

Supplementary Information

Long Tandem Arrays of *Cassandra* Retroelements and Their Role in Genome Dynamics in Plants

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Supplementary Table S1. Plant species analysed and corresponding *Cassandra* accessions.

Plant species	<i>Cassandra</i> Genbank accession
<i>Amaranthus palmeri</i>	MT230479
<i>Amblyopyrum muticum</i>	AY603371
<i>Arabidopsis thaliana</i>	AY923749
<i>Avena sativa</i>	AY271960
<i>Brachypodium distachyon</i>	DQ094839-DQ094843
<i>Brassica oleracea</i>	AY860307
<i>Brassica rapa</i>	AY860308
<i>Bromus sterilis</i>	AY271957
<i>Colpodium drakensbergense</i>	FJ975775
<i>Chaenomeles japonica</i>	AY860309
<i>Colobanthus quitensis</i>	EU882730
<i>Colpodium versicolor</i>	FJ975776
<i>Deschampsia antarctica</i>	EU867815
<i>Didymochlaena truncatula</i>	AY860311
<i>Eremopyrum distans</i>	AY603372
<i>Fragaria x ananassa</i>	AY860312
<i>Garcinia mangostana</i>	EU140956
<i>Glycine max</i>	EF125870
<i>Henrardia persica</i>	AY603374
<i>Hordeum brachyantherum</i>	AY603373
<i>Hordeum marinum</i>	AY603375
<i>Hordeum vulgare</i>	AY164585
<i>Linum usitatissimum</i>	DQ767972
<i>Lotus japonicus</i>	AY603364, AY603365
<i>Malus x domestica</i>	AY603366-AY603368
<i>Medicago truncatula</i>	AY603369
<i>Mesembryanthemum crystallinum</i>	AY603370
<i>Nephrolepis exaltata</i>	AY860313
<i>Oryza glaberrima</i>	HM481419
<i>Oryza minuta</i>	HM481420
<i>Oryza sativa</i>	AF538604, AF538611, AY271961
<i>Peridictyon sanctum</i>	AY603376
<i>Phleum pratense</i>	AF538603, AF538606-AF538617
<i>Pisum sativum</i>	DQ788719
<i>Populus tremula x Populus tremuloides</i>	EF125876

<i>Populus trichocarpa</i>	EF125877
<i>Prunus domestica</i>	AY860314
<i>Psathyrostachys fragilis</i>	AY271962
<i>Robinia pseudoacacia</i>	EF125871
<i>Rosa hybrid</i>	AY860315
<i>Rosa rugosa</i>	AY860316
<i>Rubus idaeus</i>	AY860317
<i>Rumex acetosa</i>	KC686838
<i>Saccharum hybrid</i>	KC686839
<i>Saccharum officinarum</i>	EF125872
<i>Saruma henryi</i>	EF125873
<i>Secale cereale</i>	AY359471
<i>Silene latifolia</i>	KC686837
<i>Solanum lycopersicum</i>	EU177767
<i>Sorghum bicolor</i>	AF538605, EF125875
<i>Spartina alterniflora</i>	AY603377
<i>Sphaeropteris cooperi</i>	AY860310
<i>Triticum aestivum</i>	AY271963
<i>Vaccinium corymbosum</i>	DQ673669
<i>Zea mays</i>	AF538618, AY271958, AY271959
<i>Zingeria biebersteiniana</i>	FJ975777, FJ975780
<i>Zingeria kochii</i>	FJ975778
<i>Zingeria pisdica</i>	FJ975779
<i>Zingiber officinale</i>	EF125874

Supplementary Table S2. Specific primers for Cassandra and 5S rRNA gene.

