Supplementary Table S2A. Comparison of substitution elements between AC and GU intermediate base pairs in the best-fit double-substitution rate matrix of AU to GC compensatory substitutions (showed in paper as Table S2)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Matrix | Best fit Model | GU elements | | | | | | AC elements | | | | | | | | | |
| Frequency | Mutability | α1(AU-GU) | β1(GU-GC) | α1\*β1 | β1/α1 | Frequency | Mutability | μ1（AU-AC） | γ1（AC-GC) | | μ1\*γ1 | | γ1/μ1 | |
| Acer | 16C | 0.0545 | 2.0823 | 0.2685 | 1.1664 | 0.3132 | 4.3441 | 0.0161 | 2.0305 | 0.0672 | | 0.9893 | | 0.0665 | | 14.7217 | |
| Acorus | 16C | 0.0564 | 1.4273 | 0.1297 | 0.7831 | 0.1016 | 6.0378 | 0.0044 | 8.7943 | 0.0739 | | 5.7296 | | 0.4234 | | 77.5318 | |
| Actaea | 16C | 0.0670 | 2.5823 | 0.3349 | 1.2798 | 0.4286 | 3.8214 | 0.0098 | 2.9140 | 0.0572 | | 1.5022 | | 0.0859 | | 26.2622 | |
| Actinidia | 16C | 0.0809 | 1.9914 | 0.3924 | 0.9326 | 0.3660 | 2.3767 | 0.0101 | 2.2330 | 0.0607 | | 1.1543 | | 0.0701 | | 19.0165 | |
| Ajania | 16C | 0.0418 | 1.3926 | 0.1427 | 0.6074 | 0.0867 | 4.2565 | 0.0034 | 6.2896 | 0.0643 | | 3.3975 | | 0.2185 | | 52.8383 | |
| Allium | 16C | 0.1083 | 1.5252 | 0.5341 | 0.8736 | 0.4666 | 1.6356 | 0.0105 | 0.0895 | 0.0031 | | 0.0529 | | 0.0002 | | 17.0645 | |
| Amomum | 16C | 0.1338 | 1.1848 | 0.4622 | 0.5183 | 0.2396 | 1.1214 | 0.0187 | 1.1311 | 0.0747 | | 0.5994 | | 0.0448 | | 8.0241 | |
| Angelica | 16C | 0.0558 | 4.8572 | 0.5919 | 3.0691 | 1.8166 | 5.1852 | 0.0022 | 0.2641 | 0.0013 | | 0.1673 | | 0.0002 | | 128.6923 | |
| Aquilaria | 16C | 0.0644 | 1.4251 | 0.1513 | 0.5689 | 0.0861 | 3.7601 | 0.0043 | 8.4426 | 0.0762 | | 4.3137 | | 0.3287 | | 56.6102 | |
| Aralia | 16C | 0.0463 | 2.6126 | 0.2784 | 1.5974 | 0.4447 | 5.7378 | 0.0099 | 2.4917 | 0.0540 | | 1.4405 | | 0.0778 | | 26.6759 | |
| Asarum | 16C | 0.1023 | 1.1220 | 0.0020 | 0.0051 | 0.0000 | 2.5500 | 0.0046 | 0.0001 | 0.0000 | | 0.0001 | | 0.0000 | | None | |
| Astilbe | 16C | 0.0380 | 2.6214 | 0.1931 | 1.6657 | 0.3216 | 8.6261 | 0.0070 | 4.0536 | 0.0586 | | 2.7319 | | 0.1601 | | 46.6195 | |
| Astragalus | 16C | 0.0942 | 1.5949 | 0.4090 | 1.0231 | 0.4184 | 2.5015 | 0.0040 | 3.8332 | 0.0468 | | 2.7815 | | 0.1302 | | 59.4338 | |
| Betula | 16C | 0.0740 | 2.4928 | 0.6004 | 1.5876 | 0.9532 | 2.6442 | 0.0020 | 4.7844 | 0.0327 | | 3.1882 | | 0.1043 | | 97.4985 | |
| Buglossoides | 16C | 0.0831 | 0.8358 | 0.1429 | 0.2905 | 0.0415 | 2.0329 | 0.0083 | 3.4135 | 0.0895 | | 1.8152 | | 0.1625 | | 20.2816 | |
| Bupleurum | 16C | 0.0881 | 2.6912 | 0.5897 | 1.7011 | 1.0031 | 2.8847 | 0.0031 | 0.2419 | 0.0020 | | 0.1633 | | 0.0003 | | 81.6500 | |
| Calystegia | 16C | 0.0652 | 1.4094 | 0.2133 | 0.8632 | 0.1841 | 4.0469 | 0.0095 | 2.6372 | 0.0737 | | 2.0418 | | 0.1505 | | 27.7042 | |
| Caragana | 16C | 0.0319 | 1.1009 | 0.0896 | 0.5731 | 0.0513 | 6.3962 | 0.0110 | 2.2153 | 0.0758 | | 1.4031 | | 0.1064 | | 18.5106 | |
| Carex | 16C | 0.0862 | 1.9376 | 0.3508 | 1.3868 | 0.4865 | 3.9532 | 0.0056 | 4.7320 | 0.0549 | | 3.3514 | | 0.1840 | | 61.0455 | |
| Celastrus | 16C | 0.0688 | 1.3604 | 0.1909 | 0.8220 | 0.1569 | 4.3059 | 0.0066 | 4.2131 | 0.0713 | | 3.2190 | | 0.2295 | | 45.1473 | |
| Ceratophyllum | 16C | 0.0820 | 1.4470 | 0.3104 | 0.9674 | 0.3003 | 3.1166 | 0.0042 | 5.2007 | 0.0640 | | 3.9073 | | 0.2501 | | 61.0516 | |
| Chaetanthera | 16C | 0.0913 | 1.5403 | 0.4058 | 1.1088 | 0.4500 | 2.7324 | 0.0105 | 2.1230 | 0.0378 | | 0.9019 | | 0.0341 | | 23.8598 | |
| Chloranthus | 16A | 0.1045 | 1.0739 | 0.2911 | 0.5629 | 0.1639 | 1.9337 | 0.0436 | 2.8878 | 0.3730 | | 1.7285 | | 0.6447 | | 4.6340 | |
| Circaea | 16C | 0.0617 | 1.3965 | 0.1600 | 0.7333 | 0.1173 | 4.5831 | 0.0029 | 9.9989 | 0.0760 | | 7.5018 | | 0.5701 | | 98.7079 | |
| Citrus | 16A | 0.0746 | 1.3429 | 0.2549 | 0.9573 | 0.2440 | 3.7556 | 0.0194 | 2.4067 | 0.1430 | | 2.0679 | | 0.2957 | | 14.4608 | |
| Cuscuta | 16C | 0.1489 | 0.8292 | 0.3293 | 0.3631 | 0.1196 | 1.1026 | 0.0197 | 2.2449 | 0.0596 | | 0.4973 | | 0.0296 | | 8.3440 | |
| Dahlia | 16C | 0.1428 | 0.9135 | 0.3333 | 0.5328 | 0.1776 | 1.5986 | 0.0060 | 3.6706 | 0.0619 | | 2.3585 | | 0.1460 | | 38.1018 | |
| Dendropanax | 16C | 0.0602 | 1.4972 | 0.1913 | 0.8274 | 0.1583 | 4.3251 | 0.0076 | 3.6742 | 0.0679 | | 2.3217 | | 0.1576 | | 34.1929 | |
| Draba | 16C | 0.1196 | 1.4869 | 0.3442 | 0.8913 | 0.3068 | 2.5895 | 0.0058 | 4.6004 | 0.0599 | | 3.2160 | | 0.1926 | | 53.6895 | |
