Supplemental Figure 1: Sequence context of the detected mutations at oligo(N) stretches.

M26/M27 (I-re/I-mi) – single bp insertion at oligo(G) stretch

```
5'-TACGAAAAGAAAAGGGGGGG-TATGAGATAACCATAACGGA-3' [WT]
5'-TACGAAAAGAAAAGGGGGGGGTATGAGATAACCATAACGGA-3' [mutation]
```

M9 (I-iota) – single bp insertion at oligo(A) stretch [site identical with second mutation in M44 (III-delta)]

```
5'-CCACACTTGAAAAAAAAAAA-TCGGGCCGTATCGCTCAAAT-3' [WT]
5'-CCACACTTGAAAAAAAAAAAATCGGGCCGTATCGCTCAAAT-3' [mutation]
```

M44 (III-delta) - second mutation in M44, which is a second site mutant of M42 – single bp deletion at oligo(A) stretch [site identical with M09 (I-iota)]

```
5'-CCACACTTGAAAAAAAAAAATCGGGCCGTATCGCTCAAAT-3' [WT]
5'-CCACACTTGAAAAAAAAAA-TCGGGCCGTATCGCTCAAAT-3' [mutation]
```

M39 (II-my) - second mutation in M39 – singe bp deletion at oligo(A) stretch

```
5'-ACCAAGAAAAAAAAAAAAAAGAAAATAAAGAACTCATTCC-3' [WT]
5'-ACCAAGAAAAAAAAAAAAA-GAAAATAAAGAACTCATTCC-3' [mutation]
```

M37 (II-kappa) - second mutation in M37 – single bp insertion/deletion at tandem oligo(C+A) stretch; results in a transversion

```
5'-ATAACTTGATCCCCCCCCCCCAAAAAAAAAGGATTTTCGT-3' [WT]
5'-ATAACTTGATCCCCCCCCCCAAAAAAAAAAGGATTTTCGT-3' [mutation]
```

M39 (II-my) - first mutation in M39 – perfect micro tandem duplication at oligo(C) stretch

```
5'-CCGAGGGTTTTGAATTAGCC-----CCCCCCGCTCGTATTTCACC-3' [WT]
5'-CCGAGGGTTTTGAATTAGCCTAGCCCCCCCCGCTCGTATTTCACC-3' [mutation]
```

Supplemental Figure 2: Sequence context of the detected micro tandem duplications.

M2 (I-beta) - first mutation in M2 – perfect micro tandem duplication at perfect micro tandem repeat

```
5'-ATATTACCTGAATGGTATTT----CTTTCCCGTATTTCAAATAC-3' [WT]
5'-ATATTACCTGAATGGTATTTATTTCTTTCCCGTATTTCAAATAC-3' [mutation]
```

M19 (I-tau) – perfect micro tandem duplication at imperfect micro tandem repeat

```
5'-AATAGAGCTTTTGCGCATTT----TCGTTAATCCATGAACAGAG-3' [WT]
5'-AATAGAGCTTTTGCGCATTTATTTTCGTTAATCCATGAACAGAG-3' [mutation]
```

M28 (II-alpha), identical with first mutation of M40 (II-ny), which is a second site mutant of M28 – perfect micro tandem duplication at imperfect micro tandem repeat

```
5'-TCCTTTATATGGAAATAAAA----GGGCAGGGGGCCATTCCCTT-3' [WT]
5'-TCCTTTATATGGAAATAAAAAAAAGGGCAGGGGGCCATTCCCTT-3' [mutation]
```

M33 (II-zeta) – perfect micro tandem duplication at imperfect micro tandem repeat

```
5'-TGGGCCGGTTCGATGGCTTT----ATATGAATTAGCCGTT-3' [WT]
5'-TGGGCCGGTTCGATGGCTTTCTTTATATGAATTAGCCGTT-3' [mutation]
```

M42 (III-beta), identical with first mutation of M44 (III-delta), which is a second site mutant of M42 - perfect micro tandem duplication at imperfect micro tandem repeat

```
5'-GAATGTTAGACCATAAA-----GAAGCTATTATATCCCAT-3' [WT]
5'-GAATGTTAGACCATAAAATAAAGAAGCTATTATATCCCAT-3' [mutant]
```

M47 = M36 (IV-delta = II-iota) - perfect micro tandem duplication at imperfect micro tandem repeat

```
5'-ATGTATCTTTACCAATTAAC-----CAATTTCTAAACGCGGGAGTA-3' [WT]
5'-ATGTATCTTTACCAATTAACTTAACCAATTTCTAAACGCGGGAGTA-3' [mutant]
```

M6 (I-zeta) – imperfect micro tandem duplication at imperfect micro tandem repeat

```
5'-TTTCTAGGCTTTCACAGTTT-----TGGTTTGTATATTCATAACG-3'[WT]
5'-TTTCTAGGCTTTCACAGTTTGTTTTTGGTTTGTATATTCATAACG-3'[mutant]
```

M7 (I-eta) – perfect micro tandem duplication at imperfect nested micro tandem repeat

5′-GTTAGGCTCTTTAACGATT----GTTGTAGCTCACCATATGTAT-3′ [WT]
5′-GTTAGGCTCTTTAACGATTGATTGTTGTAGCTCACCATATGTAT-3′ [mutant]

M30 (II-gamma) - perfect micro tandem duplication at perfect nested micro tandem repeat

5′-CGTTCTTTTGCTGATATTAT-----TACCAGTATTCGATACTGGG-3′ [WT]
5′-CGTTCTTTTGCTGATATTATATTATTACCAGTATTCGATACTGGG-3′ [mutation]

M41 (III-alpha) – perfect micro tandem duplication at perfect nested micro tandem repeat [site identical with M14 (I-xi)]

5′-GCCTAGTTTTGGTGTAGCAGCTATATT------TCGCTTCATCCTC-3′ [WT]
5′-GCCTAGTTTTGGTGTAGCAGCTATATTTATATTTCGCTTCATCCTC-3′ [mutation]

M24 (I-omega) – perfect micro tandem duplication at perfect nested micro tandem repeat

5′-GCCACAACATGGGCATTCTT----CTTAGCAAGAATTATTGCAG-3′ [WT]
5′-GCCACAACATGGGCATTCTTTCTTCTTAGCAAGAATTATTGCAG-3′ [mutant]

M32 (II-epsilon) - perfect micro tandem duplication at perfect micro tandem/direct repeat(s)

5′-CAATAGCTAAGGGCCCTGAG----ACTACCACTTGGATCTGGAA-3′ [WT]
5′-CAATAGCTAAGGGCCCTGAGTGAGACTACCACTTGGATCTGGAA-3′ [mutant]

M34 (II-eta) – perfect micro tandem duplication at perfect micro tandem/direct repeat(s)

5′-TTTACACACTTTTGTATTAC-----CTCTTCTTACGGCCGTATTT-3′ [WT]
5′-TTTACACACTTTTGTATTACATTACCTCTTCTTACGGCCGTATTT-3′ [WT]