ID	Sequence (5'-3')	Location	Primer design source
784	CGAGTGAGGACAAAGTGCGCAG	161→182	LTR, Cassandra, <i>Hordeum vulgare</i>
975	ATCCCTAATAAGCCAGGCTATC	4←25	LTR, Cassandra, <i>Hordeum vulgare</i>
977	TTGTCTCACTCATGCGCACC	153←173	LTR, Cassandra, <i>Hordeum vulgare</i>
4170	TGTAACCGCGAGGGTCGGCTCTGATACCA	269←297	PBS, Cassandra, <i>Hordeum vulgare</i>
1032	ACCGCGAGGGTCGGCTCTGATACCA	269←293	PBS, Cassandra, <i>Hordeum vulgare</i>
981	CATGACCGCACACCTGTCCG	308←327	Internal part, Cassandra, <i>Hordeum vulgare</i>
982	GACGAGGACGTCGGTTCCTCT	428→448	Internal part, Cassandra, <i>Hordeum vulgare</i>
1801	ACACCACCACTCAGAGGAACCGA	438←460	Internal part, Cassandra, <i>Hordeum vulgare</i>
1802	AGAGGAACCGACGTCCTCGTCG	427←448	Internal part, Cassandra, <i>Hordeum vulgare</i>
4171	CATGTAACCGCGAGGGTCGGCTCTG	275←299	Internal part, Cassandra, <i>Hordeum vulgare</i>
3801	GCTTGTGGTTGATCGACGAGG	435→455	Internal part, Cassandra, <i>Avena sativa</i>
3802	ACGCCATGTAACCGCGAGG	302←321	Internal part, Cassandra, <i>Avena sativa</i>
4172	TGGGGTTGATCGACGAGGACGTCGATCT	438→465	Internal part, Cassandra, <i>Avena sativa</i>
4173	TGGGGTTGACCGACGAGGACGTCGGTCT	438→465	Internal part, Cassandra, <i>Avena sativa</i>
4174	GCTTGTGGTTGATCGACGAGGACG	435→458	Internal part, Cassandra, <i>Avena sativa</i>
4175	GGAACGTTCTGTGGCCCGACGAGGACGTCG	410→440	Internal part, Cassandra, <i>Hordeum vulgare</i>
2260	ACACGCCAAGCCAGATCGTCC	356←377	Internal part, Cassandra, <i>Brachypodium</i>
2261	ACTGACGAGGACGTCAGGTCC	794→814	Internal part, Cassandra, <i>Brachypodium</i>
2070	TCAGCGTGTGTTTGTCTCACTCG	306←328	Internal part, Cassandra, <i>Medicago truncatula</i>
2071	ACACGCTGAAAAGACTCGTGTTG	779→801	Internal part, Cassandra, <i>Medicago truncatula</i>
921	AGTGTGCCGACGAGGACGTCG	297←322	LTR-Internal part, Cassandra, <i>Malus</i>
1611	GGCTCTGATACCAAATTGTCACATCC	232←254	LTR, Cassandra, <i>Malus</i>
2016	AGGAGCTTGGGCGACCAAAGCGGAC	181→205	LTR, Cassandra, <i>Vaccinium</i>
2495	AGACTGTGTAGGGATGGGGCTA	139→160	LTR, Cassandra, <i>Garcinia mangostana</i>
2496	CATCCCTACACAGTCTCAGGAT	133←154	LTR, Cassandra, <i>Garcinia mangostana</i>
631	AGAACTCCAAAGTTAAGCGTGC	122→143	LTR, Cassandra, <i>Silene latifolia</i>
629	AGCACGCTTAACTTTGGAGTTC	123←144	LTR, Cassandra, <i>Silene latifolia</i>
1118	TAAGGTTTTGGGGTCTGGATGGCTAG	68→93	LTR, Cassandra, fern <i>Nephrolepis exaltata</i>
1120	TAAGGTGTTAGGAACCTCCGGTCTAGC	43←69	LTR, Cassandra, fern <i>Nephrolepis exaltata</i>
622	CTTCCCAGGAGGTCACCCATC	83←103	5S ribosomal RNA gene (121 bp)
623	TGATGGGTGACCTCCTGGGAAG	82→103	5S ribosomal RNA gene (121 bp)
2721	TGGGAAGTCCTCGTGTTGCA	97→116	5S ribosomal RNA gene (121 bp)
2722	AGTGCTGGTATGATCGCACC	3←22	5S ribosomal RNA gene (121 bp)

Supplementary Table S3. *Cassandra* tandem examples in EST and genome accessions.