| Dysosma | 16C | 0.0661 | 1.2679 | 0.2244 | 0.7221 | 0.1620 | 3.2179 | 0.0044 | 4.5446 | 0.0688 | | 3.3371 | | 0.2296 | | 48.5044 | |
| Epimedium | 16A | 0.1042 | 1.3932 | 0.4321 | 0.8554 | 0.3696 | 1.9796 | 0.0028 | 1.1030 | 0.0102 | | 0.7510 | | 0.0077 | | 73.6275 | |
| Erysimum | 16C | 0.0758 | 1.9446 | 0.2639 | 0.9559 | 0.2523 | 3.6222 | 0.0084 | 4.2768 | 0.0747 | | 2.4434 | | 0.1825 | | 32.7095 | |
| Flaveria | 16C | 0.0975 | 1.1879 | 0.2644 | 0.4346 | 0.1149 | 1.6437 | 0.0074 | 2.9540 | 0.0608 | | 1.3091 | | 0.0796 | | 21.5313 | |
| Fraxinus | 16C | 0.0535 | 1.1732 | 0.0004 | 0.0021 | 0.0000 | 5.2500 | 0.0011 | 0.0001 | 0.0000 | | 0.0001 | | 0.0000 | | None | |
| Garrya | 16C | 0.0428 | 4.6652 | 0.4969 | 3.6392 | 1.8083 | 7.3238 | 0.0004 | 6.5363 | 0.0059 | | 5.2616 | | 0.0310 | | 891.7966 | |
| Goodyera | 16C | 0.0895 | 1.1878 | 0.2618 | 0.3989 | 0.1044 | 1.5237 | 0.0056 | 4.3429 | 0.0688 | | 1.6673 | | 0.1147 | | 24.2340 | |
| Gossypium | 16C | 0.0297 | 1.3946 | 0.0882 | 0.7941 | 0.0700 | 9.0034 | 0.0035 | 7.0412 | 0.0664 | | 5.0413 | | 0.3347 | | 75.9232 | |
| Habenaria | 16C | 0.1343 | 1.1116 | 0.3562 | 0.2756 | 0.0982 | 0.7737 | 0.0053 | 3.7570 | 0.0583 | | 1.1343 | | 0.0661 | | 19.4563 | |
| Hemsleya | 16A | 0.0158 | 3.6021 | 0.1281 | 2.5106 | 0.3216 | 19.5988 | 0.0019 | 4.4533 | 0.0216 | | 3.4499 | | 0.0745 | | 159.7176 | |
| Holcoglossum | 16C | 0.0447 | 1.3002 | 0.1361 | 0.7402 | 0.1007 | 5.4386 | 0.0055 | 4.1567 | 0.0670 | | 2.9817 | | 0.1998 | | 44.5030 | |
| Hypericum | 16C | 0.0398 | 1.4102 | 0.1259 | 0.6912 | 0.0870 | 5.4901 | 0.0149 | 2.4862 | 0.0725 | | 1.0607 | | 0.0769 | | 14.6303 | |
| Kadsura | 16A | 0.1050 | 0.9136 | 0.4183 | 0.6733 | 0.2816 | 1.6096 | 0.0412 | 1.3039 | 0.2342 | | 0.9613 | | 0.2251 | | 4.1046 | |
| Ligustrum | 16C | 0.0841 | 1.5828 | 0.3205 | 0.7441 | 0.2385 | 2.3217 | 0.0016 | 9.5327 | 0.0394 | | 4.9497 | | 0.1950 | | 125.6269 | |
| Lithospermum | 16C | 0.0971 | 1.2229 | 0.2726 | 0.6843 | 0.1865 | 2.5103 | 0.0044 | 4.9581 | 0.0587 | | 3.2602 | | 0.1914 | | 55.5400 | |
| Malus | 16A | 0.0473 | 1.3046 | 0.1535 | 0.7053 | 0.1083 | 4.5948 | 0.0277 | 2.8169 | 0.1446 | | 1.1353 | | 0.1642 | | 7.8513 | |
| Meconopsis | 16C | 0.1050 | 1.0012 | 0.3056 | 0.4434 | 0.1355 | 1.4509 | 0.0210 | 1.2960 | 0.0729 | | 0.5289 | | 0.0386 | | 7.2551 | |
| Melampodium | 16A | 0.0858 | 1.3346 | 0.2606 | 0.6234 | 0.1625 | 2.3922 | 0.0141 | 2.2760 | 0.0681 | | 0.9943 | | 0.0677 | | 14.6006 | |
| Meliosma | 16A | 0.0563 | 1.8782 | 0.2317 | 0.9512 | 0.2204 | 4.1053 | 0.0199 | 3.8506 | 0.1628 | | 1.8930 | | 0.3082 | | 11.6278 | |
| Morus | 16C | 0.0546 | 0.8102 | 0.1020 | 0.2438 | 0.0249 | 2.3902 | 0.0072 | 3.0895 | 0.0820 | | 1.4925 | | 0.1224 | | 18.2012 | |
| Myricaria | 16C | 0.1123 | 1.1827 | 0.2963 | 0.4803 | 0.1423 | 1.6210 | 0.0074 | 3.4404 | 0.0737 | | 1.8009 | | 0.1327 | | 24.4355 | |
| Nepenthes | 16C | 0.0913 | 1.4117 | 0.3203 | 0.8233 | 0.2637 | 2.5704 | 0.0148 | 1.9381 | 0.0748 | | 1.1840 | | 0.0886 | | 15.8289 | |
| Nymphaea | 16C | 0.0979 | 1.5318 | 0.3288 | 0.9204 | 0.3026 | 2.7993 | 0.0099 | 2.6587 | 0.0534 | | 1.4853 | | 0.0793 | | 27.8146 | |
| Oreocharis | 16A | 0.0840 | 0.9270 | 0.1455 | 0.2387 | 0.0347 | 1.6405 | 0.0175 | 1.8153 | 0.1127 | | 0.8877 | | 0.1000 | | 7.8767 | |
| Paeonia | 16C | 0.0531 | 1.3655 | 0.1929 | 0.5023 | 0.0969 | 2.6039 | 0.0085 | 2.8443 | 0.0735 | | 1.1982 | | 0.0881 | | 16.3020 | |
| Panax | 16C | 0.1020 | 0.7129 | 0.1425 | 0.2815 | 0.0401 | 1.9754 | 0.0123 | 4.5222 | 0.0643 | | 1.0523 | | 0.0677 | | 16.3655 | |
| Paphiopedilum | 16C | 0.0846 | 3.5009 | 0.6771 | 1.8713 | 1.2671 | 2.7637 | 0.0025 | 0.3389 | 0.0020 | | 0.1822 | | 0.0004 | | 91.1000 | |
| Paris | 16C | 0.1305 | 1.0366 | 0.3111 | 0.5396 | 0.1679 | 1.7345 | 0.0060 | 4.4309 | 0.0575 | | 2.1828 | | 0.1255 | | 37.9617 | |
| Parnassia | 16C | 0.0963 | 1.3980 | 0.3175 | 0.6592 | 0.2093 | 2.0762 | 0.0170 | 2.0120 | 0.0662 | | 0.7772 | | 0.0515 | | 11.7402 | |
| Persicaria | 16A | 0.0371 | 2.1903 | 0.2229 | 1.5453 | 0.3444 | 6.9327 | 0.0280 | 1.8081 | 0.1151 | | 1.0553 | | 0.1215 | | 9.1685 | |
| Peucedanum | 16C | 0.0845 | 1.5421 | 0.3269 | 0.7052 | 0.2305 | 2.1572 | 0.0119 | 2.9812 | 0.0587 | | 0.9020 | | 0.0529 | | 15.3663 | |
| Pinellia | 16A | 0.0565 | 2.7948 | 0.4056 | 2.2109 | 0.8967 | 5.4509 | 0.0191 | 3.3874 | 0.1091 | | 1.7617 | | 0.1922 | | 16.1476 | |
| Plantago | 16C | 0.0750 | 1.5818 | 0.3143 | 0.8684 | 0.2729 | 2.7630 | 0.0134 | 1.6024 | 0.0598 | | 0.9211 | | 0.0551 | | 15.4030 | |
