

Characterization of 25 full-length *S-RNase* alleles, including flanking regions, from a pool of resequenced apple cultivars

Plant Molecular Biology

Paolo De Franceschi¹, Luca Bianco, Alessandro Cestaro, Luca Dondini, Riccardo Velasco

¹ Corresponding author. Dipartimento di Scienze Agrarie, Università degli Studi di Bologna, Bologna, Italy – email paolo.defranceschi2@unibo.it

Online resource 5 Alignment between the *S-RNase* sequences obtained from the assembly of reads by GapFiller and the sequences amplified and cloned from corresponding genotypes: alleles *S*₈ (A), *S*₂₃ (B), *S*₅₈ (C) and *S*₅₀ (D).

A)

```
S8_assembly      CTTTGTGAAAAAAGATTGTCGACTACTTGCGCGTAGAGATTCCGATGTACCTCGGGGTA
S8_Sequenced     -----GTACCTCGGGGTA
                  *****

S8_assembly      TTTTGGTCCTTTTCATCCAACAATCCACGTGTCGCCTTATGATTATTTTTGGCTCCACA
S8_Sequenced     TTTTGGTCCTTTTCATCCAACAATCCACGTGTCGCCTTATGATTATTTTTGGCTCCACA
                  *****

S8_assembly      ATGAAAGTATCAGACTTTTTTCATAAAAAAATTAATTTAATAATTTGCTTGTTATGCTT
S8_Sequenced     ATGAAAGTATCAGACTTTTTTCATAAAAAAATTAATTTAATAATTTGCTTGTTATGCTT
                  *****

S8_assembly      TTTCAAATGGAGATTTTTCTTTTATGGATATCCGTCGTTTATTCGTCTTCTCCGTTCTTC
S8_Sequenced     TTTCAAATGGAGATTTTTCTTTTATGGATATCCGTCGTTTATTCGTCTTCTCCGTTCTTC
                  *****

S8_assembly      ATCCGGTCGGCAGAGGGAGACATTGAAAAAAGTAGTGGGAAGAAAGAGAGAGAAAAAGT
S8_Sequenced     ATCCGGTCGGCAGAGGGAGACATTGAAAAAAGTAGTGGGAAGAAAGAGAGAGAAAAAGT
                  *****

S8_assembly      AAAAAAATATTAATAACTATTTTCTTTTCTACTGTTGGATTGATCCATTGGCTGGC
S8_Sequenced     AAAAAAATATTAATAACTATTTTCTTTTCTACTGTTGGATTGATCCATTGGCTGGC
                  *****

S8_assembly      ATTGACTGATTATTAAGTTTTTTTTTTTCCAGGATTGCGTGGTCTACATGGGTCAAGGAT
S8_Sequenced     ATTGACTGATTATTAAGTTTTTTTTTTTCCAGGATTGCGTGGTCTACATGGGTCAAGGAT
                  *****

S8_assembly      TGTCTGACCTTCCACTTTCGGTGCCTTTCATGTCCTTCTATTTTGTATGGTCACGGTTA
S8_Sequenced     TGTCTGACCTTCCACTTTCGGTGCCTTTCATGTCCTTCTATTTTGTATGGTCACGGTTA
                  *****

S8_assembly      AATCACGTCAACATTTTATATTATTTTTTATAGAGATAATAAGACAAAAATAAATAGTA
S8_Sequenced     AATCACGTCAACATTTTATATTATTTTTTATAGAGATAATAAGACAAAAATAAATAGTA
                  *****

S8_assembly      ATATAAAATATTAGCGTGGCTTAACTGTGACCACACAAACAGAAGAAAACGGGAGGGCAC
S8_Sequenced     ATATAAAATATTAGCGTGGCTTAACTGTGACCACACAAACAGAAGAAAACGGGAGGGCAC
                  *****

S8_assembly      TAGAAATGAGAGGGCAGACAATCCTTGTCCGCTACAGGAACCCGACTAGTGAACATGG
S8_Sequenced     TAGAAATGAGAGGGCAGACAATCCTTGTCCGCTACAGGAACCCGACTAGTGAACATGG
                  *****

S8_assembly      GGATATGATATACAGTGTGCCGGAACGGGCTAAATTTAGATTTATTTATCAGTAGATA
S8_Sequenced     GGATATGATATACAGTGTGCCGGAACGGGCTAAATTTAGATTTATTTATCAGTAGATA
                  *****
```

S8_assembly GAATTTTATTACTAATAAACATAGTTGCTTTATCCCATCCACTTAGAAACACAACATATG
S8_Sequenced GAATTTTATTACTAATAAACATAGTTGCTTTATCCCATCCACTTAGAAACACAACATATG

S8_assembly ATCAAATACATGTGACCAAGATGATGACCTAAGGGCAGTGACATGACTAGTTTGAAGAG
S8_Sequenced ATCAAATACATGTGACCAAGATGATGACCTAAGGGCAGTGACATGACTAGTTTGAAGAG

S8_assembly AAATATTGAAGGAGAAAAAATTGCAATAGATTTATAGAACATGTGCGTGATCATGGATG
S8_Sequenced AAATATTGAAGGAGAAAAAATTGCAATAGATTTATAGAACATGTGCGTGATCATGGATG

S8_assembly ATAAATTAGAGCTATTTGATGAACCCCTCATTTATGCATGCATGTACGCATATGCCTACA
S8_Sequenced ATAAATTAGAGCTATTTGATGAACCCCTCATTTATGCATGCATGTACGCATATGCCTACA