M3/M5 (I-gamma/I-epsilon) - perfect micro tandem duplication at perfect micro direct repeat

5′-TAACCAGCACCGAAAACCGT--CTTTACATCGGATGGTTT-3′ [WT]
5′-TAACCAGCACCGAAAACCGTGTCTTTACATCGGATGGTTT-3′ [mutant]

M21 (I-phi) – perfect micro tandem duplication at perfect micro direct repeat

5′-CTTTTTTTTTTATGATATTT----TATACTCTAGAACATATATT-3′ [WT]
5′-CTTTTTTTTTTATGATATTTATTTTATACTCTAGAACATATATT-3′ [mutation]

M22 (I-chi) - perfect micro tandem duplication at perfect micro direct repeat

```
5'-ATATGTTTTCTGATACCGCT-----ATACAATTACAACCCGTCTT-3'[WT]
5'-ATATGTTTTCTGATACCGCTCCGCTATACAATTACAACCCGTCTT-3'[mutant]
```

M23 (I-psi) - perfect micro tandem duplication at perfect/imperfect micro direct repeat(s)

```
5'-ATTGGCGATTCTAGTATTGA-----GCGAAAGGTTACACCTATGT-3' [WT]
5'-ATTGGCGATTCTAGTATTGAATTGAGCGAAAGGTTACACCTATGT-3' [mutation]
```

M43 (III-gamma) – first mutation in M43 - perfect micro tandem duplication at imperfect micro direct repeat

```
5'-GGGGAGGCGGTGATTTAGTA--------GCAGTGGGGGGCAAGGTTGC-3' [WT]
5'-GGGGAGGCGGTGATTTAGTAATTTAGTAGCAGTGGGGGGCAAGGTTGC-3' [mutant]
```

M45 (IV-alpha) - perfect micro tandem duplication at imperfect micro direct repeat

```
3'-GCATTGTACAAGGACGTACT-----GTAGGAGTAACCCATTACCT-5' [WT]
5'-GCATTGTACAAGGACGTACTGTACTGTAGGAGTAACCCATTACCT-3' [mutant]
```

M51 (I-fa) - perfect micro tandem duplication at imperfect micro direct repeat

```
5'-CTAGGATTTATCTTTTTAAC-----CATAGGTATTCTTTCTGGAG-3' [WT]
5'-CTAGGATTTATCTTTTTAACTTAACCATAGGTATTCTTTCTGGAG-3' [mutation]
```

M1/M4 (I-alpha/I-delta) - perfect micro tandem duplication at perfect micro palindrome

```
5'-ACTATGACTATAGCCCTTGG-----TAAATTTACCAAAGACGAAA-3'[WT]
5'-ACTATGACTATAGCCCTTGGCTTGGTAAATTTACCAAAGACGAAA-3'[mutation]
```

Supplemental Figure 3: Sequence context of the detected micro deletions.

M17 (I-rho) – first mutation in M17 – micro deletion at perfect nested micro tandem repeat

```
5′-CCAATACGCGAGTTTCAACAACTCTCGTTCTTTACATTTC-3′ [WT]
5′-CCAATACGCGAGTTTCA-----TCTCGTTCTTTACATTTC-3′ [mutation]
```

M14 (I-xi) – micro deletion at perfect nested micro tandem repeat [site identical with M41 (III-alpha)]

```
5′-GCCTAGTTTTGGTGTAGCAGCTATATTTCGCTTCATCCTC-3′ [WT]
5′-GCCTAGTTTTGGTGTAG-----ATATTTCGCTTCATCCTC-3′ [mutation]
```

M11 (I-lambda) – micro deletion at imperfect micro tandem repeat

```
5′-GTAGGTATCTGGTTCACTGCTTTAGGTATTAGCACCATGG-3′ [WT]
5′-GTAGGTATCTGGTTCACT----TAGGTATTAGCACCATGG-3′ [mutant]
```

M16 (I-pi) - micro deletion at imperfect micro tandem repeat

```
5′-AACCTGTTTCTGGATCTCTTCTTTATGGAAACAATATTAT-3′ [WT]
5′-AACCTGTTTCTGGATCT-----TTATGGAAACAATATTAT-3′ [mutant]
```

M40 (II-ny) - second mutation in M40, which is a second site mutant of M28 (III-alpha) - micro deletion at imperfect micro tandem repeat

```
5′-TATGGTTCAGCAACTACCCCTATTGAATTGTTTGGTCCCA-3′ [WT]
5′-TATGGTTCAGCAACTACCC--ATTGAATTGTTTGGTCCCA-3′ [mutation]
```

M25 (I-do) – micro deletion at imperfect nested micro tandem repeat

```
5′-AGAAAAGTTATGTAAGGACAATAACCTCGTCAAGTACTAT-3′ [WT]
5′-AGAAAAGTTATGTAAGG------ACCTCGTCAAGTACTAT-3′ [mutation]
```

M49 (V-alpha) – micro deletion at perfect/imperfect micro tandem/direct(s)

```
5′-GGTACATGCGAAGAAATGATGAAAAGGGCTATATTTGCCA-3′ [WT]
5′-GGTACATGCGAAGAAAT------AAGGGCTATATTTGCCA-3′ [mutation]
```

M13 (I-ny) – micro deletion at perfect nested micro direct repeat(s)

5′-TGGTTTACGTACTAACGA**AGATC**TTTATACAGGAGCGCTT-3′ [WT]
5′-TGGTTTACGTACTAACGA----CTTTATACAGGAGCGCTT-3′ [mutant]

M18 (I-sigma) - micro deletion at imperfect micro direct repeat

5′-TCGTAATGCATGACTAC**TTAAC**AGGGGGATTCACTGCAAA-3′ [WT]
5′-TCGTAATGCATGACTAC-----AGGGGGATTCACTGCAAA-3′ [mutation]

M48 (IV-epsilon) – micro deletion at imperfect micro direct repeat(s)

5‘-AGCTTGTTACATGGGCCGTG**AGTGGGAA**CTTAGTTTCCGTCTGGGTAT-3‘ [WT]
5‘-AGCTTGTTACATGGGCCGTG--------CTTAGTTTCCGTCTGGGTAT-3‘ [mutation]

M35 (II-theta) – micro deletion at perfect micro inverted repeat

5′-ATCGATTCATAGGGTCTTA**AC**AAGAGAATTCCTATCATTA-3′ [WT]
5′-ATCGATTCATAGGGTCTTA--AAGAGAATTCCTATCATTA-3′ [mutation]

Supplemental Figure 4: Sequence context of the detected macro tandem duplications.