| Potentilla | 16C | 0.0635 | 2.1102 | 0.3665 | 1.4327 | 0.5251 | 3.9091 | 0.0032 | 0.1433 | 0.0013 | | 0.0981 | | 0.0001 | | 75.4615 | |
| Pulmonaria | 16C | 0.0754 | 0.7426 | 0.1005 | 0.2350 | 0.0236 | 2.3383 | 0.0055 | 4.6643 | 0.0852 | | 2.7374 | | 0.2332 | | 32.1291 | |
| Rhodiola | 16C | 0.0851 | 0.9156 | 0.0082 | 0.0282 | 0.0002 | 3.4390 | 0.0022 | 0.0025 | 0.0000 | | 0.0015 | | 0.0000 | | None | |
| Rhododendron | 16C | 0.1062 | 1.5447 | 0.3822 | 0.6270 | 0.2396 | 1.6405 | 0.0031 | 6.7786 | 0.0590 | | 3.2763 | | 0.1933 | | 55.5305 | |
| Sagittaria | 16C | 0.1734 | 1.0135 | 0.6112 | 0.5224 | 0.3193 | 0.8547 | 0.0055 | 1.4560 | 0.0331 | | 0.8912 | | 0.0295 | | 26.9245 | |
| Senecio | 16A | 0.1037 | 0.9350 | 0.3471 | 0.4798 | 0.1665 | 1.3823 | 0.0316 | 1.0136 | 0.1058 | | 0.4808 | | 0.0509 | | 4.5444 | |
| Sinosenecio | 16A | 0.0881 | 1.0281 | 0.2674 | 0.4473 | 0.1196 | 1.6728 | 0.0262 | 1.9944 | 0.1520 | | 0.8568 | | 0.1302 | | 5.6368 | |
| Solanum | 16A | 0.0282 | 2.2032 | 0.1538 | 1.5240 | 0.2344 | 9.9090 | 0.0543 | 1.7102 | 0.2220 | | 1.1417 | | 0.2535 | | 5.1428 | |
| Stachyurus | 16C | 0.0748 | 1.6186 | 0.2646 | 1.0655 | 0.2819 | 4.0268 | 0.0184 | 1.9471 | 0.0891 | | 1.4566 | | 0.1298 | | 16.3479 | |
| Staphylea | 16C | 0.0418 | 2.8928 | 0.2634 | 1.7300 | 0.4557 | 6.5680 | 0.0070 | 3.8748 | 0.0623 | | 2.4363 | | 0.1518 | | 39.1059 | |
| Stewartia | 16C | 0.0612 | 1.6471 | 0.2060 | 0.8888 | 0.1831 | 4.3146 | 0.0041 | 6.2753 | 0.0614 | | 3.9847 | | 0.2447 | | 64.8974 | |
| Swertia | 16A | 0.0991 | 1.2406 | 0.2965 | 0.8143 | 0.2414 | 2.7464 | 0.0205 | 2.3887 | 0.1260 | | 1.6732 | | 0.2108 | | 13.2794 | |
| Symphytum | 16A | 0.0920 | 1.8497 | 0.3387 | 0.6536 | 0.2214 | 1.9297 | 0.0008 | 3.8031 | 0.0072 | | 1.5490 | | 0.0112 | | 215.1389 | |
| Tripterospermum | 16C | 0.0761 | 1.1996 | 0.1907 | 0.5291 | 0.1009 | 2.7745 | 0.0032 | 8.4288 | 0.0708 | | 4.7370 | | 0.3354 | | 66.9068 | |
| Urtica | 16C | 0.0682 | 3.1169 | 0.5063 | 2.4763 | 1.2538 | 4.8910 | 0.0049 | 0.2494 | 0.0031 | | 0.2116 | | 0.0007 | | 68.2581 | |
| Viburnum | 16A | 0.0366 | 1.0982 | 0.0004 | 0.0030 | 0.0000 | 7.5000 | 0.0101 | 0.0003 | 0.0000 | | 0.0002 | | 0.0000 | | None | |
| Vicia | 16A | 0.1031 | 2.3825 | 0.6815 | 1.4340 | 0.9773 | 2.1042 | 0.0005 | 0.1085 | 0.0001 | | 0.0656 | | 0.0000 | | 656.0000 | |
| Zelkova | 16A | 0.0499 | 0.9391 | 0.1028 | 0.6277 | 0.0645 | 6.1060 | 0.0469 | 1.9665 | 0.1874 | | 1.2172 | | 0.2281 | | 6.4952 | |
| Average |  | 0.0786±0.0302 | 1.6389±0.8052 | 0.2828±0.1530 | 0.9064±0.6549 | 0.3066±0.3576 | 3.6924±2.6677 | 0.0111±0.0108 | 3.2122±2.2888 | 0.0701±0.0581 | | 1.8800±1.5244 | | 0.1367±0.1233 | | 59.6200±125.6449 | |

Supplementary Table S2B. Comparison of substitution elements between CA and UG intermediate base pairs in the best-fit double-substitution rate matrix of UA to CG compensatory substitutions

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Matrix | Best fit Model | UG elements | | | | | | CA elements | | | | | |
| Frequency | Mutability | α2(UA→UG) | β2(UG→CG) | α2\*β2 | β2/α2 | Frequency | Mutability | μ2（UA→CA） | γ2（CA→CG) | μ2\*γ2 | γ2/μ2 |
| Acer | 16C | 0.0515 | 2.0732 | 0.2534 | 1.3372 | 0.3388 | 5.2770 | 0.0161 | 2.0228 | 0.0672 | 1.1342 | 0.0762 | 16.8780 |
| Acorus | 16C | 0.0742 | 1.1269 | 0.1705 | 0.6549 | 0.1117 | 3.8411 | 0.0044 | 6.5386 | 0.0739 | 4.7913 | 0.3541 | 64.8349 |
| Actaea | 16C | 0.0538 | 1.7860 | 0.2691 | 0.8919 | 0.2400 | 3.3144 | 0.0098 | 1.9786 | 0.0572 | 1.0469 | 0.0599 | 18.3024 |
| Actinidia | 16C | 0.0423 | 2.2744 | 0.2050 | 1.7332 | 0.3553 | 8.4546 | 0.0101 | 2.5838 | 0.0607 | 2.1452 | 0.1302 | 35.3410 |
| Ajania | 16C | 0.0707 | 2.1141 | 0.2417 | 1.3365 | 0.3230 | 5.5296 | 0.0034 | 10.4282 | 0.0643 | 7.4756 | 0.4807 | 116.2613 |
| Allium | 16C | 0.1190 | 1.9154 | 0.5871 | 1.3377 | 0.7854 | 2.2785 | 0.0105 | 0.1139 | 0.0031 | 0.0810 | 0.0003 | 26.1290 |
| Amomum | 16C | 0.0675 | 1.5348 | 0.2333 | 0.8258 | 0.1927 | 3.5396 | 0.0187 | 1.5363 | 0.0747 | 0.9550 | 0.0713 | 12.7845 |
| Angelica | 16C | 0.0433 | 4.4945 | 0.4594 | 3.9746 | 1.8259 | 8.6517 | 0.0022 | 0.2444 | 0.0013 | 0.2167 | 0.0003 | 166.6923 |
| Aquilaria | 16C | 0.0749 | 1.1384 | 0.1758 | 0.6698 | 0.1178 | 3.8100 | 0.0043 | 6.2384 | 0.0762 | 5.0788 | 0.3870 | 66.6509 |
| Aralia | 16C | 0.0491 | 2.6703 | 0.2954 | 1.7164 | 0.5070 | 5.8104 | 0.0099 | 2.5438 | 0.0540 | 1.5478 | 0.0836 | 28.6630 |
| Asarum | 16C | 0.1137 | 0.9236 | 0.0022 | 0.0055 | 0.0000 | 2.5000 | 0.0020 | 0.0002 | 0.0000 | 0.0001 | 0.0000 | None |