S8_assembly ACTAGTAGTCCAGCACTATAAATGTAAGAACTTAACTGATCTCCAATGGATGCACACCAC
S8_Sequenced ACTAGTAGTCCAGCACTATAAATGTAAGAACTTAACTGATCTCCAATGGATGCACACCAC

S8_assembly CACTACTCCTTCAAATCGATCTAATAATCGGTCTTGTCTTGAACAAATATTATTCATG
S8_Sequenced CACTACTCCTTCAAATCGATCTAATAATCGGTCTTGTCTTGAACAAATATTATTCATG

S8_assembly GGGATCATGGGGATGATATATATGGTTACGATGCTATTTTCATTAATTATATTAATATTTG
S8_Sequenced GGGATCATGGGGATGATATATATGGTTACGATGCTATTTTCATTAATTATATTAATATTTG

S8_assembly TCTTCGTCCACTGTGGGATTCGATTATTTTCAATTTACGCTTCAATATCAACCGGCTGTC
S8_Sequenced TCTTCGTCCACTGTGGGATTCGATTATTTTCAATTTACGCTTCAATATCAACCGGCTGTC

S8_assembly TGCAACTCTAGTCGTACTCCTTGTAAAGGATCCTCCTGACAAGTTGTTTACGGTTCACGGT
S8_Sequenced TGCAACTCTAGTCGTACTCCTTGTAAAGGATCCTCCTGACAAGTTGTTTACGGTTCACGGT

S8_assembly TTGTGGCCTTCGAACAGGAATGCACCTGACCCAGAGTATTGCAAAGAAACAACCTTAAAT
S8_Sequenced TTGTGGCCTTCGAACAGGAATGCACCTGACCCAGAGTATTGCAAAGAAACAACCTTAAAT

S8_assembly GTTACCAAGGTAATATCATTAATAATCAGATAGACAATATTGTTTATTTTCATATGTACAT
S8_Sequenced GTTACCAAGGTAATATCATTAATAATCAGATAGACAATATTGTTTATTTTCATATGTACAT

S8_assembly ATACTCAACATGCACGCATGTGCGAATATTACATTTAATTTAAAATTTAATCCTAACTTT
S8_Sequenced ATACTCAACATGCACGCATGTGCGAATATTACATTTAATTTAAAATTTAATCCTAACTTT

S8_assembly TTTCTACTGAAAATATGAGTATACCTCTTGAATTC AATTATTTTAAATAAAACCCACTA
S8_Sequenced TTTCTACTGAAAATATGAGTATACCTCTTGAATTC AATTATTTTAAATAAAACCCACTA

S8_assembly TAATACATTTATCTAACAAATACCCAAGGACTAGACTTCAACTAAGCAATATCCATAATT
S8_Sequenced TAATACATTTATCTAACAAATACCCAAGGACTAGACTTCAACTAAGCAATATCCATAATT

S8_assembly AAGTTTGATTGGCAAAATTTGTAATTTTAGATGTCTAAATTACCTCTAATAACACTGACT
S8_Sequenced AAGTTTGATTGGCAAAATTTGTAATTTTAGATGTCTAAATTACCTCTAATAACACTGACT

S8_assembly TTGGGTCTGTTACTTGTAAATGTTATTTGCATTTCTTTTACATTATTTTATTCAATTAA
S8_Sequenced TTGGGTCTGTTACTTGTAAATGTTATTTGCATTTCTTTTACATTATTTTATTCAATTAA

S8_assembly ATATTTTCAATTAGCTTATGCGGATTTGGATAAATGTTTTTTTAAATGCCATGATTTCTA
S8_Sequenced ATATTTTCAATTAGCTTATGCGGATTTGGATAAATGTTTTTTTAAATGCCATGATTTCTA

S8_assembly AGCATATTAATAACAAAAATTACATGATATTAGAGTTTGTGTTGTTTTCACATTTGTG
S8_Sequenced AGCATATTAATAACAAAAATTACATGATATTAGAGTTTGTGTTGTTTTCACATTTGTG

S8_assembly TAATACTGAGCATTTTTTTGTTCCTTTTCAAATGATGGTAACAAGTAAATTAGTATATTC
S8_Sequenced TAATACTGAGCATTTTTTTGTTCCTTTTCAAATGATGGTAACAAGTAAATTAGTATATTC

S8_assembly TACAAGTATAAATATATTATTTTATTCAAAATACTAAAATAATTTATCTAAGTTCCTAGT
S8_Sequenced TACAAGTATAAATATATTATTTTATTCAAAATACTAAAATAATTTATCTAAGTTCCTAGT

S8_assembly ATATTATGTAATAATACATGCCAAAATAATTTACCTACAAAATAAATAAAAAATTGTTTTA
S8_Sequenced ATATTATGTAATAATACATGCCAAAATAATTTACCTACAAAATAAATAAAAAATTGTTTTA

S8_assembly GTCAAAATAATTATATACCTATCTTTTTTTTAAAAAAAAGGTAAATTTATTTGCACAAGC
S8_Sequenced GTCAAAATAATTATATACCTATCTTTTTTTTAAAAAAAAGGTAAATTTATTTGCACAAGC

S8_assembly GTGTGTGTGTGTATATATATATATATATATTTAAAATATTTAAAACGTGCCTAACATATGTA
S8_Sequenced GTGTGTGTGTGTATATATATATATATATATTTAAAATATTTAAAACGTGCCTAACATATGTA

S8_assembly ATAATACATGCAAAATAAAGAAGTGTGATTGATTGCACACGCCATATAATAATAAAAA
S8_Sequenced ATAATACATGCAAAATAAAGAAGTGTGATTGATTGCACACGCCATATAATAATAAAAA