M12 (I-my) – perfect macro tandem duplication at imperfect macro direct repeat

WT:

ATGATGCACGTAAGTATGATGGTATTGGGCTATGCAGCTCTTTTGTGTGGATCATTATTATCAGTAGCTC
TCTTAGTCATTACATTTCGAAAAGCTCTAA**GAATTTTTAGTAAAAAGAAAGCATTTTTAAAAGA**ATTCATT
TTCCTTTGTGGAGATCCAATATAGGAATGAACCAAGCAATGTTTTACTAAGCACCTCTTTTATTTCTTCT
AAAAACTATTACAGGGCTCAA

mutation:

ATGATGCACGTAAGTATGATGGTATTGGGCTATGCAGCTCTTTTGTGTGGATCATTATTATCAGTAGCTC
TCTTAGTCATTACATTTCGAAAAGCTCTAA**GAATTTTTAGTAAAAAGAAAGCATTTTTAAA**GAATTTTTA
GTAAAAAGAAAGCATTTTTAAAAGAATTCATTTTCCTTTGTGGAGATCCAATATAGGAATGAACCAAGCAA
TGTTTTACTAAGCACCTCTTTTATTTCTTCTAAAAACTATTACAGGGCTCAA

M8 (I-theta) – perfect macro tandem duplication at imperfect macro inverted repeat

WT:

GGCGTGGATATTGGCAGGAATTGATTGAAACTTTAGCATGGGCTCACGAACGGACGCCCTTGGCTAATTT
GATTCGGTGGAGAGATAAACCGGTGGCTCTT**TCCATTGTGCAAGCAAGATTGGTTGGATTAG**CCCACTTT
TCTGTAGGTTATATATTCACTTATGCGGCTTTCTTGATTGCTTCGACATCAGGCAAATTTGGTTAATTCT
TTCTGTGTTGTATACGCGAGAA

mutation:

GGCGTGGATATTGGCAGGAATTGATTGAAACTTTAGCATGGGCTCACGAACGGACGCCCTTGGCTAATTT
GATTCGGTGGAGAGATAAACCGGTGGCTCTT**TCCATTGTGCAAGCAAGATTGGTTGGATTAG**TTCCATTG
TGCAAGCAAGATTGGTTGGATTAGCCCACTTTTCTGTAGGTTATATATTCACTTATGCGGCTTTCTTGAT
TGCTTCGACATCAGGCAAATTTGGTTAATTCTTTCTGTGTTGTATACGCGAGAA

II-beta = III-epsilon (M29) – perfect macro tandem duplication at imperfect macro inverted repeat

WT:

AAATTATGCGGAAGCTTTACAGAATTATTATGAAGCTATGCGACTAGAAATTGATCCTTATGATCGAAGC
TATATACTCTATAACATAGGCCTTATCCAC**ACAAGTAATGGAGAACACACGAAAGCTTT**GGAATATTATT
TTCGGGCACTAGAACGAAACCCGTTCTTACCCCAAGCTTTTAATAATATGGCTGTGATCTGTCATTACGT
GCGACTATCTCCACTATAG

mutation:

AAATTATGCGGAAGCTTTACAGAATTATTATGAAGCTATGCGACTAGAAATTGATCCTTATGATCGAAGC
TATATACTCTATAACATAGGCCTTATCCAC**ACAAGTAATGGAGAACACACGAAAGCTTT**ACAAGTAATGG
AGAACACACGAAAGCTTTGGAATATTATTTTCGGGCACTAGAACGAAACCCGTTCTTACCCCAAGCTTTT
AATAATATGGCTGTGATCTGTCATTACGTGCGACTATCTCCACTATAG

M10/M15 (I-kappa/I-omikron) – perfect macro tandem duplication at imperfect dispensed macro inverted repeat(s)

WT:

CTATTAGATCGTGTCCTTAGGCATCGCGATGCAATCATATCACATCTCAATTGGGTATGTATTTTTCTAG
GCTTTCACAGTTTTGGTTTGTATATTCATA**ACGATACCATGAGCGCTTTAGGACGCCCTCAAGATATGTT**
TTCTGATACCGCTATACAATTACAACCCGTCTTTGCTCAATGGATACAAAACACCCATGCATTAGCGCCC
GGTGCAACGGCCCCTGGTGCAACAACAAGCACCAGTTTGGCTTGGGGAGGCGGTGATTTA

mutation:

CTATTAGATCGTGTCCTTAGGCATCGCGATGCAATCATATCACATCTCAATTGGGTATGTATTTTTCTAG
GCTTTCACAGTTTTGGTTTGTATATTCATA**ACGATACCATGAGCGCTTTAGGACGCCCTCAAGATATGTT**
TTCTGATACCGCTATACAATTACAACCCGTACGATACCATGAGCGCTTTAGGACGCCCTCAAGATATGTT
TTCTGATACCGCTATACAATTACAACCCGTCTTTGCTCAATGGATACAAAACACCCATGCATTAGCGCCC
GGTGCAACGGCCCCTGGTGCAACAACAAGCACCAGTTTGGCTTGGGGAGGCGGTGATTTA

I-ypsilon (M20) – first mutation in M20 – perfect macro tandem duplication at perfect/imperfect dispensed macro inverted repeat(s)

WT:

AATTTTCAACGTGCTCGGAGAGCCTGTTGATGAATTAGGACCCGTAGATACTCGTACAACATCTCCTATT
CATAGATCCGCGCCCGCCTTTATACAGTTA**GATACAAAATTATCTATTTTTGAAACAGGAATTA**AAGTAG
TCGATCTTTTAGCCCCTTATCGCCGTGGAGGAAAAATAGGCCTATTCGGGGGGGCTGGGGTAGGTAAAAC
AGTCCTCATTATGGAATTGATCAA

mutation:

AATTTTCAACGTGCTCGGAGAGCCTGTTGATGAATTAGGACCCGTAGATACTCGTACAACATCTCCTATT
CATAGATCCGCGCCCGCCTTTATACAGTTA**GATACAAAATTATCTATTTTTGAAACAGGAATTA**GATACA
AAATTATCTATTTTTGAAACAGGAATTAAAGTAGTCGATCTTTTAGCCCCTTATCGCCGTGGAGGAAAAA
TAGGCCTATTCGGGGGGGCTGGGGTAGGTAAAACAGTCCTCATTATGGAATTGATCAA

Supplemental Figure 5: Sequence context of the detected macro tandem duplication and deletion.