| Astilbe | 16C | 0.0798 | 1.9766 | 0.1705 | 1.6582 | 0.2827 | 9.7255 | 0.0070 | 2.9958 | 0.0739 | 2.7196 | 0.2010 | 36.8011 |
| Astragalus | 16C | 0.0675 | 2.2877 | 0.2932 | 1.1701 | 0.3431 | 3.9908 | 0.0040 | 5.7318 | 0.0468 | 3.1813 | 0.1489 | 67.9765 |
| Betula | 16C | 0.0347 | 4.8439 | 0.1705 | 3.9285 | 0.6698 | 23.0411 | 0.0020 | 9.5120 | 0.0739 | 7.8894 | 0.5830 | 106.7578 |
| Buglossoides | 16C | 0.0515 | 1.2325 | 0.0886 | 0.5196 | 0.0460 | 5.8646 | 0.0083 | 5.9023 | 0.0895 | 3.2472 | 0.2906 | 36.2816 |
| Bupleurum | 16C | 0.0555 | 3.1726 | 0.3711 | 2.4123 | 0.8952 | 6.5004 | 0.0031 | 0.2894 | 0.0020 | 0.2316 | 0.0005 | 115.8000 |
| Calystegia | 16C | 0.0685 | 1.7267 | 0.2238 | 1.1461 | 0.2565 | 5.1211 | 0.0095 | 3.3945 | 0.0737 | 2.7111 | 0.1998 | 36.7856 |
| Caragana | 16C | 0.1010 | 1.6365 | 0.2838 | 0.5633 | 0.1599 | 1.9848 | 0.0110 | 3.5295 | 0.0758 | 1.3790 | 0.1045 | 18.1926 |
| Carex | 16C | 0.0560 | 1.7640 | 0.1705 | 7.8894 | 1.3451 | 46.2721 | 0.0056 | 4.3126 | 0.0739 | 3.0409 | 0.2247 | 41.1488 |
| Celastrus | 16C | 0.0864 | 1.4037 | 0.2400 | 0.8524 | 0.2046 | 3.5517 | 0.0066 | 4.3871 | 0.0713 | 3.3381 | 0.2380 | 46.8177 |
| Ceratophyllum | 16C | 0.0461 | 2.2295 | 0.1705 | 1.3710 | 0.2338 | 8.0411 | 0.0042 | 8.3776 | 0.0739 | 5.5374 | 0.4092 | 74.9310 |
| Chaetanthera | 16C | 0.0941 | 1.9246 | 0.4187 | 1.1149 | 0.4668 | 2.6628 | 0.0105 | 2.4360 | 0.0378 | 0.9069 | 0.0343 | 23.9921 |
| Chloranthus | 16A | 0.0840 | 1.2039 | 0.2340 | 0.8268 | 0.1935 | 3.5333 | 0.0082 | 3.5542 | 0.0700 | 2.5392 | 0.1777 | 36.2743 |
| Circaea | 16C | 0.0107 | 1.7672 | 0.1705 | 1.0493 | 0.1789 | 6.1543 | 0.0029 | 14.0306 | 0.0739 | 10.7351 | 0.7933 | 145.2652 |
| Citrus | 16A | 0.0540 | 1.8426 | 0.1845 | 1.2937 | 0.2387 | 7.0119 | 0.0128 | 3.5273 | 0.0948 | 2.7943 | 0.2649 | 29.4757 |
| Cuscuta | 16C | 0.1205 | 0.8426 | 0.2665 | 0.3801 | 0.1013 | 1.4263 | 0.0197 | 2.2629 | 0.0596 | 0.5206 | 0.0310 | 8.7349 |
| Dahlia | 16C | 0.1179 | 1.1786 | 0.2751 | 0.7247 | 0.1994 | 2.6343 | 0.0060 | 4.8489 | 0.0619 | 3.2076 | 0.1986 | 51.8191 |
| Dendropanax | 16C | 0.0906 | 1.5121 | 0.2877 | 1.0360 | 0.2981 | 3.6010 | 0.0076 | 3.7171 | 0.0679 | 2.9071 | 0.1974 | 42.8144 |
| Draba | 16C | 0.0628 | 1.2530 | 0.1807 | 0.7248 | 0.1310 | 4.0111 | 0.0058 | 3.7167 | 0.0599 | 2.6155 | 0.1567 | 43.6644 |
| Dysosma | 16C | 0.0588 | 2.1229 | 0.1999 | 1.1431 | 0.2285 | 5.7184 | 0.0044 | 8.5151 | 0.0688 | 5.2826 | 0.3634 | 76.7820 |
| Epimedium | 16A | 0.0916 | 1.9280 | 0.3797 | 1.0341 | 0.3926 | 2.7235 | 0.0333 | 1.5572 | 0.1213 | 0.9078 | 0.1101 | 7.4839 |
| Erysimum | 16C | 0.0310 | 1.4746 | 0.1705 | 0.6255 | 0.1066 | 3.6686 | 0.0084 | 3.0730 | 0.0739 | 1.5988 | 0.1182 | 21.6346 |
| Flaveria | 16C | 0.1243 | 1.2637 | 0.3371 | 0.6009 | 0.2026 | 1.7826 | 0.0074 | 3.1926 | 0.0608 | 1.8102 | 0.1101 | 29.7730 |
| Fraxinus | 16C | 0.0747 | 0.8917 | 0.0006 | 0.0029 | 0.0000 | 4.8333 | 0.0011 | 0.0001 | 0.0000 | 0.0001 | 0.0000 | None |
| Garrya | 16C | 0.0362 | 6.2534 | 0.1705 | 5.1480 | 0.8777 | 30.1935 | 0.0004 | 8.8738 | 0.0739 | 7.4429 | 0.5500 | 100.7158 |
| Goodyera | 16C | 0.0596 | 1.7100 | 0.1742 | 0.9679 | 0.1686 | 5.5563 | 0.0056 | 6.5416 | 0.0688 | 4.0455 | 0.2783 | 58.8009 |
| Gossypium | 16C | 0.0887 | 1.7485 | 0.1705 | 0.8674 | 0.1479 | 5.0874 | 0.0035 | 9.4075 | 0.0739 | 5.5067 | 0.4069 | 74.5156 |
| Habenaria | 16C | 0.1166 | 1.2170 | 0.3093 | 0.6327 | 0.1957 | 2.0456 | 0.0053 | 4.1922 | 0.0583 | 2.6042 | 0.1518 | 44.6690 |
| Hemsleya | 16A | 0.0210 | 4.2504 | 0.1703 | 2.6928 | 0.4586 | 15.8121 | 0.0052 | 5.7743 | 0.0584 | 3.7002 | 0.2161 | 63.3596 |
| Holcoglossum | 16C | 0.0978 | 1.7067 | 0.2980 | 1.1744 | 0.3500 | 3.9409 | 0.0055 | 5.8144 | 0.0670 | 4.7307 | 0.3170 | 70.6075 |
| Hypericum | 16C | 0.0954 | 1.4357 | 0.3019 | 0.7182 | 0.2168 | 2.3789 | 0.0149 | 2.5257 | 0.0725 | 1.1020 | 0.0799 | 15.2000 |
| Kadsura | 16A | 0.0848 | 1.9645 | 0.3376 | 1.7022 | 0.5747 | 5.0421 | 0.0393 | 2.8556 | 0.2235 | 2.4305 | 0.5432 | 10.8747 |
| Ligustrum | 16C | 0.1026 | 1.8013 | 0.3908 | 1.0896 | 0.4258 | 2.7881 | 0.0016 | 11.0025 | 0.0394 | 7.2481 | 0.2856 | 183.9619 |
| Lithospermum | 16C | 0.1190 | 1.3270 | 0.3341 | 0.8143 | 0.2721 | 2.4373 | 0.0044 | 5.4547 | 0.0587 | 3.8799 | 0.2278 | 66.0971 |
| Malus | 16A | 0.0934 | 1.3890 | 0.3030 | 0.9323 | 0.2825 | 3.0769 | 0.0300 | 2.7570 | 0.1568 | 1.5008 | 0.2353 | 9.5714 |
| Meconopsis | 16C | 0.1223 | 1.2301 | 0.3560 | 0.5783 | 0.2059 | 1.6244 | 0.0210 | 1.5704 | 0.0729 | 0.6898 | 0.0503 | 9.4623 |
