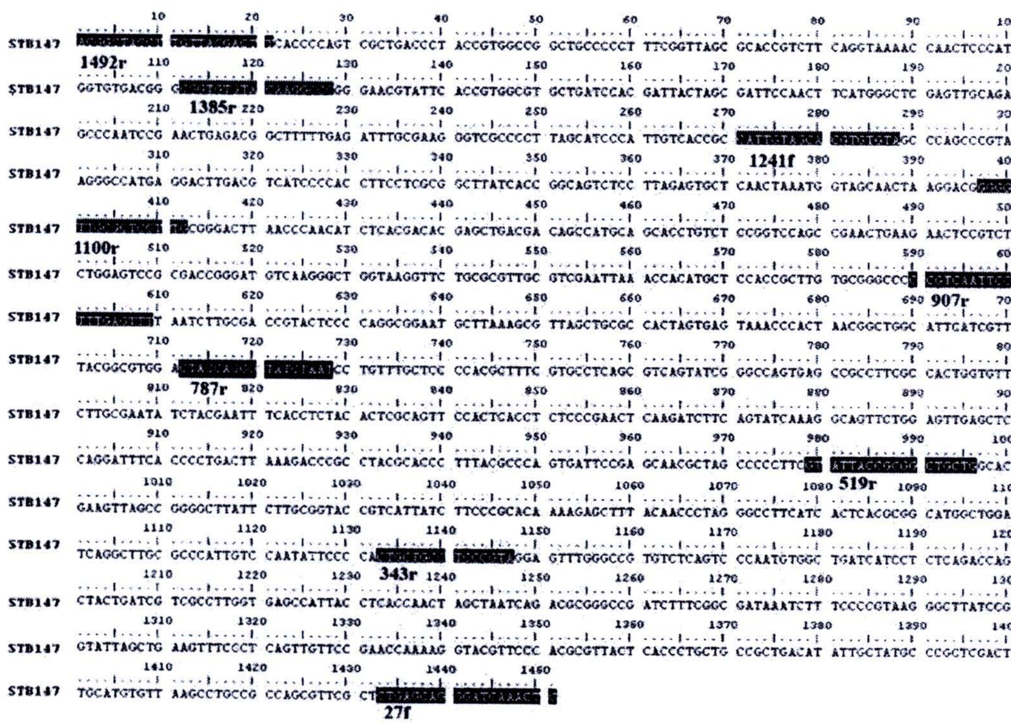

Figure G.8 16S rDNA sequence of *B.elkanii* STB147 with sequences of primers in boxes.

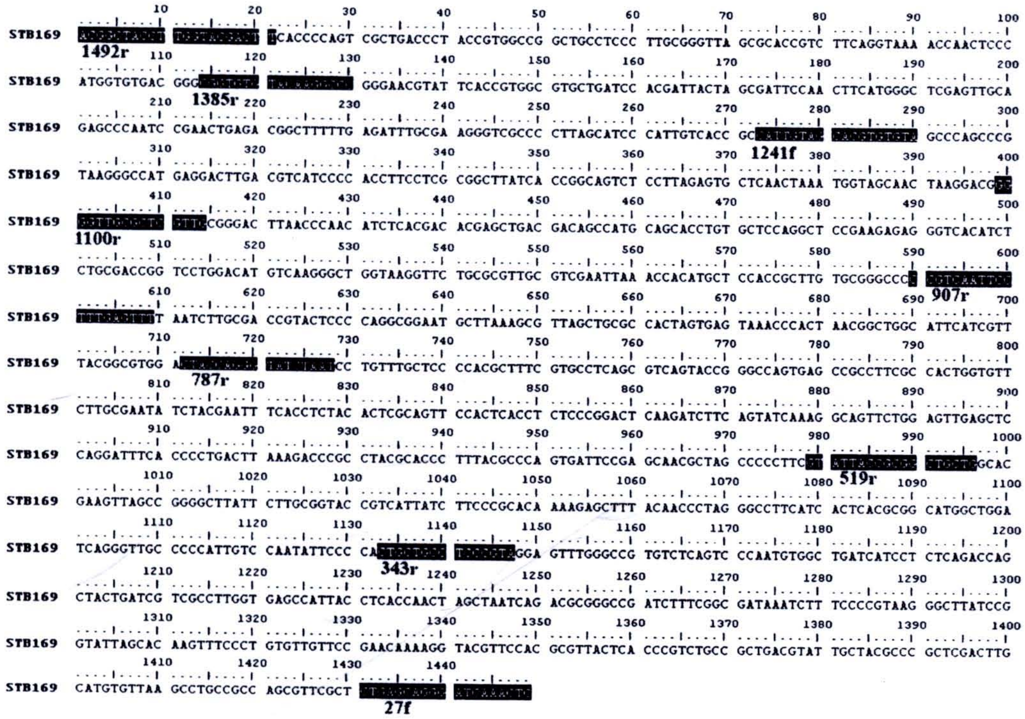

Figure G.9 16S rDNA sequence of *B. yuanmingense* STB169 with with sequences of primers in boxes.

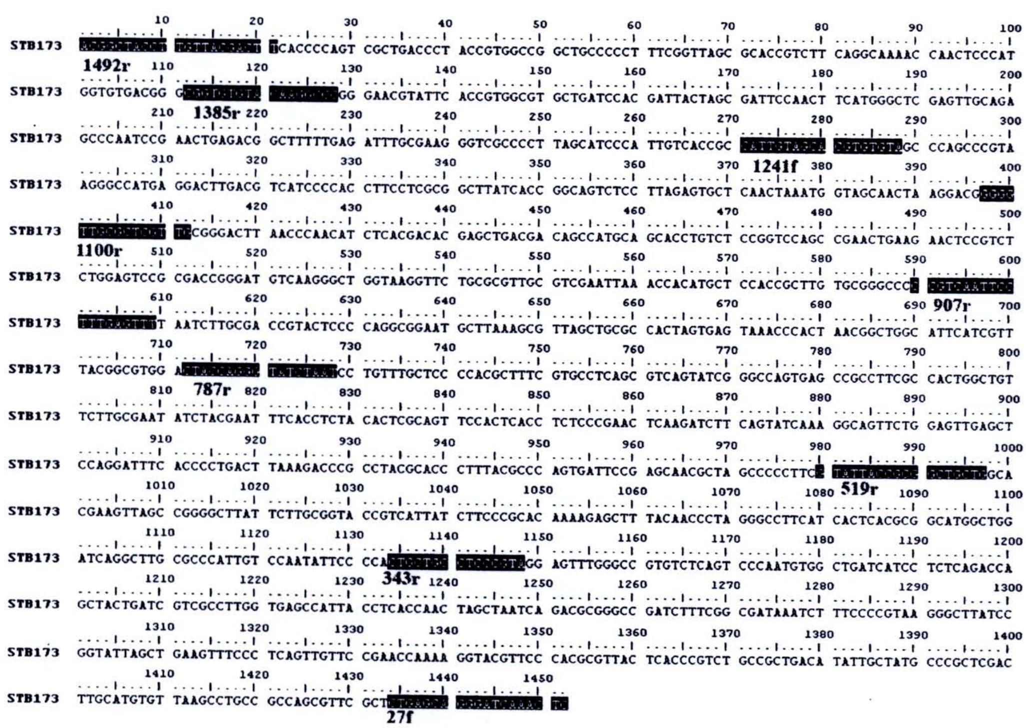

Figure G.10 16S rDNA sequence of *B. elkanii* STB173 with sequences of primers in boxes.