S8_assembly ATGTGCATAGTATATGTAATAATACATGCAAAATAATTTACCTACAAAATAAAGAATGT
S8_Sequenced ATGTGCATAGTATATGTAATAATACATGCAAAATAATTTACCTACAAAATAAAGAATGT

S8_assembly TTTTAGCAGTTTGATTCGAAAATTAATTTATTTACCTATAATTTACATAAAAACGTAGATAA
S8_Sequenced TTTTAGCAGTTTGATTCGAAAATTAATTTATTTACCTATAATTTACATAAAAACGTAGATAA

S8_assembly ATTAATTTGCGCACATATATATATATATATATAAATATAATAATAAACAATAATGTC
S8_Sequenced ATTAATTTGCGCACATATATATATATATATAAATATAATAATAAACAATAATGTC

S8_assembly CACAATACATACATGCAAAATAATCTATCTACAATGATTGTCAAACAAATATTTTGAAAT
S8_Sequenced CACAATACATACATGCAAAATAATCTATCTACAATGATTGTCAAACAAATATTTTGAAAT

S8_assembly AATAGATATTAATTTGTTTATATGACAGTCTATTTCAAATTTTCGGTTTTATTTAGATGTT
S8_Sequenced AATAGATATTAATTTGTTTATATGACAGTCTATTTCAAATTTTCGGTTTTATTTAGATGTT

S8_assembly TAAAATAAATAGGTTTCTGTCAAGGAAATAAGAGTTGTTATCTAAATTTTTTTTTCTAA
S8_Sequenced TAAAATAAATAGGTTTCTGTCAAGGAAATAAGAGTTGTTATCTAAATTTTTTTTTCTAA

S8_assembly TATGTATGTATGTGTGTGCCTCTATATATATATATATTGACAGATAGGACATCTCAAAGCCC
S8_Sequenced TATGTATGTATGTGTGTGCCTCTATATATATATATATTGACAGATAGGACATCTCAAAGCCC

S8_assembly AGTTGGACATTATTTGGCCGGATGTATACGATCGAACTAATAATGTAGGCTTTTGGGGTA
S8_Sequenced AGTTGGACATTATTTGGCCGGATGTATACGATCGAACTAATAATGTAGGCTTTTGGGGTA

S8_assembly GACAGTGGGAAAAACATGGCATCTGTGGGTCTCCCAATAACAAGACGACGTGAATTACC
S8_Sequenced GACAGTGGGAAAAACATGGCATCTGTGGGTCTCCCAATAACAAGACGACGTGAATTACC

S8_assembly TTGAAACAGTAATCAACATGTACACAATCAAGAAACAAAACGTCTTTGAAATCCTCTCAA
S8_Sequenced TTGAAACAGTAATCAACATGTACACAATCAAGAAACAAAACGTCTTTGAAATCCTCTCAA

S8_assembly AGGGGAAGATTGAACCGGAGGGGAAAAACAGGACACGGAAGGAAATTTTAAAAGCCATAC
S8_Sequenced AGGGGAAGATTGAACCGGAGGGGAAAAACAGGACACGGAAGGAAATTTTAAAAGCCATAC

S8_assembly GCAGTGGTACGAAAGGTAAGAGACCAAACCTTAAGTGCCAAAAGCATACTGGGATGACTG
S8_Sequenced GCAGTGGTACGAAAGGTAAGAGACCAAACCTTAAGTGCCAAAAGCATACTGGGATGACTG

S8_assembly AATTGGTTGAGGTCACCTCTTTGCAGCAATAGAACTTAACGAAGTTAATAAACTGCCCCG
S8_Sequenced AATTGGTTGAGGTCACCTCTTTGCAGCAATAGAACTTAACGAAGTTAATAAACTGCCCCG

S8_assembly ACCTATTTAAACCAAGTTCACAATATTTCTGTCCCTTGATTGGTATTCAGTATTAAGAGC
S8_Sequenced ACCTATTTAAACCAAGTTCACAATATTTCTGTCCCTTGATTGGTATTCAGTATTAAGAGC

S8_assembly GGGGTTAGCTAGTATATATAAGTGGTTAGCCTATATACGGATGACCGAGTTCATATATA
S8_Sequenced GGGGTTAGCTAGTATATATAAGTGGTTAGCCTATATACGGATGACCGAGTTCATATATA

S8_assembly GTACGAGAGGAATGCAATTATGTGATTGTTTTCTAATGAATAAATTGGCTTAATTAATTA
S8_Sequenced GTACGAGAGGAATGCAATTATGTGATTGTTTTCTAATGAATAAATTGGCTTAATTAATTA

S8_assembly AAACCTCGTGTGAAAATGTGAATTTTCCTTTTATGTGAACCTACACATGATCCATATAGG
S8_Sequenced AAACCTCGTGTGAAAATGTGAATTTTCCTTTTATGTGAACCTACACATGATCCATATAGG

S8_assembly GATATTATAATGTAGAATAAAAAATGTAAAATTTGAATGGTTATTTTTGTTTCAATAAAA
S8_Sequenced GATATTATAATGTAGAATAAAAAATGTAAAATTTGAATGGTTATTTTTGTTTCAATAAAA

S8_assembly ATGATTTTTATCATCGTTGGTCTTGAAATTAGACATCTCAATCAAATGGTCCCTGAAA
S8_Sequenced ATGATTTTTATCATCGTTGGTCTTGAAATTAGACATCTCAATCAAATGGTCCCTGAAA

S8_assembly TCGAATATTTATAAATTTGGTCTCACAAAATGGAATCCCGCAAATTAATTTGGTCTCTCC
S8_Sequenced TCGAATATTTATAAATTTGGTCTCACAAAATGGAATCCCGCAAATTAATTTGGTCTCTCC