| Melampodium | 16A | 0.1200 | 1.2276 | 0.3647 | 0.8167 | 0.2979 | 2.2394 | 0.0222 | 2.3624 | 0.1078 | 1.3025 | 0.1404 | 12.0826 |
| Meliosma | 16A | 0.0547 | 1.8146 | 0.2252 | 0.9044 | 0.2037 | 4.0160 | 0.0097 | 3.6280 | 0.0793 | 1.7998 | 0.1427 | 22.6961 |
| Morus | 16C | 0.1014 | 1.2986 | 0.1894 | 0.8123 | 0.1538 | 4.2888 | 0.0072 | 6.0995 | 0.0820 | 4.9731 | 0.4078 | 60.6476 |
| Myricaria | 16C | 0.0442 | 1.5011 | 0.1167 | 0.8734 | 0.1019 | 7.4841 | 0.0074 | 4.6479 | 0.0737 | 3.2748 | 0.2414 | 44.4342 |
| Nepenthes | 16C | 0.0499 | 1.6814 | 0.1749 | 0.9218 | 0.1612 | 5.2704 | 0.0148 | 2.3262 | 0.0748 | 1.3257 | 0.0992 | 17.7233 |
| Nymphaea | 16C | 0.1057 | 1.2819 | 0.3550 | 0.6831 | 0.2425 | 1.9242 | 0.0099 | 2.2502 | 0.0534 | 1.1024 | 0.0589 | 20.6442 |
| Oreocharis | 16A | 0.0932 | 1.1383 | 0.1615 | 0.4085 | 0.0660 | 2.5294 | 0.0240 | 2.8587 | 0.1544 | 1.5194 | 0.2346 | 9.8407 |
| Paeonia | 16C | 0.0554 | 2.1585 | 0.2013 | 1.4383 | 0.2895 | 7.1451 | 0.0085 | 4.7377 | 0.0735 | 3.4308 | 0.2522 | 46.6776 |
| Panax | 16C | 0.0827 | 0.7699 | 0.1155 | 0.3516 | 0.0406 | 3.0442 | 0.0123 | 4.7354 | 0.0643 | 1.3143 | 0.0845 | 20.4401 |
| Paphiopedilum | 16C | 0.0535 | 3.2422 | 0.4283 | 2.1406 | 0.9168 | 4.9979 | 0.0025 | 0.3135 | 0.0020 | 0.2084 | 0.0004 | 104.2000 |
| Paris | 16C | 0.1382 | 1.0259 | 0.3296 | 0.5689 | 0.1875 | 1.7260 | 0.0060 | 4.3879 | 0.0575 | 2.3015 | 0.1323 | 40.0261 |
| Parnassia | 16C | 0.0653 | 1.3763 | 0.2151 | 0.8307 | 0.1787 | 3.8619 | 0.0170 | 1.9839 | 0.0662 | 0.9793 | 0.0648 | 14.7931 |
| Persicaria | 16A | 0.0505 | 2.7517 | 0.3034 | 1.7404 | 0.5280 | 5.7363 | 0.0333 | 2.0318 | 0.1365 | 1.1885 | 0.1622 | 8.7070 |
| Peucedanum | 16C | 0.0474 | 1.8282 | 0.1834 | 1.2545 | 0.2301 | 6.8402 | 0.0119 | 3.3471 | 0.0587 | 1.6045 | 0.0942 | 27.3339 |
| Pinellia | 16A | 0.0159 | 3.5618 | 0.1139 | 2.4124 | 0.2748 | 21.1800 | 0.0224 | 3.6242 | 0.1282 | 1.9223 | 0.2464 | 14.9945 |
| Plantago | 16C | 0.0729 | 1.9779 | 0.3054 | 1.2011 | 0.3668 | 3.9329 | 0.0134 | 2.0311 | 0.0598 | 1.2740 | 0.0762 | 21.3043 |
| Potentilla | 16C | 0.0705 | 2.7507 | 0.4070 | 2.3262 | 0.9468 | 5.7155 | 0.0032 | 0.1874 | 0.0013 | 0.1593 | 0.0002 | 122.5385 |
| Pulmonaria | 16C | 0.1416 | 0.9163 | 0.1886 | 0.3788 | 0.0714 | 2.0085 | 0.0055 | 6.7049 | 0.0852 | 4.4126 | 0.3760 | 51.7911 |
| Rhodiola | 16C | 0.0679 | 1.2368 | 0.0065 | 0.0256 | 0.0002 | 3.9385 | 0.0022 | 0.0018 | 0.0000 | 0.0014 | 0.0000 | None |
| Rhododendron | 16C | 0.0447 | 1.9059 | 0.1610 | 1.2088 | 0.1946 | 7.5081 | 0.0031 | 8.6741 | 0.0590 | 6.3163 | 0.3727 | 107.0559 |
| Sagittaria | 16C | 0.1147 | 1.6209 | 0.4040 | 1.0298 | 0.4160 | 2.5490 | 0.0055 | 2.5036 | 0.0331 | 1.7567 | 0.0581 | 53.0725 |
| Senecio | 16A | 0.1293 | 1.4753 | 0.4329 | 0.6505 | 0.2816 | 1.5027 | 0.0454 | 1.5697 | 0.1524 | 0.6518 | 0.0993 | 4.2769 |
| Sinosenecio | 16A | 0.1335 | 1.3754 | 0.4051 | 0.7326 | 0.2968 | 1.8084 | 0.0201 | 2.2270 | 0.1169 | 1.4031 | 0.1640 | 12.0026 |
| Solanum | 16A | 0.0513 | 2.3861 | 0.2801 | 2.0174 | 0.5651 | 7.2024 | 0.0110 | 2.1478 | 0.0452 | 1.5113 | 0.0683 | 33.4358 |
| Stachyurus | 16C | 0.0252 | 1.6376 | 0.0892 | 1.1151 | 0.0995 | 12.5011 | 0.0184 | 1.9722 | 0.0891 | 1.5244 | 0.1358 | 17.1089 |
| Staphylea | 16C | 0.0338 | 3.0047 | 0.2129 | 1.8672 | 0.3975 | 8.7703 | 0.0070 | 4.0327 | 0.0623 | 2.6294 | 0.1638 | 42.2055 |
| Stewartia | 16C | 0.0988 | 1.5407 | 0.3330 | 1.0510 | 0.3500 | 3.1562 | 0.0041 | 5.7981 | 0.0614 | 4.7119 | 0.2893 | 76.7410 |
| Swertia | 16A | 0.1024 | 1.1927 | 0.3062 | 0.5800 | 0.1776 | 1.8942 | 0.0339 | 2.1605 | 0.2085 | 1.1918 | 0.2485 | 5.7161 |
| Symphytum | 16A | 0.0480 | 1.8054 | 0.1769 | 0.9445 | 0.1671 | 5.3392 | 0.0029 | 3.3795 | 0.0257 | 2.2385 | 0.0575 | 87.1012 |
| Tripterospermum | 16C | 0.0821 | 1.4007 | 0.1705 | 0.8585 | 0.1464 | 5.0352 | 0.0032 | 10.2325 | 0.0739 | 7.6870 | 0.5681 | 104.0189 |
| Urtica | 16C | 0.0576 | 3.4058 | 0.4278 | 2.7687 | 1.1844 | 6.4719 | 0.0049 | 0.2750 | 0.0031 | 0.2365 | 0.0007 | 76.2903 |
| Viburnum | 16A | 0.0777 | 0.9647 | 0.0008 | 0.0039 | 0.0000 | 4.8750 | 0.0058 | 0.0002 | 0.0000 | 0.0002 | 0.0000 | None |
| Vicia | 16A | 0.0839 | 2.9499 | 0.5548 | 1.5979 | 0.8865 | 2.8801 | 0.0016 | 0.1345 | 0.0005 | 0.0731 | 0.0000 | 146.2000 |
| Zelkova | 16A | 0.0650 | 1.0018 | 0.1338 | 0.6318 | 0.0845 | 4.7220 | 0.0374 | 1.8240 | 0.1495 | 1.2251 | 0.1832 | 8.1946 |
| Average |  | 0.0755±0.0309 | 1.8846±0.9522 | 0.2496±0.1182 | 1.2627±1.1440 | 0.3332±0.3163 | 5.8868±6.5280 | 0.0107±0.0098 | 3.8632±2.9374 | 0.0688±0.0432 | 2.5713±2.2226 | 0.1896±0.1630 | 49.9194±40.7901 |