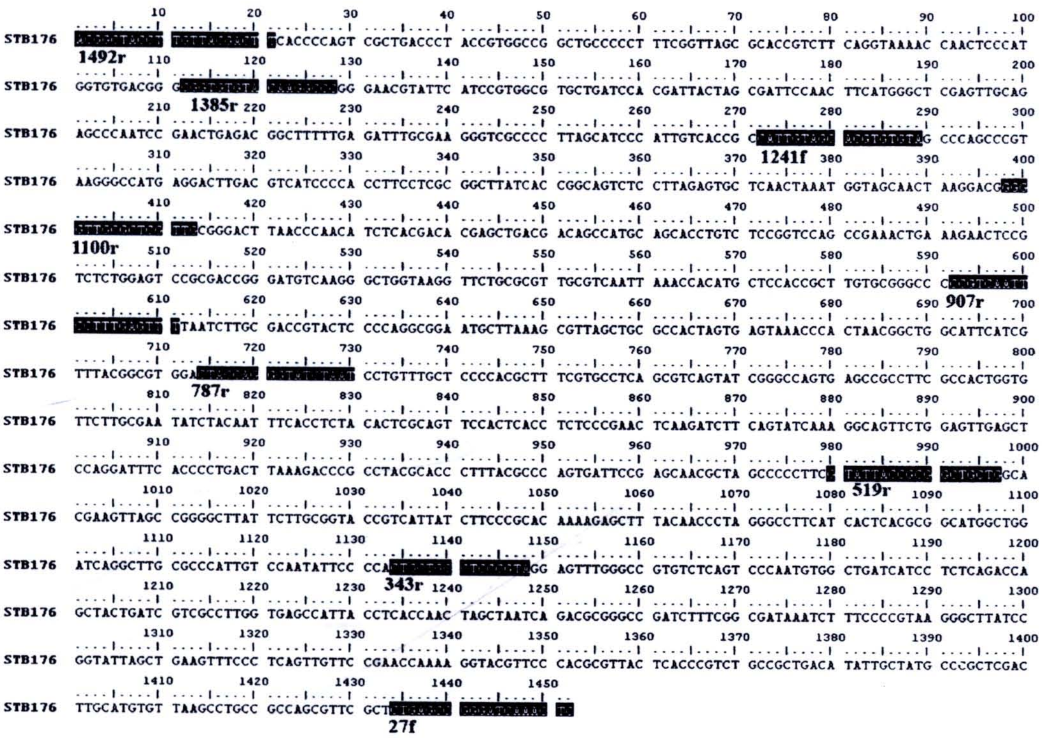

Figure G.11 16S rDNA sequence of *B. elkanii* STB176 with sequences of primers in boxes.

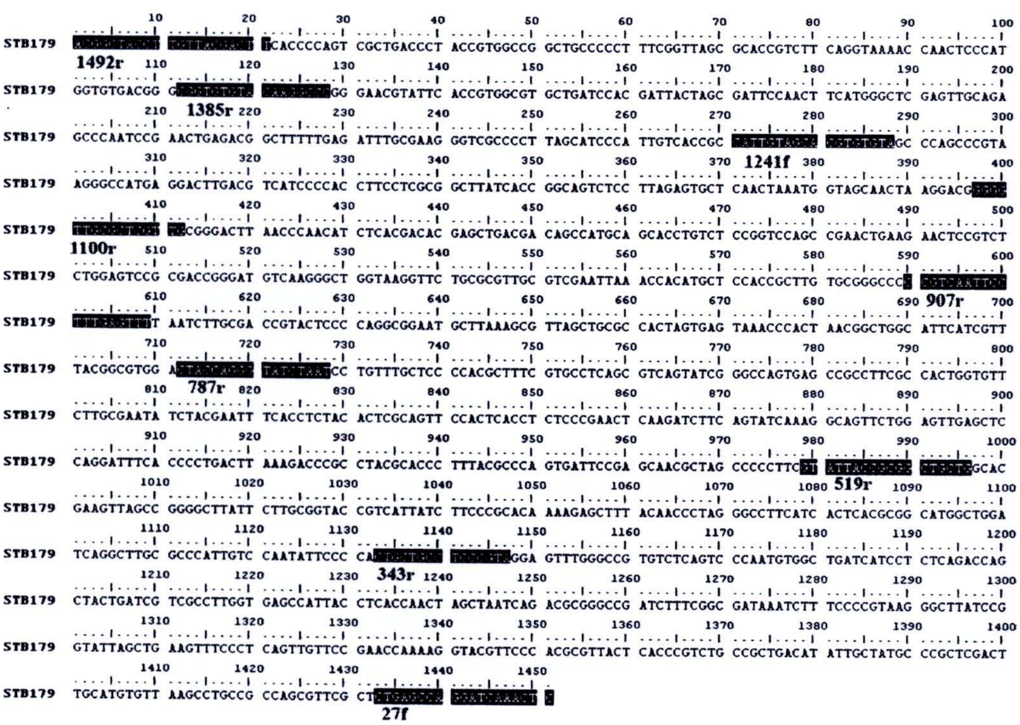

Figure G.12 16S rDNA sequence of *B. elkanii* STB179 with sequences of primers in boxes.

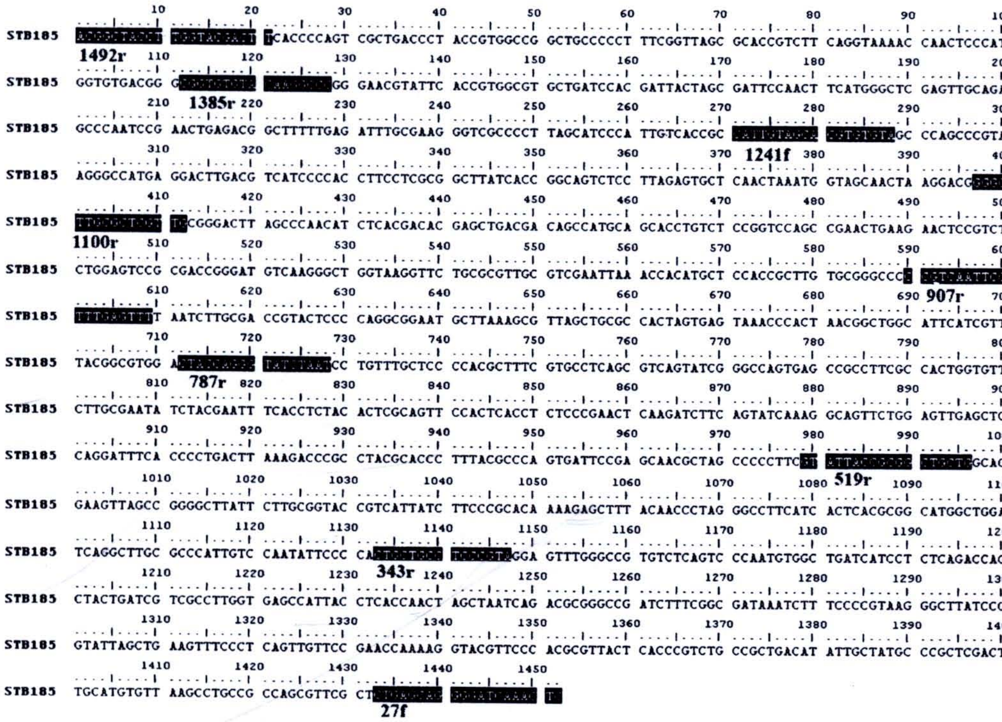

Figure G.13 Sequence of 16S rDNA of *B. elkanii* STB185 with sequences of primers in boxes.

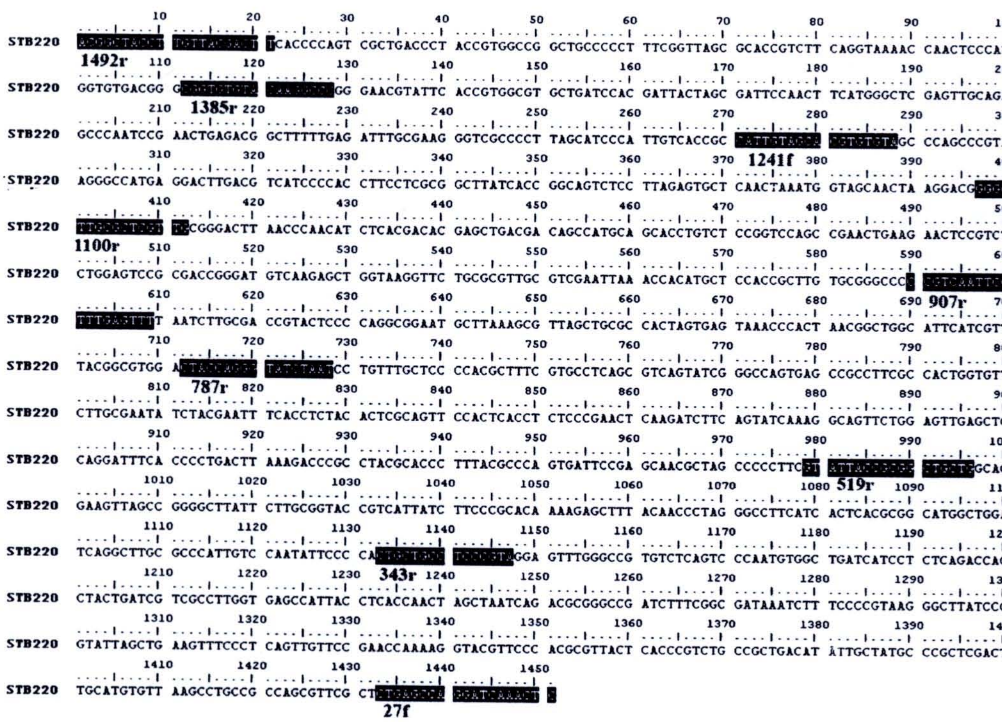

Figure G.14 Sequence of 16S rDNA of *B. elkanii* STB220 with sequences of primers in boxes.