S8_assembly ATGTCTTTCTTTAAATTTTGAGAGTTTTAATATAAAGGCTTCTCCAACTTTTTATTA
S8_Sequenced ATGTCTTTCTTTAAATTTTGAGAGTTTTAATATAAAGGCTTCTCCAACTTTTTATTA

S8_assembly ACAAGAAATCATCTAATAACTTTTATTTAATAGATAACTTAACTTTAATGAAAATGACTT
S8_Sequenced ACAAGAAATCATCTAATAACTTTTATTTAATAGATAACTTAACTTTAATGAAAATGACTT

S8_assembly AAACCTCCATGAAAATGACAAAAGTTCACGAGCAGCTAGTTTATCATTTTGTTTTTTTT
S8_Sequenced AAACCTCCATGAAAATGACAAAAGTTCACGAGCAGCTAGTTTATCATTTTGTTTTTTTT

S8_assembly TTGTTTTACTTATTTTTAACTTTCTTCTCTCCCTCTCCATTTTCATACATTGCCAACAA
S8_Sequenced TTGTTTTACTTATTTTTAACTTTCTTCTCTCCCTCTCCATTTTCATACATTGCCAACAA

S8_assembly TTTTCTGGCTCTCATTTTTTCACATTGTCATCAATTTTCTCTCCACTCTCCTCTCTCT
S8_Sequenced TTTTCTGGCTCTCATTTTTTCACATTGTCATCAATTTTCTCTCTCCACTCTCCTCTCTCT

S8_assembly CATTCATCCACATCAACTTCCTCTCTCCTCTCACCTCTTCCCCTCTCTCATGGCTGGGT
S8_Sequenced CATTCATCCACATCAACTTCCTCTCTCCTCTCACCTCTTCCCCTCTCTCATGGCTGGGT

S8_assembly TTGGTTCAAACCGTTTCGATATTTTTCGGTTTGATTTTTTTTTTTCTTCTTCTTCAGCT
S8_Sequenced TTGGTTCAAACCGTTTCGATATTTTTCGGTTTGATTTTTTTTTTTCTTCTTCTTCAGCT

S8_assembly ATAAAAAGGGAAAAGCACTGGACAACATCACCTCCCCTGCCCACCCTTCCCCATCGCC
S8_Sequenced ATAAAAAGGGAAAAGCACTGGACAACATCACCTCCCCTGCCCACCCTTCCCCATCGCC

S8_assembly ACTCCGTCGTCGACACCCACCCCTACCAGCGTCCCCAAGATCTCTCTATTGAAGAATTGG
S8_Sequenced ACTCCGTCGTCGACACCCACCCCTACCAGCGTCCCCAAGATCTCTCTATTGAAGAATTGG

S8_assembly ATTTGGTAATTTGAATTTGGTTGGTTCATTGCCAACCACACTGCCACTCCACTCTCG
S8_Sequenced ATTTGGTAATTTGAATTTGGTTGGTTCATTGCCAACCACACTGCCACTCCACTCTCG

S8_assembly ATATGCAACTTTTAAATCCCAAATTCAACTTCTACACCCCATACTCCAGCCGCCCCCTTCA
S8_Sequenced ATATGCAACTTTTAAATCCCAAATTCAACTT-----

S8_assembly CTCCACCTTCGCCTCCCCACTAGATCAACCTAGTCGCTCGCACTCCCACCCCGCGTTG
S8_Sequenced -----

S8_assembly CACCCAGCCATCCCAAGC
S8_Sequenced -----

B)

S23_assembly TTTGTGAGACTTAGTTCCATATGCAAGTTCCTTTGCCTGAGACTAGCGTGTCCAGAAAT
S23_sequenced -----AAT

S23_assembly TAGTGCCGACGAGTCGACTTCCTCAACTGTACCTGATGAAGAATCTGCTTGAGTATTAC
S23_sequenced TAGTGCCGACGAGTCGACTTCCTCAACTGTACCTGATGAAGAATCTGCTTGAGTATTAC

S23_assembly ACACCTCAAGGAGGAGTGTATAGATATTATATTTAAATATGATTGTGTAACCTCTTAGATA
S23_sequenced ACACCTCAAGGAGGAGTGTATAGATATTATATTTAAATATGATTGTGTAACCTCTTAGATA

S23_assembly GATTTAATTACTAGTTATTCTCTCCCTATTAGGACTGTATTTCCCTTGAGGACAATGATT
S23_sequenced GATTTAATTACTAGTTATTCTCTCCCTATTAGGACTGTATTTCCCTTGAGGACAATGATT

S23_assembly CTTTTCCTCTATTGTTACTATGAATAAAGGCACCTACACAAGAGAAATAACACACCCTTAC
S23_sequenced CTTTTCCTCTATTGTTACTATGAATAAAGGCACCTACACAAGAGAAATAACACACCCTTAC

S23_assembly ACACCTTCAGAATGTCTCATACTTCCCACTCTCTCTTCTGCGCCCTCTCCACCCTTGT
S23_sequenced ACACCTTCAGAATGTCTCATACTTCCCACTCTCTCTTCTGCGCCCTCTCCACCCTTGT

S23_assembly CAGATAAATTGACCACAACGAATAACTATTTTCTTTTTCCTGTTGGATTGAGTCCAAT
S23_sequenced CAGATAAATTGACCACAACGAATAACTATTTTCTTTTTCCTGTTGGATTGAGTCCAAT