M20 (I- ypsilon) – second mutation in M20 – macro tandem duplication + macro deletion at complex macro tandem/directed repeat(s)

WT:

TTATCCCTTCGTGAAAACGTTAGTAAATAGAATTAATGGCCCTGCAGTACCAAAAAAAAAGAAAAAAATT
TCCAAAAGCAAACAAAAAAAACGTCAAAAGCAAACAAAAAAAACGTCAAAAGCAAACAAAAAAAACGTCAAAA
GCAAACAAAACGAAATCAAAAGCAAACAAAACGAAATCAAAAGAAAAGTAAACGAAATCAAAAGAAAAGT
AAACGAAATCAAAAGAAAACAAAACGAAAGCTACCCACGAGGAGTCAAATTCGGCGCAACCCCAAAAACC
GAAATCAACCCACACGGAAT

mutation:

TTATCCCTTCGTGAAAACGTTAGTAAATAGAATTAATGGCCCTGCAGTACCAAAAAAAAAGAAAAAAATT
TCCAAAAGCAAACAAAAAAAACGTCAAAAGCAAACAAAAAAAACGTCAAAAGCAAACAAAAAAAACGTCAAAA
GCAAACAAAA**aaacgtcaaaagcaaacaaaa**CGAAATCAAAAG**CAAACAAAACGAAATCAAAAG**AAAAGT
AAACGAAATCAAAAGAAAAGTAAACGAAATCAAAAGAAAACAAAACGAAAGCTACCCACGAGGAGTCAAA
TTCGGCGCAACCCCAAAAACCGAAATCAACCCACACGGAAT

bold: mutation
lowercase: deletion
capital letters: perfect tandem duplication

Supplemental Figure 6: Sequence context of the detected macro deletions.

M2 (I-beta) – second mutation in M2 - macro deletion at complex macro tandem/directed repeat(s)

WT (deletion marked by lowercase):

CATCACAAACCTCCTTGTTTGTTGTATTTTGTTATTTTTTTATCTTTTTTATAAGATAATTACTTTAGAA
AGTGGAGTAGAATTACTTTTGAATAGAATAGTTCTTTTTGAAGCTGAAGCTATTCTTTATCTTTATTTTA
TCTTTATATAGAATATGCAATTTGTATTTACTCTATGTAATTTGTATCTTTATATGTAATTTGTATCTTT
ATTTTTATATGTAATTTGTATTTTTATATGTAATTTGTATTTTTATATGTAATTTGTATTTTTATATG**ta**
atttgtattttatatggaatttgtattttattatttttatatggaatttgtattttatatgGAATAT
GTAATTTGTATCTTTATTTTATAATGTAATTTGTATTTACTCTATGTAATTTGTATTTTTATATGGAATA
TGTAATTTTTGAAGTGATTCTTTCT

M30 (III-gamma) – macro deletion at complex macro tandem/directed repeat(s)

WT (deletion marked by lowercase)

GCGTGATGACTTCGATGATAACGACGATGATGACGCCGATGATGAATGGCAGGTTTACAAGGATCGTGAC
TGGGGGGTCTTGACTCGGCTGAGTACTCGTATGATGACTCGGATGATGACTCGTATGATGCCTCGGCTG
ATGACTCGGCTGATGCCTCGGCTGATG**actcggctgatg**CCTCGGCTGATGACTGGGAGGTTTACTCGGC
TGGTGACTGGGATTGGGATCTTTACTCGGCTGATGCCTCGGCTGATGACTCGGCTGATGCCTCGGCTGAT
GACTGGGAGGTTTACTCGGCTGGTGACTGGGATGTTTACTCGGCTGATGCCTCGGCTGATGACTCGGCTG
ATGCCTCGGCTGATGACTTGGATGATGACTCCGATGATGACTCCGATGATGCCAGGTATTATTATTATGA
CTGGTATTATGACTACGATGAT

types of repeats:

CCTCGG	AGGTTT	CTGATG
ACTCGG	ATGTTT	CTGGTG
ACTGGG	ATCTTT	
ATTGGG		

M50 (V-delta) – second mutation in M50 - macro deletion at perfect/imperfect macro tandem/directed repeat(s)

WT (deletion marked by lowercase):

TCCTATGAAGCCTACCAAGCCTGAAGGGCCTAAAAAGCCTAACAAGTCTAACGAGGAAGCGGAAGAGCTT
GAAGGGGATAATAAGGAAGACCTTGAAGGGGATAAGCAGAAGGATAAGAAAGATGAGCTTTTCTTCGTCG
ATTATGACGATGAGGAAGAGGAAGAAGAGCTTTTCTTCGTCGATTATGGCGATGAGGATGAGGAAGAAGA
G**cttttcttcgtcgattatgacgatgaggaagaggaagaagagcttttcttcgtcgattatggcgatgag**
gatgaggaagaagaggataagcagaaggataagaaagatgagcttttcttcgtcgattatggcgatgagg
atgaggaagaagagGATAAGCAGAAGGATAAGAAAGATGAGCTTTTCTTCGTCGATTATGACGATGAGGA
TGAGGAAGAGCTTGAAGGGGATAATAAGCCTAACAAGTCTAACG

M17 (I-rho) – second mutation in M17 – macro deletion at perfect/imperfect macro tandem repeat(s)

WT (deletion marked by lowercase)

GCCTACCAAGGCTAAAAGGAGTAAGAAAAAGCCTCTTGAGGATAAGGATGGCCAAGATCCTTTAGATCCT
TTAGATCCTTTACCTTTAGATCCTTTAGAT**cctttagatcctttacctttagatcccttta**CCTTTAGATC
CTTTACCTTTAGATCCTTTACCTTTAGATCCTTTACCTTTAGATCCTATGAAGCCTACCAAGCCTGAAGG
GCCTAATGAAGCCTACCAAGCCTGAAGGGCCTAAAAAGCCTAACAAGT

M31 (II-delta) – macro deletion at imperfect macro directed repeat

WT (deletion marked by lowercase):

ATACGTGGATATCAAAAAGGGCACGAAATTAAAGTATCTTGGCTCAATCTCTTGAGTCGCTCCGGAATTC
GATTGATGTGAAAAATTCTGGTAAAATCAT**tgattcatctggtgtctaaatata**TGATTCATTTATAAGT
TACTAGATCGAAAGTTTATGACATTCCAAAATTGATAGATCCAATGTCGCATTCAGTAAAGATTTATGAT
ACCTGTATAGGATG

M38 (II-lambda) - macro deletion at imperfect macro directed repeat

WT (deletion marked by lowercase):

TATTTGAAGCAGTTGTTCGAATTCCTTATGATAGGCAAGTAAAACAAGTTCTTGCTAATGGTAAAAAAGG
GGGTTTGAATGTGGGCGCTGTTCTTATTTT**acccgagggttttgaattagccccccccgctcgtattt**CA
CCCGAGATGAAAGAAAGGATAGGCAATCCGTCTTTTCAGAGCTATCGCCCCACTAAAAAAAATATTCTTG
TTATAGGTCCCGTTCCCGGCCAGAAATAT

V-delta (M50) – first mutation in M50 – macro deletion (1364 bp), potentially resulting from non-homologous end-joining-like pathway

WT (deletion marked by lowercase):