Figure G.15 Sequence of 16S rDNA of *B. elkanii* STB238 with sequences of primers in boxes.

Figure G.16 Sequence of 16S rDNA of *B. japonicum* STB245 with sequences of primers in boxes.

```
STB264 [illegible] [illegible] CACCCCAGTC GCTGACCCTA CCGTGGCCGG CTGCCTCCCT TGCGGGTTAG CGCACCGTCT TCAGGTAAAA CCAACTCCCA
       1492r
STB264 TGGTGTGACG GG[illegible] [illegible]G GGAACGTATT CACCGTGGCG TGCTGATCCA CGATTACTAG CGATTCCAAC TTCATGGGCT CGAGTTGCAG
              1385r
STB264 AGCCCAATCC GAACTGAGAC GGCTTTTTGA GATTTGCGAA GGGTCGCCCC TTAGCATCCC ATTGTCACCG C[illegible] [illegible]G CCCAGCCCGT
                                                                                1241f
STB264 AAGGGCCATG AGGACTTGAC GTCATCCCCA CCTTCCTCGC GGCTTATCAC CGGCAGTCTC CTTAGAGTGC TCAACTAAAT GGTAGCAACT AAGGACG[illegible]
STB264 [illegible] [illegible]CGGGACT TAACCCAACA TCTCACGACA CGAGCTGACG ACAGCCATGC AGCACCTGTG CTCCAGGCTC GAAGAGAGGG TCACATCTCT
       1100r
STB264 GCGACCGGTC CTGGACATGT CAAGGGCTGG TAAGGTTCTG CGCGTTGCGT CGAATTAAAC CACATGCTCC ACCGCTTGTG CGGGCCC[illegible] [illegible]
                                                                                                  907r
STB264 [illegible]TAA TCTTGCGACC GTACTCCCCA GGCGGAATGC TTAAAGCGTT AGCTGCGCCA CTAGTGAGTA AACCCACTAA CGGCTGGCAT TCATCGTTTA
STB264 CGGCGTGGA[illegible] [illegible] [illegible]CCTG TTTGCTCCCC ACCCTTTCGT GCCTCAGCGT CAGTACCGGG CCAGTGAGCC GCCTTCGCCA CTGGTGTTCT
              787r
STB264 TGCGAATATC TACGAATTTC ACCTCTACAC TCGCAGTTCC ACTCACCTCT CCCGGACTCA AGATCTTCAG TATCAAAGGC AGTTCTGGAG TTGAGCTCCA
STB264 GGATTTCACC CCCTGACTTA AAGACCCGCC TACGCACCCT TTACGCCCAG TGATTCCGAG CAACGCTAGC CCCCTTC[illegible] [illegible] [illegible]GCACG
                                                                                           519r
STB264 AAGTTAGCCG GGGCTTATTC TTGCGGTACC GTCATTATCT TCCCGCACAA AAGAGCTTTA CAACCCTAGG GCCTTCATCA CTCACGCGGC ATGGCTGGAT
STB264 CAGGGTTGCC CCCATTGTCC AATATTCCCC A[illegible] [illegible]GGAG TTTGGGCCGT GTCTCAGTCC CAATGTGGCT GATCATCCTC TCAGACCAGC
                                   343r
STB264 TACTGATCGT CGCCTTGGTG AGCCATTACC TCACCAACTA GCTAATCAGA CGCGGGCCGA TCTTTCGGCG ATAAATCTTT CCCCGTAAGG GCTTATCCGG
STB264 TATTAGCACA AGTTTCCCTG TGTTGTTCCG AACCAAAAGG TACGTTCCCA CGCGTTACTC ACCCGTCTGC CGCTGACGTA TTGCTACGCC CGCTCGACTT
STB264 GCATGTGTTA AGCCTGCCGC CAGCGTTCGC T[illegible] [illegible]
                                   27f
```

Figure G.17 Sequence of 16S rDNA of *B. yuanmingense* STB264 with sequences of primers in boxes.

```
STB250 [illegible] [illegible] [illegible]CACCCCAGT CGCTGACACT ACCGTGGCCG GCTGCCTCCC TTGCGGGTTA GCGCACCGTC TTCAGGTAAA ACCAACTCCC
       1492r
STB250 ATGGTGTGAC GGG[illegible] [illegible] GGGAACGTAT TCACCGTGGC GTGCTGATCC ACGATTACTA GCGATTCCAA CTTCATGGGC TCGAGTTGCA
              1385r
STB250 GAGCCCAATC CGAACTGAGA CGGCTTTTTG AGATTTGCGA AGGGTCGCCC CTTAGCATCC CATTGTCACC GC[illegible] [illegible] GCCCAGCCCG
                                                                                1241f
STB250 TAAGGGCCAT GAGGACTTGA CGTCATCCCC ACCTTCCTCG CGGCTTATCA CCGGCAGTCT CCTTAGAGTG CTCAACTAAA TGGTAGCAAC TAAGGACG[illegible]
STB250 [illegible] [illegible]CGGGAC TTAACCCAAC ATCTCACGAC ACGAGCTGAC GACAGCCATG CAGCACCTGT GTTCCAGGCT CCGAAGAGAA GGTCACATCT
       1100r
STB250 CTGCGACCGG TCCTGGACAT GTCAAGGGCT GGTAAGGTTC TGCGCGTTGC GTCGAATTAA ACCACATGCT CCACCGCTTG TGCGGGCCC[illegible] [illegible]
                                                                                                  907r
STB250 [illegible]T AATCTTGCGA CCGTACTCCC CAGGCGGAAT GCTTAAAGCG TTAGCTGCGC CACTAGTGAG TAAACCCACT AACGGCTGGC ATTCATCGTT
STB250 TACGGCGTGG A[illegible] [illegible]CC TGTTTGCTCC CCACGCTTTC GTGCCTCAGC GTCAGTATCG GGCCAGTGAG CCGCCTTCGC CACTGGTGTT
              787r
STB250 CTTGCGAATA TCTACGAATT TCACCTCTAC ACTCGCAGTT CCACTCACCT CTCCCGAACT CAAGATCTTC AGTATCAAAG GCAGTTCTGG AGTTGAGCTC
STB250 CAGGATTTCA CCCCTGACTT AAAGACCCGC CTACGCACCC TTTACGCCCA GTGATTCCGA GCAACGCTAG CCCCCTTC[illegible] [illegible] [illegible]GCAC
                                                                                           519r
STB250 GAAGTTAGCC GGGGCTTATT CTTGCGGTAC CGTCATTATC TTCCCGCACA AAAGAGCTTT ACAACCCTAG GGCCTTCATC ACTCACGCGG CATGGCTGGA
STB250 TCAGGGTTGC CCCCATTGTC CAATATTCCC CA[illegible] [illegible]GGA GTTTGGGCCG TGTCTCAGTC CCAATGTGGC TGATCATCCT CTCAGACCAG
                                   343r
STB250 CTACTGATCG TCGCCTTGGT GAGCCATTAC CTCACCAACT AGCTAATCAG ACGCGGGCCG ATCTTTCGGC GATAAATCTT TCCCCGTAAG GGCTTATCCG
STB250 GTATTAGCAC AAGTTTCCCT GTGTTGTTCC GAACCAAAAG GTACGTTCCC ACGCGTTACT CACCCGTCTG CCGCTGACGT ATTGCTACGC CCGCTCGACT
STB250 TGCATGTGTT AAGCCTGCCG CCAGCGTTCG CT[illegible] [illegible] [illegible]
                                   27f
```

Figure G.18 Sequence of 16S rDNA of *B. japonicum* STB250 with sequences of primers in boxes.