S23_assembly GATTCATTATAAAGATTTTTGCAGGGCCGCGTGGTCCAGGACAACGCTACTGATCGAATA
S23_sequenced GATTCATTATAAAGATTTTTGCAGGGCCGCGTGGTCCAGGACAACGCTACTGATCGAATA

S23_assembly TGAATATATGATACCGTGTGCCGAAACGTGCTAGGTTTACATTATCAGAAGATGGAAT
S23_sequenced TGAATATATGATACCGTGTGCCGAAACGTGCTAGGTTTACATTATCAGAAGATGGAAT

S23_assembly TTTATTACTAAAAACGTGGTTGCTTTATCCCATCCACTTAGAAACACAACATATGATCA
S23_sequenced TTTATTACTAAAAACGTGGTTGCTTTATCCCATCCACTTAGAAACACAACATATGATCA

S23_assembly AATACATGAGACCACGATGATCACCTAAGGGCATTGCACATGACAAGTTTGAATATATGA
S23_sequenced AATACATGAGACCACGATGATCACCTAAGGGCATTGCACATGACAAGTTTGAATATATGA

S23_assembly AAGAAAAAAAATTGAAATAGATTTATAGAACATGTGATCAAATACACGTGTTAACGGAT
S23_sequenced AAGAAAAAAAATTGAAATAGATTTATAGAACATGTGATCAAATACACGTGTTAACGGAT

S23_assembly GACCAACCCCTTTTATGCATGCATGTACACATTTGCCTACAACCAAGTACTATAAAGATA
S23_sequenced GACCAACCCCTTTTATGCATGCATGTACACATTTGCCTACAACCAAGTACTATAAAGATA

S23_assembly AGAGCTTAATTGATCTCCAAGTGATCCACACCACCACCTACTACTTCAAATCAATCTA
S23_sequenced AGAGCTTAATTGATCTCCAAGTGATCCACACCACCACCTACTACTTCAAATCAATCTA

S23_assembly ATTAGTAATTAATCTGCCTCGCCCTTGAACAAATATTATTCAATGGGGATTACGGGGATT
S23_sequenced ATTAGTAATTAATCTGCCTCGCCCTTGAACAAATATTATTCAATGGGGATTACGGGGATT

S23_assembly ATATATATGGTTACGACGGTATTTTCACTAGTTGTATTAATATTCTCGTCGTTACGGTT
S23_sequenced ATATATATGGTTACGACGGTATTTTCACTAGTTGTATTAATATTCTCGTCGTTACGGTT

S23_assembly GGATTTCGATTATTTTCAATTTACGCAGCAATATCAGCCGGCTGCCTGCAACTCTAATCCT
S23_sequenced GGATTTCGATTATTTTCAATTTACGCAGCAATATCAGCCGGCTGCCTGCAACTCTAATCCT

S23_assembly ACTCCTTGCAAGGATCCTCCTGCCAAGTTGTTTACGGTTCACGGTTTATGGCCTTCAAAC
S23_sequenced ACTCCTTGCAAGGATCCTCCTGCCAAGTTGTTTACGGTTCACGGTTTATGGCCTTCAAAC

S23_assembly TGGAACTTACCCGACCCAATCTTCTGCAAGAATACAACCATTACGCCTCAGCAGGTAATT
S23_sequenced TGGAACTTACCCGACCCAATCTTCTGCAAGAATACAACCATTACGCCTCAGCAGGTAATT

S23_assembly TTATTAATAATCAGATAGTCAATATTTGTTTATTTTCATATACACATATACTCGACATAGAT
S23_sequenced TTATTAATAATCAGATAGTCAATATTTGTTTATTTTCATATACACATATACTCGACATAGAT

S23_assembly TTTCATGCACGCTAGTGCAAATATTACAATTAATAAAAACATTTAATCATGAATTTTTTCT
S23_sequenced TTTCATGCACGCTAGTGCAAATATTACAATTAATAAAAACATTTAATCATGAATTTTTTCT

S23_assembly ATTTTATAATTATATTTGTCAGATAGGACATATCGAAGCCAGTTGGAATTTATTTGGCCG
S23_sequenced ATTTTATAATTATATTTGTCAGATAGGACATATCGAAGCCAGTTGGAATTTATTTGGCCG

S23_assembly AACGTATTCAATCGAACCAATCATTGGTCTTCTGGAATAAACAGTGAACAAACATGGC
S23_sequenced AACGTATTCAATCGAACCAATCATTGGTCTTCTGGAATAAACAGTGAACAAACATGGC

S23_assembly AGCTGTGGGTATCCCATATAAATGACGAAATACAATACTTTGAACTGTAATCAAATG
S23_sequenced AGCTGTGGGTATCCCATATAAATGACGAAATACAATACTTTGAACTGTAATCAAATG

S23_assembly TACATAATCAAGAAACAAAACGTCTCTAAAATCCTCTCAAGGGCCAAGATTAACCCGGAG
S23_sequenced TACATAATCAAGAAACAAAACGTCTCTAAAATCCTCTCAAGGGCCAAGATTAACCCGGAG

S23_assembly GGGAAAAACAGGACCGGACGGAAATTATAAACGCCATAAGCATTAGTACCAACAATATG
S23_sequenced GGGAAAAACAGGACCGGACGGAAATTATAAACGCCATAAGCATTAGTACCAACAATATG

S23_assembly ACACCAAACTCAAGTGCCAAAAGAATAATGGGACGATTGAATTGGTTGAGGTCACTCTT
S23_sequenced ACACCAAACTCAAGTGCCAAAAGAATAATGGGACGATTGAATTGGTTGAGGTCACTCTT