CGGATTCAAATATTTCTTATTATTCATGCCTGGCAAAAAGAAAGAATTTGAGTAAACGATCCTATTTTTT
TTTAATGAGTCTGTTTTTATGTTATTTCGTACTGTGCAATTCCTTTGTTTGTGGGATCATTTTCTCACGA
GAGGTAATGAAAAGAATTATAGAATGGATTGCTATCTATGCCTAGATCAAGGATAAATGGAAATTTTATT
GATAAGACCTTTTCAATTGTAGCCAATATCTTATTACGAATAATTCCGACAACTTCAGGGGAAAAAGAGG
CATTTACCTA**ttacagagatggtgcgatttgattattcttatttgtttgatccttagaagaaagacacgt**
gattcgggatagaaaataaagaaaaaagtaaaaaaaaaaaatttacgctttttgggggtgaagtttgtaaa
aaaacaactccctctgtcgtgtatccacgattaatgcagcctcagatgcttcaattggcgattctagtat
tgagcgaaaggttacacctatgtgggttatttatgtattgcaggtcaaccccgctccatgagtaccaata
ggtggcatagaggaagaagcactacgcctaggaatcaacaacacgaaaactttgttagaaatttgatacc
ctttccttatcaagatcggaactcagaagaatggttgggccaacaaagatccatctcgttcgtattttgg
atacacgtataaccatcgaagactgttgaagtgacgaattcctcgaaattaaggggcgtgagggacaaag
aaattgttgaagttaccttttttttatctagtatcaacacgtttgatgttaagaaaagatcttttgcggg
aaggttggctagagatttcttgtaaaaacactagccccgctcagtcaataatgcgaatatttcaatcttt
tttgattccatgtattattctcattatgcacataagggaggagccgtatgaggtgaaaatctcacgtacg
gttctgaaacggagattctttgaatcgaagacgaccgtaacggatgtcggctcagtcagaaggaaattat
gcggaagctttacagaattattatgaagctatgcgactagaaattgatccttatgatcgaagctatatac
tctataacataggccttatccacacaagtaatggagaacacacgaaagctttggaatattattttcgggc
actagaacgaaacccgttcttaccccaagcttttaataatatggctgtgatctgtcattacgtgcgacta
tctccactatagaaagaaacgggggaagagaaaagagcgaatccactagcaaatactagaaaaaatgccg
agaaaaaaattgatacatatgcatcgtaaaaaaaaacgatttttatcagctgtagcaaagaaaaaaggaa
cttcatagaagtcgaaatatgaagaaatggatatgcctagatactttattctatggataaaggatctaat
tgatagagaaagcaccgtaaagatcaattagtgaggttttgggccgatacaataagaactgcttacttac
ttttgtgatgatataagataaaaggtaggaatcgacttatgtaataaaggcgatcccctaaaggattgag
cagcggtgtagcagcagatcccaaagatagtaagacttttcttcATAATAAAGAAAAGTCTTTTTCGAAA
ATTCTATATAAATTTTTCTATGAAACCGAGATAGTTAACTTTCAGAAAATTCTAGCGAGAGTGGAAATGC
TTATGCTTTATTCTTCTGAAGGTGGGAGAAAAGATAAAACTAAAAAAACGGATTTTGAATCAAAATGAAA
GTTTGAAACTCATGTAATTAACCTCTTTTGGTTAACCCGAGAAAAATTGGATAGATCTATGAAAAATCTC
ATTATTCAATTAGATATTAGATTATCTAGAGTAGATTAAAAAAATGGGACACCACAAGAATTGAATGCTG

Supplemental Table 1. Origin of the mutant lines in the *Oenothera* plastome mutant collection

Mutant[1)]		Origin	Wild type background[2)]	Experimenter / Year
M1	I-alpha	spontaneous	hookeri de Vries	W. Stubbe in 1958
M2	I-beta	spontaneous	hookeri de Vries	C. Harte in 1958
M3	I-gamma	spontaneous	hookeri de Vries	G. Baumgarten in 1956
M4	I-delta	spontaneous	hookeri de Vries	C. Harte in 1957
M5	I-epsilon	spontaneous	hookeri de Vries	C. Harte in 1957
M6	I-zeta	spontaneous	johansen Standard	W. Stubbe in 1962
M7	I-eta	spontaneous[3)]	elata Toluca	H. Kutzelnigg in 1965
M8	I-theta	spontaneous[3)]	hookeri de Vries	H. Kutzelnigg in 1965
M9	I-iota	spontaneous	hookeri de Vries	H. Kutzelnigg in 1966
M10	I-kappa	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M11	I-lambda	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1966
M12	I-my	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1966
M13	I-ny	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1967
M14	I-xi	spontaneous	johansen Standard	W. Stubbe in 1968
M15	I-omikron	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M16	I-pi	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1966
M17	I-rho	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1969
M18	I-sigma	spontaneous	hookeri de Vries	H. Kutzelnigg in 1971
M19	I-tau	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M20	I-ypsilon	spontaneous	hookeri de Vries	W. Stubbe in 1957
M21	I-phi	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M22	I-chi	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M23	I-psi	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M24	I-omega	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M25	I-do	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M26	I-re	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M27	I-mi	spontaneous[4)]	hookeri de Vries	H. Kutzelnigg in 1971
M28	II-alpha	spontaneous	suaveolens Fuenfkirchen	W. Stubbe in 1950
M29	II-beta = III-epsilon[5)]	spontaneous	lamarckiana de Vries	O. Renner in 1934

Supplemental Table 1. (continued)

	Mutant[1)]	Origin	Wild type background[3)]	Experimenter / Year
M30	II-gamma	spontaneous	suaveolens Grado	W. Stubbe in 1950
M31	II-delta	spontaneous	suaveolens Fuenfkirchen	W. Stubbe in 1959
M32	II-epsilon	spontaneous	suaveolens Fuenfkirchen	W. Stubbe in 1960
M33	II-zeta	spontaneous[4)]	suaveolens Grado	H. Kutzelnigg in 1967
M34	II-eta	spontaneous	suaveolens Fuenfkirchen	W. Stubbe in 1956
M35	II-theta	spontaneous	suaveolens Fuenfkirchen	W. Stubbe in 1968
M36	II-iota = IV-delta[6)]	spontaneous “second site mutant of II-zeta (M33)”[4,6)]	suaveolens Grado	H. Kutzelnigg in 1969
M37	II-kappa	spontaneous	suaveolens Grado	W. Stubbe in 1957
M38	II-lambda	spontaneous	suaveolens Fuenfkirchen	Anonymous in 1973
M39	II-my	spontaneous	suaveolens Grado	Anonymous in 1971
M40	II-ny	spontaneous second site mutant of II-alpha (M28)[7)]	suaveolens Fuenfkirchen	Anonymous in 1976
M41	III-alpha	spontaneous	deserens de Vries	W. Stubbe in 1954
M42	III-beta	spontaneous	lamarckiana Sweden	W. Stubbe in 1960
M43	III-gamma	spontaneous[8)]	grandiflora Stockton 1	H. Kutzelnigg in 1966
M44	III-delta	spontaneous second site mutant of III-beta (M42)[9)]	lamarckina Sweden	H. Kutzelnigg in 1970
M45	IV-alpha	spontaneous[10)]	ammophila Standard	H. Kutzelnigg in 1966
M46	IV-beta	spontaneous	ammophila Standard	H. Kutzelnigg in 1967
M47	IV-delta	spontaneous	atrovirens Standard	M. Drillisch in 1971
M48	IV-epsilon	spontaneous	ammophila Standard	W. Stubbe in 1976
M49	V-alpha	spontaneous	argillicola Douthat 4b[11)]	W. Stubbe in 1963
M50	V-delta	spontaneous	argillicola Standard	W. Stubbe in 1964
M51	I-fa	spontaneous	johansen Standard	S. Greiner in 2011

[1)] Mutants are designated as described in Table 1.