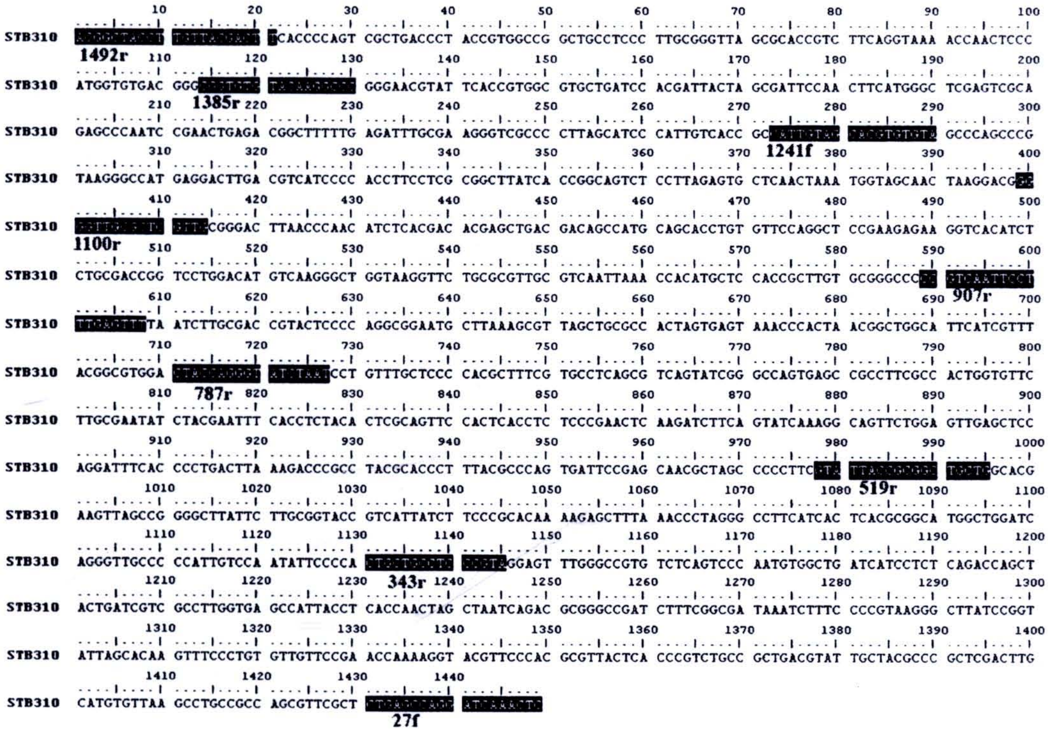

Figure G.19 Sequence of 16S rDNA of *B. japonicum* STB310 with sequences of primers in boxes.

Figure G.20 Sequence of 16S rDNA of *B. elkanii* STB327 with sequences of primers in boxes.

```
          10         20         30         40         50         60         70         80         90         100
STB8  [illegible] [illegible]TTA GATCAAGTCC CTTGAACCGC ATGTCGTGAG TCTATCCATC GTGTGGATGT GTTCTATCGA AACAATCGAT TTTACCAAAC
      nodYr 110        120        130        140        150        160        170        180        190        200
STB8  TGCGGATTGT TGGATAGCAA ACATCAGTTT GGAAAATGAA TTAGGTATGC CACGATGGCT ATTGGTCGTA CGCGGGCTCC GAGAAGAAAT CCTGGACGTG
          210        220        230        240        250        260        270        280        290        300
STB8  CGAGGATCTG CCGAATCCGT GTGCGAAGTG GCTATCTCTG CCGCACGCGC GTTGCGCCTG TTATAGGTGC GACTCTCACG CGATGCGACG CTAGGCAGGC
          310        320        330        340        350        360
STB8  CTCGATAAAC CTTCGTATGC GCGTTCCATC CCTTTCCATA TCGGC[illegible] [illegible] [illegible]
                                                     nodYf
```

Figure G.21 Sequence of *nodY* of *B. elkanii* STB8 with sequences of primers in boxes.

```
           10         20         30         40         50         60         70         80         90         100
STB30  [illegible] [illegible]TTAG ATCGAGTCCC TTGAACCGCA TGTTGTGAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAATT
       nodYr 110        120        130        140        150        160        170        180        190        200
STB30  GCGGGATGTT GGATAGCAAA CTGAAGTTTG AAAAAGTAAC CAGGCACACC ACAATGCTTT ATGGTCGTTC AGGTGAGCTC AGAGGAAAGC TCCTGGACGT
           210        220        230        240        250        260        270        280        290        300
STB30  GCGAGCGCGC CGCCGATTCC GTTTCATGGG CGTCTACAGG CGCGTCATGC GAGCCGTGTT GCGTCTCCGT GCGAAGTGCG CTCGTTTGGT CGGCAAGCGG
           310        320        330        340        350        360
STB30  GGTCCGATAA ACCTTGGTAT GGTGACGCCA TCCGTTTCCA TATTCGA[illegible] [illegible] [illegible]
                                                          nodYf
```

Figure G.22 Sequence of *nodY* of *B. japonicum* STB30 with sequences of primers in boxes.

```
           10         20         30         40         50         60         70         80         90         100
STB54  [illegible] [illegible]TTA GATCGAGTCC CTTGAACCGC ATGTTGTGAG TCTATCCATC GTGTGGATGT GTTCTATCGA AACAATCGAT TTTACCAAAT
       nodYr 110        120        130        140        150        160        170        180        190        200
STB54  TGCGGGATGT TGGATAGCAA ACTGAAGTTT GAAAAAGTAA CCAGGCACAC CACAATGCTT TATGGTCGTT CAGGTGAGCT CAGAGGAAAG CTCCTGGACG
           210        220        230        240        250        260        270        280        290        300
STB54  TGCGAGCGCG CCGCCGATTC CGTTTCATGG GCGTCTACAG GCGCGTCATG CGAGCCGTGT TGCGTCTCCG TGCGAAGTGC GCTCGTTTGG TCGGCAAGCG
           310        320        330        340        350        360
STB54  GGGTCCGATA AACCTTGGTA TGGTGACGCC ATCCGTTTCC ATATTCGA[illegible] [illegible] [illegible]
                                                           nodYf
```

Figure G.23 Sequence of *nodY* of *B. japonicum* STB54 with sequences of primers in boxes.

```
           10         20         30         40         50         60         70         80         90         100
STB67  [illegible] [illegible]TTAGA TCGAGTCCCT TGAACCGCAT GTTGTGAGTC TATCCATCGT GTGGATGTGT TCTATCGAAA CAATCGATTT TACCAAATTG
       nodYr 110        120        130        140        150        160        170        180        190        200
STB67  CGGGATGTTG GATAGCAAAC TGAAGTTTGA AAAAGTAACC AGGCACACCA CAATGCTTTA TGGTCGTTCA GGTGAGCTCA GAGGAAAGCT CCTGGACGTG
           210        220        230        240        250        260        270        280        290        300
STB67  CGAGCGCGCC GCCGATTCCG TTTCATGGGC GTCTACAGGC GCGTCATGCG AGCCGTGTTG CGTCTCCGTG CGAAGTGCGC TCGTTTGGTC GGCAAGCGGG
           310        320        330        340        350        360
STB67  GTCCGATAAA CCTTGGTATG GTGACGCCAT CCGTTTCCAT ATTCGA[illegible] [illegible] [illegible]
                                                         nodYf
```

Figure G.24 Sequence of *nodY* of *B. japonicum* STB67 with sequences of primers in boxes.

```
           10         20         30         40         50         60         70         80         90         100
STB96  [illegible] [illegible]TTAG ATCGAGTCCC TTGAACCGCA TGTTGTGAGT CTATCCATCG TGTGGATGTG TTTCTATCGA AACAATCGAT TTTACCAAAT
       nodYr 110        120        130        140        150        160        170        180        190        200
STB96  TGCGGGATGT TGGATAGCAA ACTGAAGTTT GAAAAAGTAA CCAGGCACAC CACAATGCTT TATGGTCGTT CAGGTGAGCT CAGAGGAAAG CTCCTGGACG
           210        220        230        240        250        260        270        280        290        300
STB96  TGCGAGCGCG CCGCCGATTC CGTTTCATGG GCGTCTACAG GCGCGTCATG CGAGCCGTGT TGCGTCTCCG TGCGAAGTGC GCTCGTTTGG TCGGCAAGCG
           310        320        330        340        350        360
STB96  GGGTCCGATA AACCTTGGTA TGGTGACGCC ATCCGTTTCC ATATTCGA[illegible] [illegible] [illegible]
                                                           nodYf
```

Figure G.25 Sequence of *nodY* of *B. japonicum* STB96 with sequences of primers in boxes.

```
         10         20         30         40         50         60         70         80         90         100
STB119   [illegible] TTAGATCAAG TCCCTTGAAC CGCATGTCGT GAGTCTATCC ATCGTGTGGA TGTGTTCTAT CGAAACAATC GATTTTACCA AACTGCGGAT
         nodYr
         110        120        130        140        150        160        170        180        190        200
STB119   TGTTGGATAG CAAACATCAG TTTGGAAAAT GAATTAGGTA TGCCACGATG GCTATTGGTC GTACGCGGGC TCCGAGAAGA AATCCTGGAC GTGCGAGGAT
         210        220        230        240        250        260        270        280        290        300
STB119   CTGCCGAATC CGTGTGCGAA GTGGCTATCT CTGCCGCACG CGCGTTGCGC CTGTTATAGG TGCGACTCTC ACGCGATGCG ACGCTAGGCA GGCCTCGATA
         310        320        330        340        350
STB119   AACCTTCGTA TGCGCGTTCC ATCCCTTTCC ATATCGGC[illegible]
                                                  nodYf
```