S23_assembly TGCAACGATCACAAACATAACAAAATTCATAAATTGCCGTACCCATATGGCCACAATCA
S23_sequenced TGCAACGATCACAAACATAACAAAATTCATAAATTGCCGTACCCATATGGCCACAATCA

S23_assembly CAATTTTTCTGCCCCAAAATAAATATTTCTATATTAGAGCGCGGCTAGCCAATATATATAT
S23_sequenced CAATTTTTCTGCCCCAAAATAAATATTTCTATATTAGAGCGCGGCTAGCCAATATATATAT

S23_assembly ATATATATATACATATATAATATATATATATAATGTATGTATGTATGTATTTCTAT
S23_sequenced ATATATATATACATATATAATATATATATATAATGTATGTATGTATGTATTTCTAT

S23_assembly GTAATAAATTGGCTTAATTAATTAAACTCGTGTAATGTTGGCCTATATACCGATATT
S23_sequenced GTAATAAATTGGCTTAATTAATTA---

S23_assembly ATAATGTAGAAGAAAAGGAAAATTTGGAATGGTTATTTATTTATTTATT
S23_sequenced -----

c)

S58_assembly AAGCTCTTTCATTTCTTTAAATTTAAAGTCAAAGAATTCTTTCAATTCACAATCTCTAATT
S58_sequenced -----

S58_assembly TCATGTTCAAGTAAATTTCTTGGCCTACCCACAAGGCTCATGGTGAATTTAGGGGGCGAAC
S58_sequenced -----TTAGGGGGCGAAC

S58_assembly AGTTGCTTTAGCCCATCCACAGAGAAACACAACATATGATCAAATACCTTTGATCAAGAT
S58_sequenced AGTTGCTTTAGCCCATCCACAGAGAAACACAACATATGATCAAATACCTTTGATCAAGAT

S58_assembly GATCAACTAAGGCATTGCACATGACTAGTTTGAATAGAAATATTGGAGGAGAAAAAATTG
S58_sequenced GATCAACTAAGGCATTGCACATGACTAGTTTGAATAGAAATATTGGAGGAGAAAAAATTG

S58_assembly CTATAAATCTATAGAACATGTGATCAAGTACACGTGATCAACCCCTTATTTATGCATGCA
S58_sequenced CTATAAATCTATAGAACATGTGATCAAGTACACGTGATCAACCCCTTATTTATGCATGCA

S58_assembly TGTGCACATATGCCTACAACACTACTACTATAAATATTAGATCATAGTGATCTTCGACTGAT
S58_sequenced TGTGCACATATGCCTACAACACTACTACTATAAATATTAGATCATAGTGATCTTCGACTGAT

S58_assembly CCACACCACCTTCTACAACACTTCAAAATGGATCATTAATAATTAATATGCCTCGGTCTT
S58_sequenced CCACACCACCTTCTACAACACTTCAAAATGGATCATTAATAATTAATATGCCTCGGTCTT

S58_assembly GAACAAATATTATTCAATGGGGATTACGGGGATGATACATATAGTTACGATGGTATTTTC
S58_sequenced GAACAAATATTATTCAATGGGGATTACGGGGATGATACATATAGTTACGATGGTATTTTC

S58_assembly ATTAATTGTATTAATATTGTCTTCTCTACGGTGGGACACGATTATTTCAATTTACGCA
S58_sequenced ATTAATTGTATTAATATTGTCTTCTCTACGGTGGGACACGATTATTTCAATTTACGCA

S58_assembly GCAATATCAGCCAGCTGTCTGCTACTTTAATCCTACTCCTTGTAAGGATCCTCCTGACAA
S58_sequenced GCAATATCAGCCAGCTGTCTGCTACTTTAATCCTACTCCTTGTAAGGATCCTCCTGACAA

S58_assembly GTTGTTTACGGTTCACGGTTTGTGGCCTTCAAACCTGAATGGACCGCACCCAGAAAATTG
S58_sequenced GTTGTTTACGGTTCACGGTTTGTGGCCTTCAAACCTGAATGGACCGCACCCAGAAAATTG

S58_assembly CACGAATGCAACCGTGAATTCTCAGAGGTAATATTATTGATAATCAGATAGTCACTATT
S58_sequenced CACGAATGCAACCGTGAATTCTCAGAGGTAATATTATTGATAATCAGATAGTCACTATT

S58_assembly GTTTATTTTCAATTTATGTATTTGTGTATATATACATATACTCAACATAGATTTTCATGCAC
S58_sequenced GTTTATTTTCAATTTATGTATTTGTGTATATATACATATACTCAACATAGATTTTCATGCAC

S58_assembly GCGTGTGCAAATATATAAATAAATTTAAATTTAATCATAAATTTACCTAGCTATATTATA
S58_sequenced GCGTGTGCAAATATATAAATAAATTTAAATTTAATCATAAATTTACCTAGCTATATTATA

S58_assembly TTATATTGTCAGATAACAAATATCCAAGCCAGTTGAAAATTTATTGGCCGAACGTACTC
S58_sequenced TTATATTGTCAGATAACAAATATCCAAGCCAGTTGAAAATTTATTGGCCGAACGTACTC

S58_assembly GATCGAACCAATCATGTAGGCTTCTGGAATAAACAGTGGATAAAACATGGCAGCTGTGGG
S58_sequenced GATCGAACCAATCATGTAGGCTTCTGGAATAAACAGTGGATAAAACATGGCAGCTGTGGG

