

# Evolution of *kaiA*, a key circadian gene of cyanobacteria

Volodymyr Dvornyk<sup>1,\*,#</sup>, Qiming Mei<sup>2,3,\*</sup>

<sup>1</sup> Department of Life Sciences, College of Science and General Studies, Alfaisal University, Riyadh 11533, Kingdom of Saudi Arabia

<sup>2</sup> Southern Marine Science and Engineering Guangdong Laboratory (Guangzhou), Guangzhou, People's Republic of China

<sup>3</sup> Key Laboratory of Vegetation Restoration and Management of Degraded Ecosystems, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, People's Republic of China

\* The authors contributed equally to the paper

# Correspondence to [vdvornyk@alfaisal.edu](mailto:vdvornyk@alfaisal.edu)

- Nostocales
- Synechococcales
- Oscillatoriophyceidae
- Chroococciopsidales
- Pleurocapsales
- Spirulinales
- Unidentified
- Outgroup



Single-domain KaiA

Double-domain KaiA  
Single-domain KaiA

Double-domain KaiA

*Prochlorococcus* KaiA

Double-domain KaiA

Figure S1. (a) Bayesian tree with uncorrelated log-normal clock of the 16S and 23S rRNA genes.

■ Single-domain KaiA  
■ Double-domain KaiA  
■ *Prochlorococcus* KaiA

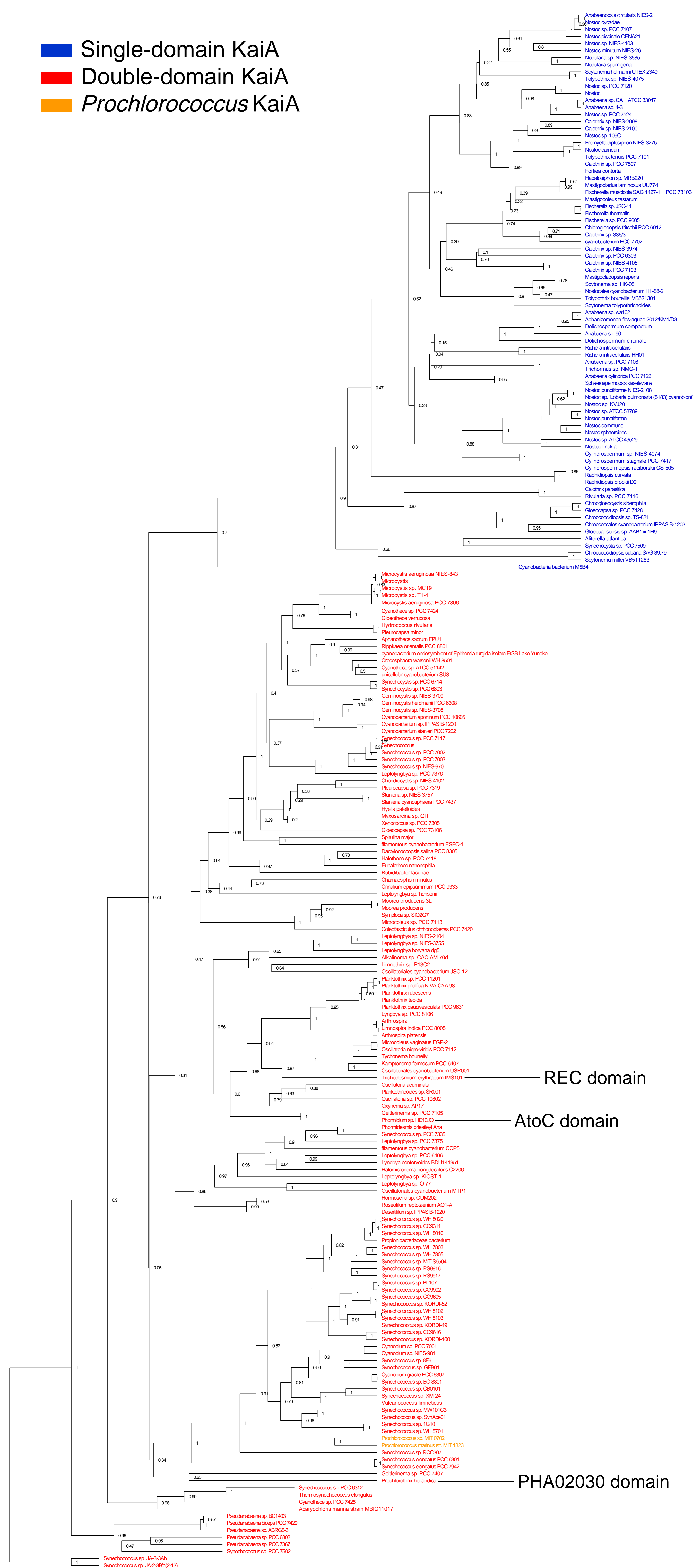
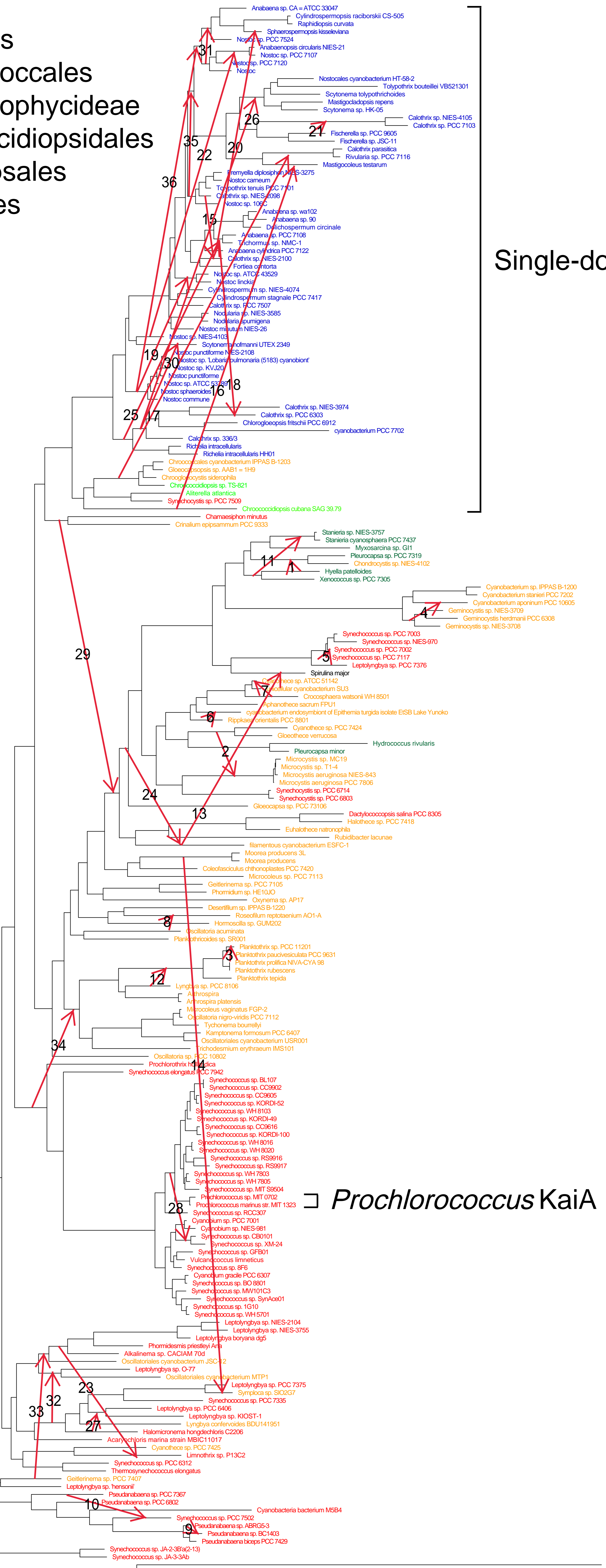


Figure S1. (b) Bayesian tree with uncorrelated log-normal clock of the KaiA proteins.

- Nostocales
- Synechococcales
- Oscillatoriophyceae
- Chroococciopsidales
- Pleurocapsales
- Spirulinales
- Outgroup



Single-domain KaiA

Double-domain KaiA

*Prochlorococcus* KaiA

Figure S2. HGTs having occurred in the evolution of the *kaiA* genes.