Figure G.26 Sequence of *nodY* of *B. elkanii* STB119 with sequences of primers in boxes.

```
         10         20         30         40         50         60         70         80         90         100
STB120   [illegible]TTAG ATCAAGTCCC TTGAACCGCA TGTCGTGAGC TCTATCCATC GCTGTGGATG TGTTCTATCG AAACAATCGA TTTTACCAAA
         nodYr
         110        120        130        140        150        160        170        180        190        200
STB120   CTGCGGATTG TTGGATAGCA AACATCAGTT TGGAAAATGA ATTAGGTATG CCACGATGGC TATTGGTCGT ACGCGGGCTC CGAGAAGAAA TCCTGGACGT
         210        220        230        240        250        260        270        280        290        300
STB120   GCGAGGATCT GCCGAATCCG TGTGCGAAGT GGCTATCTCT GCCGCACGCG CGTTGCGCCT GTTATAGGTG GACTCTCACG CGATGCGACG CTAGGCAGGC
         310        320        330        340        350        360
STB120   CTCGATAAAC CTTCGTATGC GCGTTCCATC CCTTTCCATA TCGGC[illegible]
                                                      nodYf
```

Figure G.27 Sequence of *nodY* of *B. elkanii* STB120 with sequences of primers in boxes.

```
         10         20         30         40         50         60         70         80         90         100
STB147   [illegible]TTAG ATCAAGTCCC TTGAACCGCA TGTCGTGAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAACT
         nodYr
         110        120        130        140        150        160        170        180        190        200
STB147   GCGGATTGTT GGATAGCAAA CATCAGTTTG GAAAATGAAT TAGGTATGCC ACGATGGCTA TTGGTCGTAC GCGGGCTCCG AGAAGAAATC CTGGACGTGC
         210        220        230        240        250        260        270        280        290        300
STB147   GAGGATCTGC CGAATCCGTG TGCGAAGTGG CTATCTCTGC CGCACGCGCG TTGCGCCTGT TATAGGTGCG ACTCTCACGC GATGCGACGC TAGGCAGGCC
         310        320        330        340        350
STB147   TCGATAAACC TTCGTATGCG CGTTCCATCC CTTTCCATAT CGGC[illegible]
                                                     nodYf
```

Figure G.28 Sequence of *nodY* of *B. elkanii* STB147 with sequences of primers in boxes.

```
         10         20         30         40         50         60         70         80         90         100
STB169   [illegible]TTAGA TCGAGTCCTT TGAACCGCAT GTTGTCAGTC TATCCATCGT GTGGATGTGT TCTATCGAAA CAATCGATTT TACCAAATTG
         nodYr
         110        120        130        140        150        160        170        180        190        200
STB169   CGGGATGTTG GATAGCAAAC TGAAGTTTGA AAAAGTAATT AGGCACACCA CAATGGTTTA TCGTCGTTTA GGTGAGCTCA GAGAAAAGCG CGTAGACGTG
         210        220        230        240        250        260        270        280        290        300
STB169   CGAGCGCACC GCCCCATCTG TTTCATGGGC GTCTATACGC GCGGCGTGCG AGCCGTGTTG CTTCTCCGTG CGAAGCGCGC TCGTTTCGAC GCTAAGCGGA
         310        320        330        340        350        360
STB169   GCCTGATAAA CGTTGGTATG CGGATTTCAT CCGTTTCCAT ATTTGG[illegible]
                                                       nodYf
```

Figure G.29 Sequence of *nodY* of *B. yuanmingense* STB169 with sequences of primers in boxes.

```
         10         20         30         40         50         60         70         80         90         100
STB173   [illegible]TTA GATCAAGTCC CTTGAACCGC ATGTCGTGAG TCTATCCATC GTGTGGATGT GTTCTATCGA AACAATCGAT TTTACCAAAC
         nodYr
         110        120        130        140        150        160        170        180        190        200
STB173   TGCGGATTGT TGGATAGCAA ACATCAGTTT GGAAAATGAA TTAGGTATGC CACGATGGCT ATTGGTCGTA CGCGGGCTCC GAGAAGAAAT CCTGGACGTG
         210        220        230        240        250        260        270        280        290        300
STB173   CGAGGATCTG CCGAATCCGT GTGCGAAGTG GCTATCTCTG CCGCACGCGC GTTGCGCCTG TTATAGGTGC GACTCTCACG CGATGCGACG CTAGGCAGGC
         310        320        330        340        350        360
STB173   CTCGATAAAC CTTCGTATGC GCGTTCCATC CCTTTCCATA TCGGC[illegible]
                                                      nodYf
```

Figure G.30 Sequence of *nodY* of *B. elkanii* STB173 with sequences of primers in boxes.

```
STB176  [illegible] [illegible]TTAG ATCAAGTCCC TTGAACCGCA TGTCGTGAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAACT
        nodYr
STB176  GCGGATTGTT GGATAGCAAA CATCAGTTTG GAAAATGAAT TATGTATGCC ACGATGGCTA TTGGTCGTAC GCGGGCTCCG AGAAGAAATC CTGGACGTGC
STB176  GAGGATCTGC CGAATCCGTG TGCGAAGTGG CTATCTCTGC CGCACGCGCG TTGCGCCTGT TATAGGTGCG ACTCTCACGC GATGCGACGC TAGGCAGGCC
STB176  TCGATAAACC TTCGTATGCG CGTCCTATCC CTTTCCATAT CGGC[illegible] [illegible]
                                                      nodYf
```

Figure G.31 Sequence of *nodY* of *B. elkanii* STB176 with sequences of primers in boxes.

```
STB179  [illegible] [illegible]TTAG ATCAAGTCCC TTGAACCGCA TGTCGTGAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAACT
        nodYr
STB179  GCGGATTGTT GGATAGCAAA CATCAGTTTG GAAAATGAAT TAGGTATGCC ACGATGGCTA TTGGTCGTAC GCGGGCTCCG AGAAGAAATC CTGGACGTGC
STB179  GAGGATCTGC CGAATCCGTG TGCGAAGTGG CTATCTCTGC CGCACGCGCG TTGCGCCTGT TATAGGTGCG ACTCTCACGC GATGCGACGC TAGGCAGGCC
STB179  TCGATAAACC TTCGTATGCG CGTTCCATCC CTTTCCATAT CGGC[illegible] [illegible]
                                                      nodYf
```

Figure G.32 Sequence of *nodY* of *B. elkanii* STB179 with sequences of primers in boxes.

```
STB185  [illegible] [illegible]TTA GATCAAGTCC CTTGAACCGC ATGTCGTGAG TCTATCCATC GTGTGGATGT GTTCTATCGA AACAATCGAT TTTACCAAAC
        nodYr
STB185  TGCGGATTGT TGGATAGCAA ACATCAGTTT GGAAAATGAA TTAGGTATGC CACGATGGCT ATTGGTCGTA CGCGGGCTCC GAGAAGAAAT CCTGGACGTG
STB185  CGAGGATCTG CCGAATCCGT GTGCGAAGTG GCTATCTCTG CCGCACGCGC GTTGCGCCTG TTATAGGTGC GACTCTCACG CGATGCGACG CTAGGCAGGC
STB185  CTCGATAAAC CTTCGTATGC GCGTTCCATC CCTTTCCATA TCGGC[illegible] [illegible]
                                                       nodYf
```

Figure G.33 Sequence of *nodY* of *B. elkanii* STB185 with sequences of primers in boxes.

```
STB220  [illegible] [illegible]TTAGA TCAAGTCCCT TGAACCGCAT GTCGTGAGTC TATCCATCGT GTGGATGTGT TCTATCGAAA CAATCGATTT TACCAAACTG
        nodYr
STB220  CGGAAGGTTG GATAGCAAAC ATCAGTTTGG AAGATGAATT AGGTATGCCA CAATGGCTAT TGGTCGTACG CGGGCTCCGA GAAGAAATCC TGGACGTGCG
STB220  AGCACCTGCC GATTCCGTGT GCGAAGTGGC TATCTCTGCC GCACGCGAGT TGCGCCTCTT GTAGGTGCGA CTCTCACGCG ATGCGACGCT AGGCAGGCGC
STB220  CGATAAACCT TCGTATGCGT GTTCCATCCC TTTCCATATC GGC[illegible] [illegible]
                                                     nodYf
```