S58_assembly AATCCCCAATAATGAACGACACGCATTACTTTCAAACAGTAATCAACATGTACATAACC
S58_sequenced AATCCCCAATAATGAACGACACGCATTACTTTCAAACAGTAATCAACATGTACATAACC

```
S58_assembly      CAGAAACAAAATATCTCTGGAATCCTCTCAAAGGCGAAGATTGAACCGGTGGGGGGGAAA
S58_sequenced     CAGAAACAAAATATCTCTGGAATCCTCTCAAAGGCGAAGATTGAACCGGTGGGGGGGAAA
*****

S58_assembly      AGGCCACTGGTGGATATTGAAAATGCCATACGGAAGAGTATCAACAATAAGAAACCAAAA
S58_sequenced     AGGCCACTGGTGGATATTGAAAATGCCATACGGAAGAGTATCAACAATAAGAAACCAAAA
*****

S58_assembly      TTCAAGTGCCAAATGAAGAATAAGGTGACTAAATTGGTTGAGATCAGTCTTTCAGCGAT
S58_sequenced     TTCAAGTGCCAAATGAAGAATAAGGTGACTAAATTGGTTGAGATCAGTCTTTCAGCGAT
*****

S58_assembly      GGCAGCTTAACTCAGTTCATAAATGCCCCGCCCATTTCTACCAGGATCACCATATCTC
S58_sequenced     GGCAGCTTAACTCAGTTCATAAATGCCCCGCCCATTTCTACCAGGATCACCATATCTC
*****

S58_assembly      TGCCCTCCGATATTGATTATTAAGAGCGCGGATATATATATATATATATATATATGTATGT
S58_sequenced     TGCCCTCCGATATTGATTATTAAGAGCGCGGATATATATATATATATATATATATATGTATGT
*****

S58_assembly      ATATGTGTGTGTGTGTGTACACATATATACACATATGTATATGTATATTGTATACAAGTA
S58_sequenced     ATATGTGTGTGTGTGTGTACACATATATACACATATGTATATGTATATTGTATACAAGTA
*****

S58_assembly      GTTTGCCTATGCACGGATTACGATTTTCATAGATCGGGCGAGAGAAATGCAGTTATGTGA
S58_sequenced     GTTTGCCTATGCACGGATTACGATTTTCATAGATC-----
*****

S58_assembly      TTGTATTTCTAATGAATA
S58_sequenced     -----
```

D)

S50_assembly -----
S50_sequenced TTAGGGGGCGAACAGTTGCTTTAGCCCATCCACTTAGAACCATCCACTTAGAAACACAAC

S50_assembly -----
S50_sequenced ATATGATCAAATACCCTTGATCAAGATGATCAACTAAGGGCATTGCACATGACTAGTTTG

S50_assembly -----
S50_sequenced AATAGAGATATTGGAGGAGAAAAAATTGCTATAAATCAATAGAACATGTGATCAAGTACA

S50_assembly -----
S50_sequenced CGTGATCAACCCCTTATTTATGCATGCATGTACACATATGCCTACAACACTACTATAAATAT

S50_assembly -----
S50_sequenced AAGATCTTAGTGATCTCCAACCTGATCCACACCACCGCTACAACACTACTCAAATGGATCA

S50_assembly -----ACAAATATTATTCAATGGGGATTACGGGGAT
S50_sequenced AATTAATAATTAATATGCCTCGGTCTTAAACAAATATTATTCAATGGGGATTACGGGGAT

S50_assembly GATATATATAGTTACGATAGTATTTTCATTAATTGTATTGATATTGTCTTCCCCTACGGT
S50_sequenced GATATATATAGTTACGATAGTATTTTCATTAATTGTATTGATATTGTCTTCCCCTACGGT

S50_assembly GGGATACGATTATTTTCAATTTACGCAGCAATATCAGCCAGCTGTCTGCAACTCTAAACC
S50_sequenced GGGATACGATTATTTTCAATTTACGCAGCAATATCAGCCAGCTGTCTGCAACTCTAAACC

S50_assembly TACTCCTTGTAAGGATCCTCCTGACAAGTTGTTTACGGTTCACGGTTTGTGGCCTTCAA
S50_sequenced TACTCCTTGTAAGGATCCTCCTGACAAGTTGTTTACGGTTCACGGTTTGTGGCCTTCAA

S50_assembly CTGGAATGGACCTCACCCAGAAAATTGCACTAATGCAACCGTGAATTCTCACAGGTAAT
S50_sequenced CTGGAATGGACCTCACCCAGAAAATTGCACTAATGCAACCGTGAATTCTCACAGGTAAT

S50_assembly ATTACTGATACTCAGATAGTCACTGTTGTTTATTTCAATTTATGTACCTGTGTATATATAC
S50_sequenced ATTACTGATACTCAGATAGTCACTGTTGTTTATTTCAATTTATGTACCTGTGTATATATAC

S50_assembly ATATACTCAACATAGATTTTTCATGCAGTCGTGTGCAAATATTACAATAAATTTAAATTTA
S50_sequenced ATATACTCAACATAGATTTTTCATGCAGTCGTGTGCAAATATTACAATAAATTTAAATTTA

S50_assembly ATCATAAATTTACCTATATTATATATATATTATGTCAGATAAAAAATATCCAAGCCCAGTT
S50_sequenced ATCATAAATTTACCTATATTATATATATATTATGTCAGATAAAAAATATCCAAGCCCAGTT

S50_assembly GAAAATTATTTGGCCGAACGTACTCGATCGAACCAATCATGTAGGCTTCTGGAATAAACA
S50_sequenced GAAAATTATTTGGCCGAACGTACTCGATCGAACCAATCATGTAGGCTTCTGGAATAAACA