[2)] For details on the corresponding wild type *Oenothera* strains, please refer to Supplemental Table 2.

[3] This mutant was isolated during a “mutagenesis” approach using streptomycin. Since the mutagenic action of streptomycin could not be demonstrated in the corresponding study, the mutant is treated as a spontaneous one. For details see Kutzelnigg (1968).

[4] This mutant was isolated during a mutagenesis approach using the chloroplast mutagen methyl-nitro-nitroso-guanidine (MNNG). However, the mutagenic action of this agent could not be demonstrated in the corresponding study (Kutzelnigg, 1968), but shown later (see Greiner, 2012 for summary). Nevertheless, the detected mutation in the mutant does not fit to the molecular action of MNNG, mostly causing transitions (Sockett et al., 1991; Table 1). The mutant is therefore treated as a spontaneous one.

[5] This mutant was obtained from W. Stubbe with the description “II-beta; isolated by O. Renner in 1934, identical with the earlier described II-zeta”. However, since the mutant shares the genetic background of the plastome III of lamarckiana de Vries (or its *vetaurea* form) we re-designated this mutant to III-epsilon.

[6] The mutant M36 (II-iota) was identified by phenotype as second site mutant of M33 (II-zeta). It should be in the genetic background of basic plastome II. However, in this analysis M36 (II-iota) was found to be identical with M47 (IV-delta) in a plastome IV background. If the mutant pair II-iota/IV-delta was mixed up is unsure. There is the possibility that M36 (II-iota) might be a *de novo* mutation of the nursery plastome IV used for maintenance of M33 (II-zeta); see Material and Methods for details.

[7] M40 (II-ny) is a second site mutant, which was isolated based on a phenotypic change of the already pre-existing chloroplast mutant M28 (II-alpha).

[8] This mutant was isolated during a “mutagenesis” approach using streptomycin (tentative). Since the mutagenic action of streptomycin could not be demonstrated in the corresponding study, the mutant is treated as a spontaneous one. For details see Kutzelnigg (1968).

[9] M44 (III-delta) is a second site mutant, which was isolated based on a phenotypic change of the already pre-existing chloroplast mutant M42 (III-beta).

[10] This mutant was isolated during a “mutagenesis” approach using trypaflavin. Since the mutagenic action of trypaflavin could not be demonstrated in the corresponding study, the mutant is treated as a spontaneous one. For details see Kutzelnigg (1968).

[11] The wild type strain argillicola Douthat 4b is no longer present in our genetic stocks.

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Supplemental Table 2A. Wild type *Oenothera* strains used this work[1)]

Species	Strain	Locality	Collection date	Collector	Reference
O. elata ssp. *elata*	elata Toluca	Mexico, México, Toluca de Lerdo	1937	P. A. Munz	[1]
O. elata ssp. *hookeri*	johansen Standard	USA, CA, Sutter Co., Yuba City	1927	C. B. Wolf	[2]
O. elata ssp. *hookeri*	hookeri de Vries	USA, CA, Alameda Co., Berkeley	1904	H. de Vries	[3]
O. grandiflora	grandiflora Stockton 1	USA, AL, Baldwin Co., Stockton	1962	P. Biebel	[4,5]
O. biennis	suaveolens Grado	Italy, Friuli-Venezia Giulia, Grado	before 1950	H. Zeidler	[6,7]
O. biennis	*xa*/*xa*-suaveolens Fuenfkirchen	Hungary, Baranya, Pécs	before 1949	E. Preuss	[6,7]
O. glazioviana	*r*/*r*-lamarckiana Sweden	Sweden, Skåne Län, Almaröd	1906	N. Heribert-Nilsson	[8]
O. parviflora	atrovirens Standard[2)]	USA, NY, Erie Co., Sandy Hill	1902/1903	D. T. MacDouglas	[3,9]
O. oakesiana	ammophila Standard	Germany, Schleswig-Holstein, Helgoland	1922	E. Hoeppener	[10]
O. argillicola	argillicola Douthat 1	USA, VA, Allegheny Co., Wilson Creek	1947	R. B. Platt	[11]
O. argillicola	argillicola Standard	USA, WV, Greenbrier Co., White Sulphur Springs	1928	H. H. Bartlett	[12]

[1)] For details on *Oenothera* taxonomy and strain designation see [13-15].

[2)] According to Renner [9] this line was originally "received from Amsterdam" by N. v. Gescher in 1907. The material is quite likely identical to that collected by D. T. MacDouglas in 1902/1903 as described in [3]. Also see [16].

Supplemental Table 2B. Nuclear genome mutants derived from *O. glazioviana* strain lamarckiana de Vries used in this work[1].

Species[2]	Mutant	Description	Isolated in	Worker	Reference
O. glazioviana	deserens de Vries[3]	chromosome translocation mutant	1913	H. de Vries	[14,17]
O. glazioviana	blandina de Vries[4]	chromosome translocation mutant	1908	H. de Vries	[14,18,19]
O. glazioviana	*vet*/*vet*-lamarckiana de Vries[4]	spontaneous single locus mutation *vetaurea* (*vet* or *v*) on chromosome 1·2 affecting flower color	1921	G. H. Shull	[14,20,21]

[1] For details on *Oenothera* taxonomy and strain designation see [13-15].

[2] The original lamarckiana de Vries was first collected in 1886 at Hilversum (The Netherlands, Noord-Holland) by Hugo de Vries [3].

[2] *Syn*: *O. deserens* de Vries; *O. lamarckiana* de Vries mut. *deserens.*

[3] *Syn*: *O. blandina* de Vries; *O. lamarckiana* de Vries mut. *blandina*; *O. lamarckiana* de Vries mut. *veluntina.*

[4] *Syn*: *O. lamarckiana* de Vries mut. *vetaurea.*

Supplemental Table 2C. Chloroplast substitutions lines obtained from introgression breeding used in this work.