Figure G.34 Sequence of *nodY* of *B. elkanii* STB220 with sequences of primers in boxes.

```
STB238  [illegible] [illegible]TTAGA TCAAGTCCCT TGAACCGCAT GTCGTGAGTC TATCCATCGT GTGGATGTGT TCTATCGAAA CAATCGATTT TACCAAACTG
        nodYr
STB238  CGGATTGTTG GATAGCAAAC ATCAGTTTGG AAAATGAATT AGGTATGCCA CGATGGCTAT TGGTCGTACG CGGGCTCCGA GAAGAAATCC TGGACGTGCG
STB238  AGGATCTGCC GAATCCGTGT GCGAAGTGGC TATCTCTGCC GCACGCGCGT TGCGCCTGTT ATAGGTGCGA CTCTCACGCG ATGCGACGCT AGGCAGGCCT
STB238  CGATAAACCT TCGTATGCGC GTTCCATCCC TTTCCATATC GGC[illegible] [illegible]
                                                     nodYf
```

Figure G.35 Sequence of *nodY* of *B. elkanii* STB238 with sequences of primers in boxes.

```
                 10         20         30         40         50         60         70         80         90        100
STB245  [illegible] [illegible]TTAGA TCAAGTCCCT TGAACCGCAT GTCGTGAGTC TATCCATCGT GTGGATGTGT TCTATCGAAA CAATCGATTT TACCAAACTG
        nodYr   110        120        130        140        150        160        170        180        190        200
STB245  CGGATTGTTG GATAGCAAAC ATCAGTTTGG AAAATGAATT AGGTATGCCA CGATGGCTAT TGGTCGTACG CGGGCTCCGA GAAGAAATCC TGGACGTGCG
                210        220        230        240        250        260        270        280        290        300
STB245  AGGATCTGCC GAATCCGTGT GCGAAGTGGC TATCTCTGCC GCACGCGCGT TGCGCCTGTT ATAGGTGCGA CTCTCACGCG ATGCGACGCT AGGCAGGCCT
                310        320        330        340        350
STB245  CGATAAACCT TCGTATGCGC GTTCCATCCC TTTCCATATC GGC[illegible] [illegible]
                                                      nodYf
```

Figure G.36 Sequence of *nodY* of *B. elkanii* STB245 with sequences of primers in boxes.

```
                 10         20         30         40         50         60         70         80         90        100
STB250  [illegible] [illegible]TTAG ATCGAGTCCC TTGAACCGCA TGTTGTGAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAATT
        nodYr   110        120        130        140        150        160        170        180        190        200
STB250  GCGGGATGTT GGATAGCAAA CTGAAGTTTG AAAAAGTAAC CAGGCACACC ACAATGCTTT ATGGTCGTTC AGGTGAGCTC AGAGGAAAGC TCCTGGACGT
                210        220        230        240        250        260        270        280        290        300
STB250  GCGAGCGCGC CGCCGATTCC GTTTCATGGG CGTCTACAGG CGCGTCATGC GAGCCGTGTT GCGTCTCCGT GCGAAGTGCG CTCGTTTGGT CGGCAAGCGG
                310        320        330        340        350        360
STB250  GGTCCGATAA ACCTTGGTAT GGTGACGCCA TCCGTTTCCA TATTCGA[illegible] [illegible] [illegible]
                                                          nodYf
```

Figure G.37 Sequence of *nodY* of *B. japonicum* STB250 with sequences of primers in boxes.

```
                 10         20         30         40         50         60         70         80         90        100
STB264  [illegible] [illegible]TTAG ATCGAGTCCT TTGAACCGCA TGTTGTCAGT CTATCCATCG TGTGGATGTG TTCTATCGAA ACAATCGATT TTACCAAATT
        nodYr   110        120        130        140        150        160        170        180        190        200
STB264  GCGGGATGTT GGATAGCAAA CTGAAGTTTG AAAAAGTAAC CAGGCACACC ACAACGGATT TTGGTCGTTC AGGTGAGCTC AGAGGAAAGC TCCTGGACGT
                210        220        230        240        250        260        270        280        290        300
STB264  GCGAGCGCGC CGCCGAGTCC GTTTCATGGC CGTCTACAGG CGCGGCATGC GAGCCGTGTT GCGCCTCCGT GCGAAGTGCG CTCGTTTGGT CGGCAAGCGG
                310        320        330        340        350        360
STB264  CGTCCGATAA ACCTTGGTAT GGGGATGCCA TCCGTTTCCA TATTCGA[illegible] [illegible] [illegible]
                                                          nodYf
```

Figure G.38 Sequence of *nodY* of *B. yuanmingense* STB264 with sequences of primers in boxes.

```
                 10         20         30         40         50         60         70         80         90        100
STB310  [illegible] [illegible]TTAGAT CGAGTCCCTT GAACCGCATG TTGTGAGTCT ATCCATCGTG TGGATGTGTT CTATCGAAAC AATCGATTTT ACCAAATTGC
        nodYr   110        120        130        140        150        160        170        180        190        200
STB310  GGGATGTTGG ATAGCAAACT GAAGTTTGAA AAAGTAACCA GGCACACCAC AATGCTTTAT GGTCGTTCAG GTGAGCTCAG AGGAAAGCTC CTGGACGTGC
                210        220        230        240        250        260        270        280        290        300
STB310  GAGCGCGCCG CCGATTCCGT TTCATGGGCG TCTACAGGCG CGTCATGCGA GCCGTGTTGC GTCTCCGTGC GAAGTGCGCT CGTTTGGTCG GCAAGCGGGG
                310        320        330        340        350        360
STB310  TCCGATAAAC CTTGGTATGG TGACGCCATC CGTTTCCATA TTCGA[illegible] [illegible]
                                                       nodYf
```

Figure G.39 Sequence of *nodY* of *B. japonicum* STB310 with sequences of primers in boxes.

```
                 10         20         30         40         50         60         70         80         90        100
STB327  [illegible] [illegible]TTAGAT CAAGTCCCTT GAACCGCATG TCGTGAGTCT ATCCATCGTG TGGATGTGTT CTATCGAAAC AATCGATTTT ACCAAACTGC
        nodYr   110        120        130        140        150        160        170        180        190        200
STB327  GGATTGTTGG ATAGCAAACA TCAGTTTGGA AAATGAATTA GGTATGCCAC GATGGCTATT GGTCGTACGC GGGCTCCGAG AAGAAATCCT GGACGTGCGA
                210        220        230        240        250        260        270        280        290        300
STB327  GGATCTGCCG AATCCGTGTG CGAAGTGGCT ATCTCTGCCG CACGCGCGTT GCGCCTGTTA TAGGTGCGAC TCTCACGCGA TGCGACGCTA GGCAGGCCTC
                310        320        330        340
STB327  GATAAACCTT CGTATGCGCG TTCCATCCCT TTCCATATCG GC[illegible]
                                                   nodYf
```

Figure G.40 Sequence of *nodY* of *B. elkanii* STB327 with sequences of primers in boxes.

APPENDIX E

SUMMARY OF ABILITY/INABILITY OF THREE REFERENCE STRAINS AND THREE REPRESENTATIVE STB STRAINS TO USE 95 CARBON AND NITROGEN SOURCES

Table G.1 Determination of ability/inability to utilize 95 carbon/nitrogen sources by reference strains and by *Bradyrhizobium elkanii* strain STB 327.