Supplementary Table S2C. Comparison of substitution elements between AC and GU intermediate base pairs in the best-fit double-substitution rate matrix of GC to AU compensatory substitutions

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Matrix | Best fit Model | GU elements | | | | | | AC elements | | | | | |
| Frequency | Mutability | α3(GC→GU) | β3(GU→AU) | α3\*β3 | β3/α3 | Frequency | Mutability | μ3（GC→AC） | γ3（AC→AU) | μ3\*γ3 | γ3/μ3 |
| Acer | 16C | 0.0545 | 2.0823 | 0.2685 | 0.6428 | 0.1726 | 2.3940 | 0.0161 | 2.0305 | 0.0672 | 0.5452 | 0.0366 | 8.1131 |
| Acorus | 16C | 0.0564 | 1.4273 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0044 | 8.7943 | 0.0739 | 2.3395 | 0.1729 | 31.6576 |
| Actaea | 16C | 0.0670 | 2.5823 | 0.3349 | 1.0723 | 0.3591 | 3.2019 | 0.0098 | 2.9140 | 0.0572 | 1.2586 | 0.0720 | 22.0035 |
| Actinidia | 16C | 0.0809 | 1.9914 | 0.3924 | 0.8066 | 0.3165 | 2.0556 | 0.0101 | 2.2330 | 0.0607 | 0.9983 | 0.0606 | 16.4465 |
| Ajania | 16C | 0.0418 | 1.3926 | 0.1427 | 0.4822 | 0.0688 | 3.3791 | 0.0034 | 6.2896 | 0.0643 | 2.6973 | 0.1734 | 41.9487 |
| Allium | 16C | 0.1083 | 1.5252 | 0.5341 | 0.5713 | 0.3051 | 1.0696 | 0.0105 | 0.0895 | 0.0031 | 0.0346 | 0.0001 | 11.1613 |
| Amomum | 16C | 0.1338 | 1.1848 | 0.4622 | 0.3629 | 0.1677 | 0.7852 | 0.0187 | 1.1311 | 0.0747 | 0.4197 | 0.0314 | 5.6185 |
| Angelica | 16C | 0.0558 | 4.8572 | 0.5919 | 1.7763 | 1.0514 | 3.0010 | 0.0022 | 0.2641 | 0.0013 | 0.0968 | 0.0001 | 74.4615 |
| Aquilaria | 16C | 0.0644 | 1.4251 | 0.1513 | 0.5363 | 0.0811 | 3.5446 | 0.0043 | 8.4426 | 0.0762 | 4.0669 | 0.3099 | 53.3714 |
| Aralia | 16C | 0.0463 | 2.6126 | 0.2784 | 0.7944 | 0.2212 | 2.8534 | 0.0099 | 2.4917 | 0.0540 | 0.7164 | 0.0387 | 13.2667 |
| Asarum | 16C | 0.1023 | 1.1220 | 0.0020 | 0.0017 | 0.0000 | 0.8500 | 0.0046 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | None |
| Astilbe | 16C | 0.0380 | 2.6214 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0070 | 4.0536 | 0.0739 | 1.1805 | 0.0872 | 15.9743 |
| Astragalus | 16C | 0.0942 | 1.5949 | 0.4090 | 0.3619 | 0.1480 | 0.8848 | 0.0040 | 3.8332 | 0.0468 | 0.9841 | 0.0461 | 21.0278 |
| Betula | 16C | 0.0740 | 2.4928 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0020 | 4.7844 | 0.0739 | 1.5410 | 0.1139 | 20.8525 |
| Buglossoides | 16C | 0.0831 | 0.8358 | 0.1429 | 0.1832 | 0.0262 | 1.2820 | 0.0083 | 3.4135 | 0.0895 | 1.1447 | 0.1025 | 12.7899 |
| Bupleurum | 16C | 0.0881 | 2.6912 | 0.5897 | 0.8141 | 0.4801 | 1.3805 | 0.0031 | 0.2419 | 0.0020 | 0.0782 | 0.0002 | 39.1000 |
| Calystegia | 16C | 0.0652 | 1.4094 | 0.2133 | 0.2370 | 0.0506 | 1.1111 | 0.0095 | 2.6372 | 0.0737 | 0.5606 | 0.0413 | 7.6065 |
| Caragana | 16C | 0.0319 | 1.1009 | 0.0896 | 0.2220 | 0.0199 | 2.4777 | 0.0110 | 2.2153 | 0.0758 | 0.5434 | 0.0412 | 7.1689 |
| Carex | 16C | 0.0862 | 1.9376 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0056 | 4.7320 | 0.0739 | 0.8002 | 0.0591 | 10.8281 |
| Celastrus | 16C | 0.0688 | 1.3604 | 0.1909 | 0.2375 | 0.0453 | 1.2441 | 0.0066 | 4.2131 | 0.0713 | 0.9301 | 0.0663 | 13.0449 |
| Ceratophyllum | 16C | 0.0820 | 1.4470 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0042 | 5.2007 | 0.0739 | 0.8494 | 0.0628 | 11.4939 |
| Chaetanthera | 16C | 0.0913 | 1.5403 | 0.4058 | 0.2777 | 0.1127 | 0.6843 | 0.0105 | 2.1230 | 0.0378 | 0.2259 | 0.0085 | 5.9762 |
| Chloranthus | 16A | 0.1045 | 1.0739 | 0.2911 | 0.3324 | 0.0968 | 1.1419 | 0.0436 | 2.8878 | 0.3730 | 1.0208 | 0.3808 | 2.7367 |
| Circaea | 16C | 0.0617 | 1.3965 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0029 | 9.9989 | 0.0739 | 2.4059 | 0.1778 | 32.5562 |
| Citrus | 16A | 0.0746 | 1.3429 | 0.2549 | 0.1246 | 0.0318 | 0.4888 | 0.0194 | 2.4067 | 0.1430 | 0.2692 | 0.0385 | 1.8825 |
| Cuscuta | 16C | 0.1489 | 0.8292 | 0.3293 | 0.2202 | 0.0725 | 0.6687 | 0.0197 | 2.2449 | 0.0596 | 0.3016 | 0.0180 | 5.0604 |
| Dahlia | 16C | 0.1428 | 0.9135 | 0.3333 | 0.1273 | 0.0424 | 0.3819 | 0.0060 | 3.6706 | 0.0619 | 0.5633 | 0.0349 | 9.1002 |
| Dendropanax | 16C | 0.0602 | 1.4972 | 0.1913 | 0.3928 | 0.0751 | 2.0533 | 0.0076 | 3.6742 | 0.0679 | 1.1021 | 0.0748 | 16.2312 |
| Draba | 16C | 0.1196 | 1.4869 | 0.3442 | 0.3252 | 0.1119 | 0.9448 | 0.0058 | 4.6004 | 0.0599 | 1.1736 | 0.0703 | 19.5927 |
| Dysosma | 16C | 0.0661 | 1.2679 | 0.2244 | 0.2604 | 0.0584 | 1.1604 | 0.0044 | 4.5446 | 0.0688 | 1.2035 | 0.0828 | 17.4927 |