Line	Nuclear Genome Donor[1)]	Chloroplast Genome Donor[1)]	Basic plastome[3)]	Produced by	Use in this work as	Reference
johansen Standard I^{hookdV}	*O. elata* ssp. *hookeri* strain johansen Standard	*O. elata* ssp. *hookeri* strain hookeri de Vries	I	S. Greiner	wild type control for Northern analyses	this work
johansen Standard II^{suvaG}	*O. elata* ssp. *hookeri* strain johansen Standard	*O. biennis* strain suaveolens Grado	II	W. Stubbe	wild type control for Northern analyses[2)]	[22,23]
johansen Standard IV^{atroSt}	*O. elata* ssp. *hookeri* strain johansen Standard	*O. parviflora* strain atrovirens Standard	IV	W. Stubbe	nursery plastome donor[4)]	[22,23]
argillicola Douthat 1 IV^{atroSt}	*O. argiilicola* strain argillicola Douthat 1	*O. parviflora* strain atrovirens Standard	IV	W. Stubbe	nursery plastome donor[4)]	this work

[1)] For details on the stains see Supplemental Table 1A.

[2)] This line with the chloroplast genome of *O. biennis* strain suaveolens Grado was used a wild type control for the chloroplast mutants II-delta, II-theta and II-kappa (see Material and Methods). The latter mutant has occurred in the background of *O. biennis* strain suaveolens Grado. II-delta and II-theta are derived from *O. biennis* strain suaveolens Fuenfkirchen, (Supplemental Table 1). The chloroplast genomes of both wild type strains are identical, however (see Supplemental Table 3 for details).

[3)] See Supplemental Table 3 for details on the wildtype plastomes.

[4)] For details see [24].

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Supplemental Table 3. Summary on the wild type *Oenothera* chloroplast genomes determined *de novo* or re-sequenced in this work[1)]

Species	Strain[1)]	Basic plastome[2)]	Size [bp]	GenBank/EMBL accession number	Sequencing Method	Reference
O. elata ssp. *elata*	elata Toluca	I	165,403	KT881169.2	Illumina[3)]	this work
O. elata ssp. *hookeri*	johansen Standard	I	165,899	AJ271079.4	Illumina, PacBio, 454[4)] Sanger	[1,2]; this work
O. elata ssp. *hookeri*	hookeri de Vries	I	165,359	KT881170.1	Illumina[5)], 454, Sanger	this work
O. biennis[6)]	suaveolens Grado	II	164,796	EU262889.2	Illumina, Sanger	[1,2]; this work
O. biennis[6)]	*xa*/*xa*-suaveolens Fuenfkirchen	II	164,796	KT881175.1	Illumina, 454[2)]	this work
O. glazioviana	*r*/*r*-lamarckiana Sweden	III	165,359	EU262890.2	Illumina, Sanger	[1,2]; this work
O. glazioviana	*vet*/*vet*-lamarckiana de Vries	III	165,408	KT881174.1	Illumina[3)]	this work
O. glazioviana	deserens de Vries	III	165,381	KT881172.1	Illumina[3)]	this work
O. glazioviana	blandina de Vries	III	165,387	KT881171.1	Illumina[3)]	this work
O. grandiflora	grandiflora Stockton 1	III	166,545	KT881173.1	Illumina[3)]	this work
O. parviflora	atrovirens Standard	IV	163,367	EU262891.2	Illumina, Sanger	[1,2]; this work
O. oakesiana	ammophila Standard	IV	163,575	KT881176.1	Illumina, 454[2)]	this work
O. argillicola	argillicola Douthat 1	V	165,061	EU262887.2	Illumina, Sanger	[1,2], this work
O. argillicola	argillicola Standard	V	165,063	KT881177.1	Illumina, Sanger	this work

[1)] For details on the corresponding *Oenothera* strains see Supplemental Table 2.

[2)] In *Oenothera* five genetically distinguishable plastome types (I-V) can be recognized based on their compatibility relation with three nuclear genomes (A, B, C) in either homozygous (AA, BB, CC) or stable heterozygous (AB, AC, BC) state. Basic plastome and nuclear genome type are an important factor of species definition in *Oenothera*. For details see e.g. [1-5].

[3)] Gap closure performed by Sanger sequencing. For details see Methods.

[4)] 454 reads were obtained from M6 (I-zeta). See Supplemental Table 1 and 4 for details.

[5)] Illumina reads were obtained from M9 (I-iota) and M19 (I-tau). See Supplemental Table 1 and 4 for details.

[6)] The chloroplast genomes of the two *O. biennis* lines, belonging to the morphotype of the European mico-species *O. suaveolens* [cf. 6,7], were found to be identical.

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Supplemental Table 4. Major phenotypic classes of the *Oenothera* plastome mutants

Mutant[1)]		Mutation in gene or locus	Leaf phenotype[2)] Young	Medium	Old	Major phenotypic class of mature leaves
M1	I-alpha	*psbD*	4	3-4	4	pale
M2	I-beta	*petD* and SSC-IRA junction	4	3	1	white
M3	I-gamma	*psbA*	3	2-3	1	white
M4	I-delta	*psbD*	4	3-4	4	pale
M5	I-epsilon	*psbA*	3	2-3	1	white
M6	I-zeta	*psaA*	1-2	1	1	white
M7	I-eta	*psaA*	2	1-2	1	white
M8	I-theta	*psaB*	2	1-2	1	white
M9	I-iota	*atpB*	(1)	(1-4)	(4)	pale
M10	I-kappa	*psaA*	1-2	1-2	1-2	white
M11	I-lambda	*psbA*	3-4	1-2	1	white
M12	I-my	*ccsA*	4	3-4	1	white
M13	I-ny	*psaB*	2	1-2	1	white
M14	I-xi	*psbD*	4	3-4	1	white
M15	I-omikron	*psaA*	1-2	1-2	1-2	white
M16	I-pi	*psbA*	3-4	2-3	1	white
M17	I-rho	*psbA* and upstream *accD*	3-4	2	1	white
M18	I-sigma	*rbcL*	4	4	4	pale
M19	I-tau	*rps7*	(1-4)	(1-4)	(1-4)	pale
M20	I-ypsilon	*atpB* and *ycf1* (*tic214*)	(1)	(1)	(1)	white
M21	I-phi	*ccsA*	3-4	2	2	white
M22	I-chi	*psaA*	1-2	1	1	white
M23	I-psi	*ycf3* (intron)	1-2	2	2	white
M24	I-omega	*psaA*	1-2	1	1	white
M25	I-do	*ccsA*	3	2	2	white
M26	I-re	*petA*	2-3	1-2	1-2	white
M27	I-mi	*petA*	2-3	1-2	1-2	white
M28	II-alpha	*ycf4*	3	2-3	1	white
M29	II-beta = III-epsilon	*ycf3*	2	1	1	white
M30	II-gamma	*psbE*	4	2-3	1-2	white
M31	II-delta	*ndhE-psaC* spacer	4	4	4	pale
M32	II-epsilon	*psaA*	2	1	1	white
M33	II-zeta	*psbB*	4	2-3	1	white
M34	II-eta	*petB*	4	3	1	white
M35	II-theta	*petB* (intron)	4	3	1	white
M36	II-iota = IV-delta	*psaA*	2	2	2	white
M37	II-kappa	*ycf3* (intron) and *ndhF-rpl32* spacer	3-4	3-4	4	pale
M38	II-lambda	*petA*	4	3-4	2-3	pale
M39	II-my	*petA* and *ndhG-ndhI* spacer	3-4	3-4	1-2	white
M40	II-ny	*ycf4* and *psbB*	2	1-2	1	white
M41	III-alpha	*psbD*	4	3-4	1	white
M42	III-beta	*psaB*	1-3	1-3	1-3	pale
M43	III-gamma	*psaA* and *trnQ-accD* spacer	1-2	1-2	1	white
M44	III-delta	*psaB* and *atpB*	1	1	1	white
M45	IV-alpha	*psaA*	3	1-2	1	white
M46	IV-beta	*rbcL*	4	4	3-4	pale
M47	IV-delta	*psaA*	2	2	2	white
M48	IV-epsilon	*psbA*	3	2-3	1-2	white
M49	V-alpha	*rbcL* (tentative)	4	4	4	pale
M50	V-delta	*ycf3* and *accD*	4	3	1	white
M51	I-fa	*ccsA*	3	2-3	1-2	white