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB327 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
α-Cyclodextrin	-	-	-	-	-	-	-
Dextrin	+	+	+	-	+	+	+
Glycogen	-	-	+	-	-	+	-
Tween 40	++	++	++	++	++	++	++
Tween 80	++	++	++	++	++	++	++
N-Acetyl-D-Galactosamine	-	-	-	-	-	-	-
N-Acetyl-D-Glucosamine	-	-	-	-	-	-	-
Adonitol	+	-	-	-	+	+	+
L-Arabinose	++	++	++	+	+	+	+
D-Arabitol	+	++	-	+	+	+	+
D-Cellobiose	-	+	-	-	-	-	-
i-Erythritol	-	-	-	-	-	-	-
D-Fructose	+	+	-	+	+	+	+
L-Fucose	+	-	-	+	+	+	+
D-Galactose	+	+	+	+	+	+	+
Gentiobiose	-	-	-	-	-	-	-
α-D-Glucose	++	++	++	+	+	+	+

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB327 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
m-Inositol	-	-	-	-	-	-	-
α-D-Lactose	-	-	-	-	-	-	-
Lactulose	-	-	-	-	+	++	+
Maltose	-	-	-	-	-	-	-
D-Mannitol	++	++	++	+	+	+	+
D-Mannose	++	++	++	-	-	-	-
D-Melibiose	-	-	-	-	-	-	-
β-Methyl-D-Glucoside	+	-	-	-	-	-	-
D-Psicose	+	-	-	+	+	+	+
D-Raffinose	-	-	-	-	-	-	-
L-Rhamnose	-	+	-	-	-	+	-
D-Sorbitol	+	-	-	-	+	+	+
Sucrose	-	-	-	-	-	-	-
D-Trehalose	-	-	-	-	-	+	-
Turanose	-	-	-	-	+	-	-
Xylitol				-	+	-	-
Pyruvic Acid Methyl Ester	+++	+++	+++	+	++	++	++
Succinic Acid Mono-Methyl-Ester	+++	+++	+++	+	+	++	+
Acetic Acid	+++	+++	+++	+	+	+	+
Cis-Aconitic Acid	-	-	-	+	+	-	+
Citric Acid	+	-	-	+	+	+	+
Formic Acid	+	+	-	+	++	++	++
D-Galactonic Acid Lactone	++	++	-	+	+	++	+
D-Galacturonic Acid	+	-	-	-	+	+	+
D-Gluconic Acid	++	++	++	+	+	+	+

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB327 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
D-Glucosaminic Acid	+	-	-	+	+	+	+
D-Glucuronic Acid	+	-	-	-	+	+	+
α-Hydroxybutyric Acid	-	++	++	-	-	-	-
β-Hydroxybutyric Acid	+++	+++	+++	++	++	++	++
γ-Hydroxybutyric Acid	+++	+++	+++	+	+	++	+
p-Hydroxy Phenylacetic Acid	+	-	+	-	+	+	+
Itaconic acid	-	++	++	-	-	+	-
α-Keto Butyric Acid	-	++	+	-	-	-	-
α-Keto Glutaric Acid	+	++	+	+	+	+	+
α-Keto Valeric Acid	-	++	+	-	-	-	-
D,L-Lactic Acid	+++	+++	+++	+	++	++	++
Malonic Acid	+	-	+	-	+	+	+
Propionic Acid	++	++	++	+	+	++	+
Quinic Acid	+	-	-	-	+	++	+
D-Saccharic Acid	+++	+++	+	++	++	++	++
Sebacic Acid	+	-	+	+	++	++	++
Succinic Acid	+++	+++	+++	+	+	+	+
Bromosuccinic Acid	++	++	++	+	+	+	+
Succinamic Acid	+++	+++	+++	++	++	++	++
Glucuronamide	+	-	-	+	-	+	+
L-Alaninamide	+	++	-	+	+	+	+
D-Alanine	+	-	-	+	+	+	+
L-Alanine	+	-	+	-	+	+	+
L-Alanyl-glycine	+	+	-	-	+	+	+
L-Asparagine	+	-	-	-	+	+	+
L-Aspartic Acid	+	-	+	-	++	++	++
L-Glutamic Acid	+	-	-	+	++	++	++

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB327 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
Glycyl-L-Aspartic Acid	+	-	-	-	+	+	+
Glycyl-L-Glutamic Acid	-	-	+	-	+	-	-
L-Histidine	-	-	-	-	-	-	-
Hydroxy-L-Proline	-	-	-	-	-	-	-
L-Leucine	+	++	++	+	+	+	+
L-Ornithine	-	-	+	-	-	-	-
L-Phenylalanine	+	++	+	-	+	+	+
L-Proline	+	++	-	-	+	+	+
L-Pyroglutamic Acid	++	++	++	+	+	+	+
D-Serine	+	-	-	+	+	+	+
L-Serine	+	-	-	-	+	+	+
L-Threonine	-	+	-	-	-	-	-
D,L-Carnitine	-	-	-	-	+	-	-
γ-Amino Butyric Acid	-	+	-	-	-	+	-
Urocanic Acid	-	-	-	+	-	-	-
Inosine	-	-	-	-	-	-	-
Uridine	-	-	-	-	-	-	-
Thymidine	-	-	-	-	-	-	-
Phenyethyl-amine	-	-	-	-	-	+	-
Putrescine	-	-	-	-	-	-	-
2-Aminoethanol	-	-	-	-	-	-	-
2,3-Butanediol	+	-	-	-	+	+	+
Glycerol	+	++	+	+	+	+	+
D,L-α-Glycerol Phosphate	+	-	-	-	+	+	+
α-D-Glucose-1-Phosphate	-	-	-	-	-	-	-
D-Glucose-6-	-	-	-	-	+	-	-

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB327 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
Phosphate							

Table G.2 Determination of ability/inability to utilize 95 carbon/nitrogen sources by reference strains and by *Bradyrhizobium japonicum* strain STB 310.

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB310 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
α-Cyclodextrin	-	-	-	+	+	-	+
Dextrin	+	+	+	+	+	+	+
Glycogen	-	-	+	-	-	-	-
Tween 40	++	++	++	++	++	++	++
Tween 80	++	++	++	++	+++	+++	+++
N-Acetyl-D-Galactosamine	-	-	-	-	-	-	-
N-Acetyl-D-Glucosamine	-	-	-	-	-	-	-
Adonitol	+	-	-	-	-	-	-
L-Arabinose	++	++	++	++	++	++	++
D-Arabitol	+	++	-	++	+	++	++
D-Cellobiose	-	+	-	++	+	-	+
i-Erythritol	-	-	-	-	-	-	-
D-Fructose	+	+	-	+	+	++	+
L-Fucose	+	-	-	-	-	-	-
D-Galactose	+	+	+	+	+	-	+

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB310 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
Gentiobiose	-	-	-	-	-	-	-
α-D-Glucose	++	++	++	++	++	++	++
m-Inositol	-	-	-	-	-	-	-
α-D-Lactose	-	-	-	-	-	-	-
Lactulose	-	-	-	-	-	-	-
Maltose	-	-	-	-	-	-	-
D-Mannitol	++	++	++	++	+	++	++
D-Mannose	++	++	++	++	++	++	++
D-Melibiose	-	-	-	-	-	-	-
β-Methyl-D-Glucoside	+	-	-	-	-	-	-
D-Psicose	+	-	-	-	-	-	-
D-Raffinose	-	-	-	-	-	-	-
L-Rhamnose	-	+	-	+	+	-	+
D-Sorbitol	+	-	-	-	-	-	-
Sucrose	-	-	-	-	-	-	-
D-Trehalose	-	-	-	-	-	-	-
Turanose	-	-	-	-	-	-	-
Xylitol	-	-	-	-	-	-	-
Pyruvic Acid Methyl Ester	+++	+++	+++	+++	+++	+++	+++
Succinic Acid Mono-Methyl-Ester	+++	+++	+++	+++	+++	+++	+++
Acetic Acid	+++	+++	+++	+++	+++	+++	+++
Cis-Aconitic Acid	-	-	-	-	-	-	-
Citric Acid	+	-	-	-	-	-	-
Formic Acid	+	+	-	+	+	++	+
D-Galactonic Acid Lactone	++	++	-	+	++	++	++

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB310 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
D-Galacturonic Acid	+	-	-	-	+	-	-
D-Gluconic Acid	++	++	++	++	++	++	++
D-Glucosaminic Acid	+	-	-	-	-	-	-
D-Glucuronic Acid	+	-	-	-	-	-	-
α-Hydroxybutyric Acid	-	++	++	++	++	+++	++
β-Hydroxybutyric Acid	+++	+++	+++	+++	+++	+++	+++
γ-Hydroxybutyric Acid	+++	+++	+++	+++	+++	+++	+++
p-Hydroxy Phenylacetic Acid	+	-	+	+	+	-	+
Itaconic acid	-	++	++	++	++	++	++
α-Keto Butyric Acid	-	++	+	++	++	++	++
α-Keto Glutaric Acid	+	++	+	++	++	++	++
α-Keto Valeric Acid	-	++	+	++	++	++	++
D,L-Lactic Acid	+++	+++	+++	+++	+++	+++	+++
Malonic Acid	+	-	+	-	-	-	-
Propionic Acid	++	++	++	++	++	++	++
Quinic Acid	+	-	-	-	-	-	-
D-Saccharic Acid	+++	+++	+	+++	+++	+++	+++
Sebacic Acid	+	-	+	+	-	-	-
Succinic Acid	+++	+++	+++	+++	+++	+++	+++
Bromosuccinic Acid	++	++	++	++	++	++	++
Succinamic Acid	+++	+++	+++	+++	+++	+++	+++
Glucuronamide	+	-	-	-	-	-	-
L-Alaninamide	+	++	-	++	++	++	++
D-Alanine	+	-	-	-	-	-	-
L-Alanine	+	-	+	-	-	-	-
L-Alanyl-glycine	+	+	-	+	+	-	+
L-Asparagine	+	-	-	-	-	-	-