S50_assembly GTGGATAAAACATGGCAGCTGTGGGTATCCACAATAATGAACGACACGCATTACTTTCA
S50_sequenced GTGGATAAAACATGGCAGCTGTGGGTATCCACAATAATGAACGACACGCATTACTTTCA

S50_assembly AACAGTAATCAACATGTACATAACCCAGAAACAAAACGTTTCTGAAATCCTCTCAAAGGC
S50_sequenced AACAGTAATCAACATGTACATAACCCAGAAACAAAACGTTTCTGAAATCCTCTCAAAGGC

S50_assembly GAAGATTGAACCGTTGGGAATACAAAGGCCACTGGCGCATATTGAAAATGCCATACGGAG
S50_sequenced GAAGATTGAACCGTTGGGAATACAAAGGCCACTGGCGCATATTGAAAATGCCATACGGAG

S50_assembly TAGTATCAACAATAAGAAACCAAATTC AAGTGCCAAAAGAATTCTGGGGTGACTGAATT
S50_sequenced TAGTATCAACAATAAGAAACCAAATTC AAGTGCCAAAAGAATTCTGGGGTGACTGAATT

S50_assembly GGTTGAGGTCAGTCTTTGCAGCGATGGCAGCTTAACGCAGTTCAGAAATTGCCCCACCC
S50_sequenced GGTTGAGGTCAGTCTTTGCAGCGATGGCAGCTTAACGCAGTTCAGAAATTGCCCCACCC

S50_assembly ACAACCGGGATCACCATATCTCTGCCCGCCGATATTCAGTATTAAGAGCGCGGATATAT
S50_sequenced ACAACCGGGATCACCATATCTCTGCCCGCCGATATTCAGTATTAAGAGCGCGGATATAT

S50_assembly GTGTGTGTACACATATATATACATAAGTATATAAGTAGTTGGTCTATATACAGATTACGA
S50_sequenced GTGTGTGTACACATATATATACATAAGTATATAAGTAGTTGGTCTATATACAGATTACGA

S50_assembly TTTCCATATATCGGGCGAGAGGAATGCAGTTATGTTATTGTATTTCTAATGAATAAATTC
S50_sequenced TTTCCATATATCGGGCGAGAGGAATGCAGTTATGTTATTGTATTTCTAATGAATAAATTC

S50_assembly GCTTAATTAATCAAACTCGTGTGAATATGTGAATTTTCCTTTTATACGAACTTATACGT
S50_sequenced GCTTAATTAATCAAACTCGTGTGAATATGTGAATTTTCCTTTTATACGAACTTATACGT

S50_assembly TAATCTATATACGGATATTATAATGTAGAATGAAAAGGTAAAAGGTAAACCTCGACCGGG
S50_sequenced TAATCTATATACGGATATTATAATGTAGAATGAAAAGGTAAAAGGTAAACCTCGACCGGG

S50_assembly AAGAATGAAAATGTAAAACCTGAATAGTTATTTTTGTATCAATAAAAAAGGAATTTATC
S50_sequenced AAGAATGAAAATGTAAAACCTGAATAGTTATTTTTGTATCAATAAAAAAGGAATTTATC

S50_assembly GGGGTTAGTCCATAAAATTAGACATTTCAATCAAAATGATTCCGAAATATAATATTCAT
S50_sequenced GGGGTTAGTCCATAAAATTAGACATTTCAATCAAAATGATTCCGAAATATAATATTCAT

S50_assembly CAATTTGGTTTAGGAAAATGGAATCTGCAAATCAATTTGATCATTTTATTCTCTTATTAT
S50_sequenced CAATTTGGTTTAGGAAAATGGAATCTGCAAATCAATTTGATCATTTTATTCTCTTATTAT

S50_assembly TAAATTTTCTGTTAGTTTACTGATGTGGCACTAAGTGGGTCTATCCCATCCAATAAAATG
S50_sequenced TAAATTTTCTGTTAGTTTACTGATGTGGCACTAAGTGGGTCTATCCCATCCAATAAAATG

S50_assembly GCGACATGGATTAATTTGTGATTAACCTAAACTTATCGGCGCTCTACGTCGCGAACT
S50_sequenced GCGACATGGATTAATTTGTGATTAACCTAAACTTATCGGCGCTCTACGTCGCGAACT

S50_assembly CCCCCTCCCTCGCCATCTCTGTGAGGCCGCCACCGTGAAATTAAGGCGCAGTGCAGCC
S50_sequenced -----

S50_assembly TTGTCTTCCCGAACTCCACGCACGCTCTCCGTCTCCAGAACTTCGCCATCAACTACGA
S50_sequenced -----

S50_assembly CGCCAAGAGGATCGATTGTTGGGCCGTGGTGGCTGAGTTGATGGATCCAATTGAAAAGT
S50_sequenced -----

S50_assembly CAATCTTATTTGCTAGATTCGACTGGTATGGATGTGTTGGATGCTGATTTGTTTTGTAG
S50_sequenced -----

S50_assembly ATATTAATGGTTGTTGGTTGTCTTGGTTAGTTCAAAGAGAGAGGGGAGAGTCTTGGAG
S50_sequenced -----

S50_assembly AAGGGTTGGCGGTGGTGAATTTCCGGTGGGTACGTGGGTGAGATGGGGTTTGGTTGGTGT
S50_sequenced -----

S50_assembly TCTTGTGGCAGTTGTAAAGGATGAGAAGATGAGAATAAGATGAGAAGTTTGTGGATTTG
S50_sequenced -----

S50_assembly GTATTAATTTTCTTTTATAAAAATTTTCCTTTTTTCCGGATCTAACTAATTT
S50_sequenced -----