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20:0.0200890000000000024):0.024773999999999985):0.096143000000000053,((Synec  
7803:0.068988000000000005,Synec7805:0.0215879999999999496):0.0785810000000  
0023,(Synec9504:2.000000000279556E-  
6,(Proch:0.316869999999999976,Proch1323:0.88134599999999997):2.692582):0.0888  
9900000000006):0.089739000000000024):0.025815999999999984):0.04819800000000  
0185):0.230957000000000008):0.0283409999999999283):0.060840000000000067):0.04  
241199999999967):0.196412000000000048):0.71862699999999997):0.2480310000000  
001):0.039296999999999947):0.09248200000000004):0.009967999999999755):0.0580  
4700000000018):0.018574000000000009):0.0163070000000000293):0.0434529999999  
9952):0.066042000000000038):0.26555600000000001):0.417174);

Criteria values before the computation :

Robinson and Foulds distance (RF) = 218

Least-squares coefficient(LS) = 285.010

Bipartition dissimilarity = 443.0

Bootstrap values were computed with 1 gene trees

HGT results:

1 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Hyelpa) to subtree (Chond4102, Pleur7319)

RF = 214 , LS = 281.052 , BD = 439.5

rRF = 216 , rLS = 281.096 , rBD = 440.5

2 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Cyano7424, Gloeoverr) to subtree (Micro7806, Micro843, MicroMC19, MicroT14)

RF = 214 , LS = 280.745 , BD = 437.0

rRF = 216 , rLS = 280.764 , rBD = 439.0

3 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Plank98) to subtree (Plank11201)

RF = 214 , LS = 281.091 , BD = 440.0

rRF = 216 , rLS = 281.102 , rBD = 441.0

4 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Gemin3708, Gemin3709, Gemin6308) to subtree (Cyano10605)

RF = 216 , LS = 281.044 , BD = 442.0

rRF = 216 , rLS = 281.096 , rBD = 442.0

5 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Synec7117) to subtree (Synec7002)

RF = 216 , LS = 281.105 , BD = 441.5

rRF = 216 , rLS = 281.116 , rBD = 441.5

6 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Rippk8801) to subtree (endosEpith)

RF = 216 , LS = 281.046 , BD = 439.5

rRF = 216 , rLS = 281.055 , rBD = 439.5

7 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Croco8501) to subtree (Cyano51142)

RF = 216 , LS = 281.122 , BD = 442.0

rRF = 216 , rLS = 281.122 , rBD = 442.0

8 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Horm202) to subtree (RoseoAO1A)

RF = 216 , LS = 281.170 , BD = 442.0

rRF = 216 , rLS = 281.113 , rBD = 442.0

9 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (PseudG53) to subtree (Pseud1403)

RF = 216 , LS = 281.226 , BD = 442.0

rRF = 216 , rLS = 281.122 , rBD = 442.0

10 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Pseud6802, Pseud7367) to subtree (Synec7502)

RF = 172 , LS = 278.762 , BD = 399.5

rRF = 174 , rLS = 279.169 , rBD = 400.5

11 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Chond4102, Hyelpa, Pleur7319, Xenoc7305) to subtree (Stani3757, Stani7437)

RF = 174 , LS = 279.018 , BD = 400.5

rRF = 174 , rLS = 279.043 , rBD = 400.5

12 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Lyngb8106) to subtree (Plank11201, Plank9631, Plank98, Plankrub, Planktepi)

RF = 160 , LS = 278.588 , BD = 392.0

rRF = 160 , rLS = 278.585 , rBD = 392.0

13 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (filamESFC1) to subtree (Spiruma)

RF = 148 , LS = 276.880 , BD = 383.0

rRF = 150 , rLS = 278.965 , rBD = 385.0

14 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Moore3L, Mooreprod) to subtree (Symp2G7)

RF = 150 , LS = 274.225 , BD = 378.5

rRF = 152 , rLS = 280.402 , rBD = 391.5

15 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Calot2098) to subtree (Calot2100)

RF = 150 , LS = 274.127 , BD = 381.0

rRF = 152 , rLS = 279.801 , rBD = 386.5

16 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Chrooc3979) to subtree (Mastitest)