GenBank accession	Sequence with <i>Cassandra</i> tandems (red is LTR, blue is internal part of <i>Cassandra</i>)
<p><i>Saruma henryi</i> (dt599514)</p>	<p>aaacagattgtacataccttttatgtgacgtcgtgcttgacttngagtaagttcaggatgggtgacctgaccgggaagtcttgttgagggggagccaaatgcgacaat attattattattagaggggtgggggtgttacaaatgggatcagagccagtgcccagatggggggagcatgcacaagcctataaaagtcgccagttaagacgttgggtcc taagaggggggtgattgtagcgtcccatattacctgggtatggagatgggcttatatgtatacttacacccttaataataacaacgcatttttaaagtcgtgatggcaa tgatcccataagaactccgtagttaagcgtgctcgggtgagagcaatttcaggatgggtgacctgatcgggaagtcttgttgagggggagccaaaagcggataatatt gttgttattagaggggtgggggtgttacaaatgggatcagagccaataccagcctgagatggggggagcgtgcaactagcccatgaaggtcgtcagcagggacgctggg tcctaagaggggtgattgtgacgtcccacatcgctgggtatggagatgggactgtgcttgtatgtaaaatccacaccatttctaataacaacacgttttaaagat gtgatggcaatgatcccataaaaactctgtagttaagcgtgtttggcttagagtaattttaggatgagtgacctgacggaaagtcttgttgagggggagccaaaagca gacaatattgttgttattagaggggtgggggtgttacattttgtaccaatgttgatatgtgacccttcaaaagtcacc</p>
<p><i>Arabidopsis thaliana</i> (all138645)</p>	<p>caactcaccgattgaaactgatatttctcctccactatttgccaaaaagaacaatttaagaaacttattataactcataaaacaacaaataactcggata ttgcttaaaacttaatgatttcaaatcttttctctctaataatcgtgcaatttttaaaagattttatccttaattagttgcaataatttttcttagccaccaagaa agacctaatcgtctatataacatttttgcaacacttttataaaataaatcctcaagttggattttgtttacaaggaatgtcattcgcattaattattatcaattaa ttaataattcctaattactagtgtaacactccgagagaactccacagttaagtgcttgggtttgagtagtttcaggatgggtgaccttcggagaagtgattgtcgg aaccatgtgagtgaggacaaagaatgggaaaagaaaatgtgataaacttgaatagatggtaataatctttaaagcctcctggacgtgacgcaactgactgttgacaga gggtggcccattggcccagagaggacgtagggcccactgataggggcagtcgggacgttacaagtggatctgagccaaaccataagagtgtagagtcagaagg ctcgcaccatcggggtatagccttgggtgcgaacgaggtcattcgcgatctgttagtggggatgaattgtaacaccccgatttcaggaatattgtggtgcatgaggag aggttttaacataatttatttgccacctatgtcaccaaaatgtacttatcttttcgggtcaaaggtcttgagagaattccacagttaagcatgcttggactggaata gtttcaagattggtgaccttcgagaagtgattgtcggaaacctgagtgagaacaaagcatgggaaaagctcatttgggtgattttagggtcagtaacaagtaat taaagcctcccagcatggtgacccgaccgtcggataggggtggatccattggcccagagattacgtggggcccacaaatagtgggtggtcagagcattagaagtggt tatcagagccgaacctaaatgagtggtgagtcagaaggctcgcaccatcgggggttacgttcttactgcacaacgaacacgtaacaatctgttaatgcggtgaatt gtaataccccggtttcaggaattggtttggccacctatgtcatcaaagtgcaacttatcttttcgggtcaaacatcctgagagaacgccacagttaagcatgcttgggc tcgaatagttcaggatgggtgacctcccgggaagtgattgtcggaccaatgcgtgtgaggacaaagcatggagaatgatcatgtggtgattttagggatggtaaca agtctttaaagcctctctcaggttacgcaccccaccattggacagaagtgagccatggggccaaaagagaacgtggggccaactggtaagggcggtcggggcgta caactagcatttcattatctaataatctctatcgggttattagaaaaatattaggaattattaatattatacttttattaaggtaaaatattatagttatttcaagt ttattaacattttagaataatttaacaaaaaatggttttagaataatttataaaatatttaaaaaaacatttgaagaaaagttttaaattgatttgaattataatttct taataaaagtattatttaaaaaaacacgaaaaataatgtttaatttcaccgaaccagattagatggttaggaagagttttagaataattttaaagaaaatttgggaaa atgcctattttctaaattttgtttgaaaaataacctacccattttgtatttttaaatatattttttaaataagaaaaataaaaaatataccttat</p>
<p><i>Lotus japonicas</i> (ap006403)</p>	<p>ccgcaaggcccaccataatctcatctgttcttcgaggatgatgtaacttctcttttgcaaagcctcctcaatacaagttcaattgggtggcggacactttacaagctt ttgcaactcattcaggtttgaagataaataatctcaaaatcaaaggctatttcttccaaggggtgtgagatatgaaatcagagatgagatccgggtccattgctcccaccc ctttgtcaatgatcttgggcttacttgggtcttcccttgactggaggaaggatgtagacaccggggccgacgagggcggggagtgatcgccggtgcaagtgaggca cggacaaggagcggctcctggcaggcttctaggcggaaagggcacatgactgaaccgatctcacaccgaacaagaggtattccgagattgtgtagggatggactata cagttgaggagggcataatgatttgattgtactaccataacaacaagttgcaacttcttttcgggagccaaactcataagaactccatggttaagtgtgctagcc ttggatcaatattatgatgggtgacctcctgggaagtttcccgggaagcgcgcgagtgaggacaaagcgcgctgaaaagactcgtgttgttaccgtgaggttagtc gtcacgtcaggatgttataattggatcagagccgacctctccagtacggtgtggttcggggacgaaccaagcggaaagtgggtgggcttgtagacacctggggccga cgagggcggggagtgatcgccggtgcaagtgaggcacagacaaggagcggctcctggcaggcttctaggcggagaggcacatgactgaaccgatctcacaccgaaca agaggtattccgagattgtgtagggatggactatacagttgaggaaggcatatgatttgattgtactaccataacaacaagttgcaacttcttttcgggagccc aactcataagaactccatggttaagtgtgctagccttggatcaatattatgatgggtgacctcctgggaagtttcccgggaagcgcgcgagtgaggacaaagcgcg ctgaaaagactcgtgttgttaccgtgaggttagtcgtcacgtcaggatgttacaattggatcagagccacctctccagtacggtgtggttcggggacgaaccaag cgaagttgggtggcttgtagacacctggggccgacgagggcggggagtgatcgccggtgcaagtgaggcacggacaaggagcggctcctggcaggcttctaggcggag</p>