| Epimedium | 16A | 0.1042 | 1.3932 | 0.4321 | 0.2785 | 0.1203 | 0.6445 | 0.0028 | 1.1030 | 0.0102 | 0.2445 | 0.0025 | 23.9706 |
| Erysimum | 16C | 0.0758 | 1.9446 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0084 | 4.2768 | 0.0739 | 1.7590 | 0.1300 | 23.8024 |
| Flaveria | 16C | 0.0975 | 1.1879 | 0.2644 | 0.4805 | 0.1270 | 1.8173 | 0.0074 | 2.9540 | 0.0608 | 1.4473 | 0.0880 | 23.8043 |
| Fraxinus | 16C | 0.0535 | 1.1732 | 0.0004 | 0.0007 | 0.0000 | 1.7500 | 0.0011 | 0.0001 | 0.0000 | 0.0000 | 0.0000 | None |
| Garrya | 16C | 0.0428 | 4.6652 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0004 | 6.5363 | 0.0739 | 1.2731 | 0.0941 | 17.2273 |
| Goodyera | 16C | 0.0895 | 1.1878 | 0.2618 | 0.4997 | 0.1308 | 1.9087 | 0.0056 | 4.3429 | 0.0688 | 2.0884 | 0.1437 | 30.3547 |
| Gossypium | 16C | 0.0297 | 1.3946 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0035 | 7.0412 | 0.0739 | 1.7519 | 0.1295 | 23.7064 |
| Habenaria | 16C | 0.1343 | 1.1116 | 0.3562 | 0.5945 | 0.2118 | 1.6690 | 0.0053 | 3.7570 | 0.0583 | 2.4471 | 0.1427 | 41.9743 |
| Hemsleya | 16A | 0.0158 | 3.6021 | 0.1281 | 0.6694 | 0.0858 | 5.2256 | 0.0019 | 4.4533 | 0.0216 | 0.9198 | 0.0199 | 42.5833 |
| Holcoglossum | 16C | 0.0447 | 1.3002 | 0.1361 | 0.2767 | 0.0377 | 2.0331 | 0.0055 | 4.1567 | 0.0670 | 1.1146 | 0.0747 | 16.6358 |
| Hypericum | 16C | 0.0398 | 1.4102 | 0.1259 | 0.4269 | 0.0537 | 3.3908 | 0.0149 | 2.4862 | 0.0725 | 0.6551 | 0.0475 | 9.0359 |
| Kadsura | 16A | 0.1050 | 0.9136 | 0.4183 | 0.1632 | 0.0683 | 0.3902 | 0.0412 | 1.3039 | 0.2342 | 0.2331 | 0.0546 | 0.9953 |
| Ligustrum | 16C | 0.0841 | 1.5828 | 0.3205 | 0.6644 | 0.2129 | 2.0730 | 0.0016 | 9.5327 | 0.0394 | 4.4198 | 0.1741 | 112.1777 |
| Lithospermum | 16C | 0.0971 | 1.2229 | 0.2726 | 0.3029 | 0.0826 | 1.1112 | 0.0044 | 4.9581 | 0.0587 | 1.4431 | 0.0847 | 24.5843 |
| Malus | 16A | 0.0473 | 1.3046 | 0.1535 | 0.4569 | 0.0701 | 2.9765 | 0.0277 | 2.8169 | 0.1446 | 0.7355 | 0.1064 | 5.0864 |
| Meconopsis | 16C | 0.1050 | 1.0012 | 0.3056 | 0.2608 | 0.0797 | 0.8534 | 0.0210 | 1.2960 | 0.0729 | 0.3111 | 0.0227 | 4.2675 |
| Melampodium | 16A | 0.0858 | 1.3346 | 0.2606 | 0.4198 | 0.1094 | 1.6109 | 0.0141 | 2.2760 | 0.0681 | 0.6695 | 0.0456 | 9.8311 |
| Meliosma | 16A | 0.0563 | 1.8782 | 0.2317 | 0.7508 | 0.1740 | 3.2404 | 0.0199 | 3.8506 | 0.1628 | 1.4942 | 0.2433 | 9.1781 |
| Morus | 16C | 0.0546 | 0.8102 | 0.1020 | 0.2319 | 0.0237 | 2.2735 | 0.0072 | 3.0895 | 0.0820 | 1.4194 | 0.1164 | 17.3098 |
| Myricaria | 16C | 0.1123 | 1.1827 | 0.2963 | 0.3733 | 0.1106 | 1.2599 | 0.0074 | 3.4404 | 0.0737 | 1.3999 | 0.1032 | 18.9946 |
| Nepenthes | 16C | 0.0913 | 1.4117 | 0.3203 | 0.2882 | 0.0923 | 0.8998 | 0.0148 | 1.9381 | 0.0748 | 0.4145 | 0.0310 | 5.5414 |
| Nymphaea | 16C | 0.0979 | 1.5318 | 0.3288 | 0.3781 | 0.1243 | 1.1499 | 0.0099 | 2.6587 | 0.0534 | 0.6102 | 0.0326 | 11.4270 |
| Oreocharis | 16A | 0.0840 | 0.9270 | 0.1455 | 0.2174 | 0.0316 | 1.4942 | 0.0175 | 1.8153 | 0.1127 | 0.8087 | 0.0911 | 7.1757 |
| Paeonia | 16C | 0.0531 | 1.3655 | 0.1929 | 0.5672 | 0.1094 | 2.9404 | 0.0085 | 2.8443 | 0.0735 | 1.3529 | 0.0994 | 18.4068 |
| Panax | 16C | 0.1020 | 0.7129 | 0.1425 | 0.1737 | 0.0248 | 1.2189 | 0.0123 | 4.5222 | 0.0643 | 0.6495 | 0.0418 | 10.1011 |
| Paphiopedilum | 16C | 0.0846 | 3.5009 | 0.6771 | 1.6090 | 1.0895 | 2.3763 | 0.0025 | 0.3389 | 0.0020 | 0.1567 | 0.0003 | 78.3500 |
| Paris | 16C | 0.1305 | 1.0366 | 0.3111 | 0.2664 | 0.0829 | 0.8563 | 0.0060 | 4.4309 | 0.0575 | 1.0777 | 0.0620 | 18.7426 |
| Parnassia | 16C | 0.0963 | 1.3980 | 0.3175 | 0.4533 | 0.1439 | 1.4277 | 0.0170 | 2.0120 | 0.0662 | 0.5344 | 0.0354 | 8.0725 |
| Persicaria | 16A | 0.0371 | 2.1903 | 0.2229 | 0.4534 | 0.1011 | 2.0341 | 0.0280 | 1.8081 | 0.1151 | 0.3097 | 0.0356 | 2.6907 |
| Peucedanum | 16C | 0.0845 | 1.5421 | 0.3269 | 0.6018 | 0.1967 | 1.8409 | 0.0119 | 2.9812 | 0.0587 | 0.7696 | 0.0452 | 13.1107 |
| Pinellia | 16A | 0.0565 | 2.7948 | 0.4056 | 0.4346 | 0.1763 | 1.0715 | 0.0191 | 3.3874 | 0.1091 | 0.3463 | 0.0378 | 3.1742 |
| Plantago | 16C | 0.0750 | 1.5818 | 0.3143 | 0.4326 | 0.1360 | 1.3764 | 0.0134 | 1.6024 | 0.0598 | 0.4589 | 0.0274 | 7.6739 |
| Potentilla | 16C | 0.0635 | 2.1102 | 0.3665 | 0.6537 | 0.2396 | 1.7836 | 0.0032 | 0.1433 | 0.0013 | 0.0448 | 0.0001 | 34.4615 |
| Pulmonaria | 16C | 0.0754 | 0.7426 | 0.1005 | 0.1626 | 0.0163 | 1.6179 | 0.0055 | 4.6643 | 0.0852 | 1.8941 | 0.1614 | 22.2312 |
| Rhodiola | 16C | 0.0851 | 0.9156 | 0.0082 | 0.0181 | 0.0001 | 2.2073 | 0.0022 | 0.0025 | 0.0000 | 0.0010 | 0.0000 | None |