RF = 152 , LS = 243.493 , BD = 377.0

rRF = 152 , rLS = 310.073 , rBD = 391.5

17 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Chroo1203, Chroo821, Chrooside, Gloeo1H9) to subtree (Calotpara, Rivul7116)

RF = 152 , LS = 191.594 , BD = 362.0

rRF = 154 , rLS = 344.629 , rBD = 395.5

18 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Anaba7108, TrichN1) to subtree (Calot6303)

RF = 152 , LS = 275.052 , BD = 380.0

rRF = 154 , rLS = 277.622 , rBD = 381.5

19 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Nosto2108, Nosto53789, NostoK20, NostoLoba, Nostocomm, Nostopunc, Nostospha) to subtree (Nosto43529, Nostolinc)

RF = 152 , LS = 276.150 , BD = 374.0

rRF = 152 , rLS = 276.200 , rBD = 367.5

20 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Anaba7122) to subtree (Sphaekiss)

RF = 152 , LS = 277.588 , BD = 379.0

rRF = 152 , rLS = 278.197 , rBD = 387.5

21 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Fisch9605) to subtree (Calot4105, Calot7103)

RF = 152 , LS = 278.158 , BD = 384.0

rRF = 152 , rLS = 278.112 , rBD = 384.0

22 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Nosto4103, NostoN26) to subtree (AnabaN21, Nosto7107)

RF = 90 , LS = 163.884 , BD = 275.0

rRF = 92 , rLS = 157.978 , rBD = 267.5

23 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Alkal70d, Lepto2104, Lepto3755, Leptodg5) to subtree (Limno13C2)

RF = 90 , LS = 161.769 , BD = 273.5

rRF = 92 , rLS = 162.341 , rBD = 273.5

24 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (AphanFPU1, Chond4102, Croco8501, Cyano10605, Cyano1200, Cyano51142, Cyano7202, Cyano7424, Gemin3708, Gemin3709, Gemin6308, Gloeo73106, Gloeoverr, Hydrriyu, Hyelpa, Lepto7376, Micro7806, Micro843, MicroMC19, MicroT14, MyxosGI1, Pleur7319, Pleurmino, Rippk8801, Stani3757, Stani7437, Synec6714, Synec6803, Synec7002, Synec7003, Synec7117, Synec970, Xenoc7305, endosEpith, uniceSU3) to subtree (Spiruma, filamESFC1)

RF = 92 , LS = 162.247 , BD = 274.5

rRF = 92 , rLS = 162.915 , rBD = 274.5

25 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Calot3974, Riche, Riche01) to subtree (Anaba7108, Calot6303, TrichN1)

RF = 68 , LS = 123.428 , BD = 225.0

rRF = 68 , rLS = 136.164 , rBD = 230.5

26 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Calot3363, Calot4105, Calot7103, Chlor6912, Fisch9605, FischJSC11, cyano7702) to subtree (Mastirepe, Nosto582, ScytoHK05, Tolyp1301)

RF = 70 , LS = 132.013 , BD = 238.5

rRF = 70 , rLS = 132.433 , rBD = 238.5

27 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Halom2206, Lepto7375, PhormAna, Synec7335) to subtree (Lepto6406, Lyngb1951)

RF = 70 , LS = 131.858 , BD = 238.5

rRF = 70 , rLS = 131.867 , rBD = 238.5

28 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Proch, Proch1323, Synec107, Synec7803, Synec7805, Synec8016, Synec8020, Synec8103, Synec9504, Synec9605, Synec9616, Synec9902, Synec9916, Synec9917, SynecK100, SynecK49, SynecK52) to subtree (Synec0101, SynecXM24, Vulcalimn)

RF = 58 , LS = 94.356 , BD = 192.0

rRF = 58 , rLS = 89.394 , rBD = 191.5

29 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Chamaminu, Crina9333) to subtree (AphanFPU1, Chond4102, Croco8501, Cyano10605, Cyano1200, Cyano51142, Cyano7202, Cyano7424, Dacty8305, Euhalna, Gemin3708, Gemin3709, Gemin6308, Gloeo73106, Gloeoverr, Halot7418, Hydrvivu, Hyelpa, Lepto7376, Micro7806, Micro843, MicroMC19, MicroT14, MyxosGI1, Pleur7319, Pleurmino, Rippk8801, Rubila, Spiruma, Stani3757, Stani7437, Synec6714, Synec6803, Synec7002, Synec7003, Synec7117, Synec970, Xenoc7305, endosEpith, filamESFC1, uniceSU3)