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Malus

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Malus
(mdc000340.5
89:1..3145
phytozome)

*Prunus
domesticus*

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Fragaria

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gaggggttatgtgccttatatgtacatgccacctcca

Supplementary Table S4. Relative *Cassandra* copy numbers per 1C in *H.spontaneum* Evolution Canyon samples and for *H.vulgare* cultivars measured using dot blot hybridization and qPCR.

<i>H.spontaneum</i> Evolution Canyon lines	<i>Cassandra</i> element copy number		<i>Cassandra</i> tandem ² copy number by qPCR
	by dot blot	by qPCR ¹	
1-SH		3061	632
2-SH	4333	2454	543
3-SH		1278	272
4-SH		1601	400
5-SH	4237	3023	581
6-SH		2644	404
7-SH		1316	244
8-SH		2075	351
9-SH		2094	351
Avg. ±SD	4285 ±66.525 (±1.55%)	2172 ±418 (±19.26%)	420 ±84 (±20.03%)
11-SM		2170	369
12-SM		2340	400
13-SM		2720	464
14-SM	5437	2985	548
15-SM		3536	680
16-SM		2606	474
17-SM		3004	528
18-SM		3422	687
19-SM		2511	438
20-SM		2625	474
Avg. ±SD	5437	2792 ±261 (±9.34%)	506 ±63 (±12.47%)
21-SL		1980	313
22-SL	5032	3365	680
23-SL		2758	483
24-SL		3536	751
25-SL		3023	548
26-SL		3555	626
27-SL	5859	1449	237
28-SL		3004	518
29-SL		2853	412
30-SL		2720	460
Avg. ±SD	5446 ±573 (±10.52%)	2824 ±393 (±13.92%)	503 ±94 (±18.60%)
31-NL		2891	493
32-NL		2910	488
33-NL		3118	533
34-NL	3896	3896	575
35-NL		3403	400
36-NL		2340	272
37-NL		3592	433

39-NL		2872	328
40-NL		2720	285
Avg. ±SD	3896	3082 ±294 (±9.53%)	423 ±67 (±15.94%)
42-NM	4389	3232	469
43-NM		4674	1150
44-NM		3839	493
45-NM		2815	304
46-NM		2208	252
47-NM	5123	3517	416
48-NM		3384	442
49-NM		3668	513
Avg. ±SD	4756 ±509 (±10.69%)	3417 ±471 (±13.77%)	505 ±179 (±35.46%)
51-NH		1980	222
52-NH		3479	451
53-NH	5081	5736	848
54-NH		2853	292
55-NH		2056	226
57-NH		3365	508
58-NH		2587	261
59-NH	6040	1752	200
60-NH		3877	381
61-NH		3137	408
Avg. ±SD	5561 ±665 (±11.95%)	3082 ±686 (±22.26%)	380 ±115 (±30.29%)
<i>H.vulgare</i> , winter barley, 424 (Tu Da Mai 1, China)	6732		
<i>H.vulgare</i> , winter barley, 431 (Han 85-222, China)	7364		
<i>H.vulgare</i> , winter barley, 833 (Casbon, USA)	5930		
<i>H.vulgare</i> , winter barley, 938 (Tennessee Winter, USA)	6761		
<i>H.vulgare</i> , Kymppi, (callus)	5550		

¹ PCR fragment with primers: 784 and 977

² PCR fragment with primers: 981 and 982