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB310 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
L-Aspartic Acid	+	-	+	-	-	++	-
L-Glutamic Acid	+	-	-	+	-	-	-
Glycyl-L-Aspartic Acid	+	-	-	-	+	-	-
Glycyl-L-Glutamic Acid	-	-	+	-	-	-	-
L-Histidine	-	-	-	-	-	-	-
Hydroxy-L-Proline	-	-	-	-	-	-	-
L-Leucine	+	++	++	++	++	++	++
L-Ornithine	-	-	+	-	-	-	-
L-Phenylalanine	+	++	+	++	++	+++	++
L-Proline	+	++	-	++	++	-	++
L-Pyroglutamic Acid	++	++	++	++	++	+++	++
D-Serine	+	-	-	-	-	-	-
L-Serine	+	-	-	-	-	-	-
L-Threonine	-	+	-	+	+	++	+
D,L-Carnitine	-	-	-	-	-	-	-
γ-Amino Butyric Acid	-	+	-	+	+	-	+
Urocanic Acid	-	-	-	+	-	-	-
Inosine	-	-	-	-	-	-	-
Uridine	-	-	-	-	-	-	-
Thymidine	-	-	-	-	-	-	-
Phenyethyl-amine	-	-	-	-	-	-	-
Putrescine	-	-	-	-	-	-	-
2-Aminoethanol	-	-	-	-	-	-	-
2,3-Butanediol	+	-	-	-	-	-	-
Glycerol	+	++	+	++	++	+++	++
D,L-α-Glycerol Phosphate	+	-	-	-	+	-	-
α-D-Glucose-1-	-	-	-	-	-	-	-

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB310 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
Phosphate							
D-Glucose-6-Phosphate	-	-	-	-	-	-	-

Table G.3 Determination of ability/inability to utilize 95 carbon/nitrogen sources by reference strains and by *Bradyrhizobium yuanmingense* strain STB 264.

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB264 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
α-Cyclodextrin	-	-	-	+	+	-	+
Dextrin	+	+	+	+	+	+	+
Glycogen	-	-	+	-	-	-	-
Tween 40	++	++	++	+	+	++	+
Tween 80	++	++	++	+	++	++	++
N-Acetyl-D-Galactosamine	-	-	-	-	-	-	-
N-Acetyl-D-Glucosamine	-	-	-	-	-	-	-
Adonitol	+	-	-	-	-	-	-
L-Arabinose	++	++	++	++	++	+++	++
D-Arabitol	+	++	-	+	+	+	+
D-Cellobiose	-	+	-	-	-	-	-
i-Erythritol	-	-	-	-	-	-	-
D-Fructose	+	+	-	+	+	+	+

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB264 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
L-Fucose	+	-	-	+	-	+	+
D-Galactose	+	+	+	+	+	+	+
Gentiobiose	-	-	-	-	-	-	-
α-D-Glucose	++	++	++	+	+	+	+
m-Inositol	-	-	-	-	-	-	-
α-D-Lactose	-	-	-	-	-	-	-
Lactulose	-	-	-	-	-	-	-
Maltose	-	-	-	-	-	-	-
D-Mannitol	++	++	++	+	+	+	+
D-Mannose	++	++	++	+	+	+	+
D-Melibiose	-	-	-	-	-	-	-
β-Methyl-D-Glucoside	+	-	-	-	-	-	-
D-Psicose	+	-	-	-	-	-	-
D-Raffinose	-	-	-	-	-	-	-
L-Rhamnose	-	+	-	+	-	+	+
D-Sorbitol	+	-	-	-	-	-	-
Sucrose	-	-	-	-	-	-	-
D-Trehalose	-	-	-	-	-	-	-
Turanose	-	-	-	-	-	-	-
Xylitol	-	-	-	-	-	-	-
Pyruvic Acid Methyl Ester	+++	+++	+++	+	++	++	++
Succinic Acid Mono-Methyl-Ester	+++	+++	+++	++	++	++	++
Acetic Acid	+++	+++	+++	+	+	++	+
Cis-Aconitic Acid	-	-	-	-	-	-	-
Citric Acid	+	-	-	-	-	-	-
Formic Acid	+	+	-	+	+	++	+

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB264 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
D-Galactonic Acid Lactone	++	++	-	+	-	+	+
D-Galacturonic Acid	+	-	-	-	-	-	-
D-Gluconic Acid	++	++	++	+	+	+	+
D-Glucosaminic Acid	+	-	-	-	-	-	-
D-Glucuronic Acid	+	-	-	-	-	-	-
α-Hydroxybutyric Acid	-	++	++	+	+	+	+
β-Hydroxybutyric Acid	+++	+++	+++	++	+++	+++	+++
γ-Hydroxybutyric Acid	+++	+++	+++	++	++	++	++
p-Hydroxy Phenylacetic Acid	+	-	+	+	-	+	+
Itaconic acid	-	++	++	+	-	+	+
α-Keto Butyric Acid	-	++	-	+	-	+	+
α-Keto Glutaric Acid	-	++	-	+	-	-	-
α-Keto Valeric Acid	-	++	-	+	+	+	+
D,L-Lactic Acid	+++	+++	+++	++	++	++	++
Malonic Acid	-	-	-	-	-	-	-
Propionic Acid	++	++	++	+	+	+	+
Quinic Acid	+	-	-	-	-	-	-
D-Saccharic Acid	+++	+++	+	+	-	-	-
Sebacic Acid	+	-	+	+	-	+	+
Succinic Acid	+++	+++	+++	++	++	++	++
Bromosuccinic Acid	++	++	++	++	++	++	++
Succinamic Acid	+++	+++	+++	++	++	++	++
Glucuronamide	+	-	-	+	-	-	-
L-Alaninamide	+	++	-	-	-	-	-
D-Alanine	+	-	-	+	-	-	-
L-Alanine	+	-	+	-	-	-	-

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB264 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
L-Alanyl-glycine	+	+	-	-	-	-	-
L-Asparagine	+	-	-	-	-	-	-
L-Aspartic Acid	+	+	+	-	-	-	-
L-Glutamic Acid	+	-	-	+	-	+	+
Glycyl-L-Aspartic Acid	+	-	-	+	-	-	-
Glycyl-L-Glutamic Acid	-	-	+	+	-	-	-
L-Histidine	-	-	-	-	-	-	-
Hydroxy-L-Proline	-	-	-	-	-	-	-
L-Leucine	+	++	++	+	-	+	+
L-Ornithine	-	-	+	-	-	-	-
L-Phenylalanine	+	++	+	+	+	+	+
L-Proline	+	++	-	+	+	-	+
L-Pyroglutamic Acid	++	++	++	++	++	++	++
D-Serine	+	-	-	-	-	-	-
L-Serine	+	-	-	-	-	-	-
L-Threonine	-	+	-	+	+	+	+
D,L-Carnitine	-	-	-	-	-	-	-
γ-Amino Butyric Acid	-	+	-	+	-	-	-
Urocanic Acid	-	-	-	-	-	-	-
Inosine	-	-	-	-	-	-	-
Uridine	-	-	-	-	-	-	-
Thymidine	-	-	-	-	-	-	-
Phenyethyl-amine	-	-	-	-	-	-	-
Putrescine	-	-	-	-	-	-	-
2-Aminoethanol	-	-	-	-	-	-	-
2,3-Butanediol	+	-	-	-	-	-	-
Glycerol	+	++	+	+	+	+	+
D,L-α-Glycerol	+	-	-	-	-	-	-

Carbon/Nitrogen sources on Biolog GN2 MicroPlate	Summary of results from 7 determinations						
	B. elkanii NBRC 14791	*B. japonicum* NBRC 14783	*B. liaoningense* NBRC 100396	STB264 Grown on TY			Summary of results from 3 determinations
				1st	2nd	3rd	
Phosphate							
α-D-Glucose-1-Phosphate	-	-	-	-	-	-	-
D-Glucose-6-Phosphate	-	-	-	-	-	-	-

BIOGRAPHY

Mrs Sujidkanlaya Maruekarajtinplaeng was born on May 9, 1970. She obtained a Bachelor of Science Degree in Microbiology from Khon Kaen University, Thailand, in 1993, and a Master of Science Degree in Industrial Microbiology from Chulalongkorn University in 1999. She has been a faculty member at the Faculty of Science and Technology, Phranakhon Sri Ayutthaya University since 2006.

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