RF = 60 , LS = 94.974 , BD = 199.5

rRF = 60 , rLS = 93.530 , rBD = 197.0

30 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Calot3363, Calot4105, Calot7103, Chlor6912, Fisch9605, FischJSC11, Mastirepe, Nosto582, ScytoHK05, Scytotoly, Tolyp1301, cyano7702) to subtree (Scyto2349)

RF = 60 , LS = 95.008 , BD = 195.0

rRF = 60 , rLS = 95.423 , rBD = 195.0

31 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Nosto7120, Nostoc) to subtree (Anaba33047, Nosto7524)

RF = 60 , LS = 93.929 , BD = 198.0

rRF = 60 , rLS = 93.926 , rBD = 198.0

32 Regular (bootstrap value = 100.0% inverse = 100.0%)



From subtree (Halom2206, Lepto6406, Lepto7375, LeptoK1, Lyngb1951, PhormAna, Synec7335) to subtree (LeptoO77, OscilMTP1)

RF = 60 , LS = 95.755 , BD = 198.0

rRF = 60 , rLS = 95.964 , rBD = 200.5

33 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Geitl7407) to subtree (Alkal70d, Lepto2104, Lepto3755, Leptodg5, Limno13C2, Oscil12)

RF = 62 , LS = 96.295 , BD = 198.0

rRF = 62 , rLS = 96.053 , rBD = 199.5

34 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Cyano6307, Cyano7001, Cyano981, Geitl7105, Oscil10802, Oscilacum, Oxyne17, Phrom10JO, PlankSR001, Proch, Proch1323, Prochholl, Synec0101, Synec101C3, Synec107, Synec1G10, Synec307, Synec5701, Synec7803, Synec7805, Synec7942, Synec8016, Synec8020, Synec8103, Synec8801, Synec8F6, Synec9504, Synec9605, Synec9616, Synec9902, Synec9916, Synec9917, SynecAce01, SynecGFB01, SynecK100, SynecK49, SynecK52, SynecXM24, Vulcalimn) to subtree (ArthrPara, Arthro, Kampt6407, Lyngb8106, MicroFGP2, Oscil001, Oscil7112, Plank11201, Plank9631, Plank98, Plankrub, Planktepi, Trich101, Tychobou)

RF = 22 , LS = 54.614 , BD = 95.5

rRF = 22 , rLS = 54.704 , rBD = 95.5

35 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Calot2098, Calot2100, Calot7507, Forticont, Fremy3275, Nostoc106, Nostocarn, Tolyp7101) to subtree (Anaba33047, AnabaN21, Calot3363, Calot4105, Calot7103, Chlor6912, Fisch9605, FischJSC11, Mastirepe, Nodul3585, Nodulpum, Nosto4103, Nosto582, Nosto7107, Nosto7120, Nosto7524, NostoN26, Nostoc, Scyto2349, ScytoHK05, Scytotoly, Tolyp1301, cyano7702)

RF = 18 , LS = 30.584 , BD = 91.5

rRF = 18 , rLS = 30.374 , rBD = 91.5

36 Regular (bootstrap value = 100.0% inverse = 100.0%)

From subtree (Nosto2108, Nosto43529, Nosto53789, NostoK20, NostoLoba, Nostocomm, Nostolinc, Nostopunc, Nostospha) to subtree (Anaba33047, AnabaN21,

Calot2098, Calot2100, Calot3363, Calot4105, Calot7103, Calot7507, Chlor6912, Fisch9605, FischJSC11, Forticont, Fremy3275, Mastirepe, Nodul3585, Nodulspum, Nosto4103, Nosto582, Nosto7107, Nosto7120, Nosto7524, NostoN26, Nostoc, Nostoc106, Nostocarn, Scyto2349, ScytoHK05, Scytotoly, Tolyp1301, Tolyp7101, cyano7702)

RF = 14 , LS = 17.092 , BD = 33.0

rRF = 14 , rLS = 16.630 , rBD = 33.0