[1)] Mutants are designated as described in Table 1.

[2)] 1 = nearly white, 2 = yellowish cream-colored, 3 = light green, 4 = nearly green

Supplemental Table 5. Sequencing and assembly methods of the full chloroplast genomes determined in this study

Species or mutant[1)]	Wild type strain or mutant[1)]	Sequencing method[2)]	GenBank/EMBL accession number[3)]	Assembly / Mutant identification
O. elata ssp. *elata*	elata Toluca	Illumina	KT881169.1	*de novo*
O. elata ssp. *hookeri*	johansen Standard	Illumina, 454[4)], PacBio	AJ271079.4	Sanger reference-guided assembly
O. elata ssp. *hookeri*	hookeri de Vries	Illumina[5)], 454	KT881170.1	Sanger reference-guided assembly
O. biennis	suaveolens Grado	Illumina	EU262889.2	Sanger reference-guided assembly
O. biennis	*xa* /*xa* -suaveolens Fuenfkirchen	Illumina, 454	KT881175.1	*de novo*
O. glazioviana	*r* /*r* -lamarckiana Sweden	Illumina	EU262890.2	Sanger reference-guided assembly
O. glazioviana	*vet* /*vet* -lamarckiana de Vries	Illumina	KT881174.1	*de novo*
O. glazioviana	deserens de Vries	Illumina	KT881172.1	*de novo*
O. glazioviana	blandina de Vries	Illumina	KT881171.1	*de novo*
O. grandiflora	grandiflora Stockton 1	Illumina	KT881173.1	*de novo*
O. parviflora	atrovirens Standard	Illumina	EU262891.2	Sanger reference-guided assembly
O. oakesiana	ammophila Standard	Illumina, 454	KT881176.1	*de novo*
O. argillicola	argillicola Douthat 1	Illumina	EU262887.2	Sanger reference-guided assembly
O. argillicola	argillicola Standard	Illumina	KT881177.1	*de novo*
M1	I-alpha	Illumina, 454	-	*de novo*
M2	I-beta	Illumina	-	wild type reference-guided assembly
M3	I-gamma	Illumina, 454	-	*de novo*
M4	I-delta	Illumina, 454	-	*de novo*
M5	I-epsilon	Illumina	-	wild type reference-guided assembly
M6	I-zeta	Illumina, 454	-	*de novo*
M7	I-eta	Illumina, 454	-	*de novo*
M8	I-theta	Illumina, 454	-	*de novo*
M9	I-iota	Illumina, 454	-	*de novo*
M10	I-kappa	Illumina, 454	-	*de novo*
M11	I-lambda	Illumina	-	wild type reference-guided assembly
M12	I-my	Illumina	-	wild type reference-guided assembly
M13	I-ny	Illumina	-	wild type reference-guided assembly
M14	I-xi	Illumina	-	wild type reference-guided assembly
M15	I-omikron	Illumina	-	wild type reference-guided assembly
M16	I-pi	Illumina	-	wild type reference-guided assembly
M17	I-rho	Illumina	-	wild type reference-guided assembly
M18	I-sigma	Illumina	-	wild type reference-guided assembly
M19	I-tau	Illumina	-	wild type reference-guided assembly
M20	I-ypsilon	Illumina	-	wild type reference-guided assembly
M21	I-phi	Illumina	-	wild type reference-guided assembly
M22	I-chi	Illumina	-	wild type reference-guided assembly
M23	I-psi	Illumina	-	wild type reference-guided assembly
M24	I-omega	Illumina	-	wild type reference-guided assembly
M25	I-do	Illumina	-	wild type reference-guided assembly
M26	I-re	Illumina	-	wild type reference-guided assembly
M27	I-mi	Illumina	-	wild type reference-guided assembly
M28	II-alpha	Illumina	-	wild type reference-guided assembly
M29	II-beta = III-epsilon	Illumina, 454	-	*de novo*
M30	II-gamma	Illumina	-	wild type reference-guided assembly
M31	II-delta	Illumina	-	wild type reference-guided assembly
M32	II-epsilon	Illumina	-	wild type reference-guided assembly
M33	II-zeta	Illumina	-	wild type reference-guided assembly
M34	II-eta	Illumina	-	wild type reference-guided assembly
M35	II-theta	Illumina	-	wild type reference-guided assembly
M36	II-iota = IV-delta	Illumina	-	wild type reference-guided assembly
M37	II-kappa	Illumina	-	wild type reference-guided assembly
M38	II-lambda	Illumina	-	wild type reference-guided assembly
M39	II-my	Illumina	-	wild type reference-guided assembly
M40	II-ny	Illumina	-	wild type reference-guided assembly
M41	III-alpha	Illumina	-	wild type reference-guided assembly
M42	III-beta	Illumina	-	wild type reference-guided assembly
M43	III-gamma	Illumina, 454	-	*de novo*
M44	III-delta	Illumina	-	wild type reference-guided assembly
M45	IV-alpha	Illumina	-	wild type reference-guided assembly
M46	IV-beta	Illumina	-	wild type reference-guided assembly
M47	IV-delta	Illumina	-	wild type reference-guided assembly
M48	IV-epsilon	Illumina, 454	-	*de novo*
M49	V-alpha	Illumina	-	wild type reference-guided assembly
M50	V-delta	Illumina	-	wild type reference-guided assembly
M51	I-fa	Illumina	-	wild type reference-guided assembly

[1)] For details on the wild type strains and chloroplast mutant lines, see Table 1 and Supplemental Table 2.

[2)] Gap closure performed by Sanger sequencing. For details see Material and Methods.

[3)] See Supplemental Table 3 for details on the wildtype reference plastomes.

[4)] 454 reads were obtained from M6 (I-zeta). See Table 1 and Supplemental Table 1 for details.

[4)] Illumina reads were obtained from M9 (I-iota) and M19 (I-tau). See Table 1 and Supplemental Table 1 for details.