| Rhododendron | 16C | 0.1062 | 1.5447 | 0.3822 | 0.6622 | 0.2531 | 1.7326 | 0.0031 | 6.7786 | 0.0590 | 3.4603 | 0.2042 | 58.6492 |
| Sagittaria | 16C | 0.1734 | 1.0135 | 0.6112 | 0.3278 | 0.2004 | 0.5363 | 0.0055 | 1.4560 | 0.0331 | 0.5592 | 0.0185 | 16.8943 |
| Senecio | 16A | 0.1037 | 0.9350 | 0.3471 | 0.2222 | 0.0771 | 0.6402 | 0.0316 | 1.0136 | 0.1058 | 0.2227 | 0.0236 | 2.1049 |
| Sinosenecio | 16A | 0.0881 | 1.0281 | 0.2674 | 0.4696 | 0.1256 | 1.7562 | 0.0262 | 1.9944 | 0.1520 | 0.8994 | 0.1367 | 5.9171 |
| Solanum | 16A | 0.0282 | 2.2032 | 0.1538 | 0.3971 | 0.0611 | 2.5819 | 0.0543 | 1.7102 | 0.2220 | 0.2975 | 0.0660 | 1.3401 |
| Stachyurus | 16C | 0.0748 | 1.6186 | 0.2646 | 0.1917 | 0.0507 | 0.7245 | 0.0184 | 1.9471 | 0.0891 | 0.2621 | 0.0234 | 2.9416 |
| Staphylea | 16C | 0.0418 | 2.8928 | 0.2634 | 0.9039 | 0.2381 | 3.4317 | 0.0070 | 3.8748 | 0.0623 | 1.2729 | 0.0793 | 20.4318 |
| Stewartia | 16C | 0.0612 | 1.6471 | 0.2060 | 0.5107 | 0.1052 | 2.4791 | 0.0041 | 6.2753 | 0.0614 | 2.2898 | 0.1406 | 37.2932 |
| Swertia | 16A | 0.0991 | 1.2406 | 0.2965 | 0.2467 | 0.0731 | 0.8320 | 0.0205 | 2.3887 | 0.1260 | 0.5070 | 0.0639 | 4.0238 |
| Symphytum | 16A | 0.0920 | 1.8497 | 0.3387 | 0.8773 | 0.2971 | 2.5902 | 0.0008 | 3.8031 | 0.0072 | 2.0793 | 0.0150 | 288.7917 |
| Tripterospermum | 16C | 0.0761 | 1.1996 | 0.1297 | 0.3198 | 0.0415 | 2.4657 | 0.0032 | 8.4288 | 0.0739 | 3.4502 | 0.2550 | 46.6874 |
| Urtica | 16C | 0.0682 | 3.1169 | 0.5063 | 0.4375 | 0.2215 | 0.8641 | 0.0049 | 0.2494 | 0.0031 | 0.0374 | 0.0001 | 12.0645 |
| Viburnum | 16A | 0.0366 | 1.0982 | 0.0004 | 0.0013 | 0.0000 | 3.2500 | 0.0101 | 0.0003 | 0.0000 | 0.0001 | 0.0000 | None |
| Vicia | 16A | 0.1031 | 2.3825 | 0.6815 | 0.9384 | 0.6395 | 1.3770 | 0.0005 | 0.1085 | 0.0001 | 0.0429 | 0.0000 | 429.0000 |
| Zelkova | 16A | 0.0499 | 0.9391 | 0.1028 | 0.0723 | 0.0074 | 0.7033 | 0.0469 | 1.9665 | 0.1874 | 0.1401 | 0.0263 | 0.7476 |
| Average |  | 0.0786±0.0302 | 1.6389±0.8052 | 0.2642±0.1514 | 0.4273±0.3030 | 0.1393±0.1851 | 1.8215±0.9409 | 0.0111±0.0108 | 3.2122±2.2888 | 0.0721±0.0575 | 1.0103±0.9377 | 0.0747±0.0734 | 28.5807±59.0762 |

Supplementary Table S2D. Comparison of substitution elements between CA and UG intermediate base pairs in the best-fit double-substitution rate matrix of UA to CG compensatory substitutions

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Matrix | Best fit Model | UG elements | | | | | | CA elements | | | | | | |
| Frequency | Mutability | α4(UA→UG) | β4(UG→CG) | α4\*β4 | β4/α4 | Frequency | Mutability | | μ4（UA→CA） | γ4（CA→CG) | μ4\*γ4 | γ4/μ4 |
| Acer | 16C | 0.0515 | 2.0732 | 0.2534 | 0.4629 | 0.1173 | 1.8268 | 0.0161 | 2.0228 | | 0.0672 | 0.3926 | 0.0264 | 5.8423 |
| Acorus | 16C | 0.0742 | 1.1269 | 0.1705 | 0.1397 | 0.0238 | 0.8194 | 0.0044 | 6.5386 | | 0.0739 | 1.0221 | 0.0755 | 13.8309 |
| Actaea | 16C | 0.0538 | 1.7860 | 0.2691 | 0.6632 | 0.1785 | 2.4645 | 0.0098 | 1.9786 | | 0.0572 | 0.7785 | 0.0445 | 13.6101 |
| Actinidia | 16C | 0.0423 | 2.2744 | 0.2050 | 0.2894 | 0.0593 | 1.4117 | 0.0101 | 2.5838 | | 0.0607 | 0.3582 | 0.0217 | 5.9012 |
| Ajania | 16C | 0.0707 | 2.1141 | 0.2417 | 0.4931 | 0.1192 | 2.0401 | 0.0034 | 10.4282 | | 0.0643 | 2.7578 | 0.1773 | 42.8896 |
| Allium | 16C | 0.1190 | 1.9154 | 0.5871 | 0.5102 | 0.2995 | 0.8690 | 0.0105 | 0.1139 | | 0.0031 | 0.0309 | 0.0001 | 9.9677 |
| Amomum | 16C | 0.0675 | 1.5348 | 0.2333 | 0.4058 | 0.0947 | 1.7394 | 0.0187 | 1.5363 | | 0.0747 | 0.4693 | 0.0351 | 6.2825 |
| Angelica | 16C | 0.0433 | 4.4945 | 0.4594 | 0.5074 | 0.2331 | 1.1045 | 0.0022 | 0.2444 | | 0.0013 | 0.0277 | 0.0000 | 21.3077 |
| Aquilaria | 16C | 0.0749 | 1.1384 | 0.1758 | 0.1448 | 0.0255 | 0.8237 | 0.0043 | 6.2384 | | 0.0762 | 1.0976 | 0.0836 | 14.4042 |
| Aralia | 16C | 0.0491 | 2.6703 | 0.2954 | 0.7332 | 0.2166 | 2.4821 | 0.0099 | 2.5438 | | 0.0540 | 0.6612 | 0.0357 | 12.2444 |
| Asarum | 16C | 0.1137 | 0.9236 | 0.0022 | 0.0029 | 0.0000 | 1.3182 | 0.0020 | 0.0002 | | 0.0000 | 0.0001 | 0.0000 | None |
| Astilbe | 16C | 0.0798 | 1.9766 | 0.4056 | 0.0823 | 0.0334 | 0.2029 | 0.0070 | 2.9958 | | 0.0586 | 0.1350 | 0.0079 | 2.3038 |
| Astragalus | 16C | 0.0675 | 2.2877 | 0.2932 | 0.9132 | 0.2678 | 3.1146 | 0.0040 | 5.7318 | | 0.0468 | 2.4829 | 0.1162 | 53.0534 |
| Betula | 16C | 0.0347 | 4.8439 | 0.2815 | 0.7805 | 0.2197 | 2.7726 | 0.0020 | | 9.5120 | 0.0327 | 1.5674 | 0.0513 | 47.9327 |  |
| Buglossoides | 16C | 0.0515 | 1.2325 | 0.0886 | 0.3523 | 0.0312 | 3.9763 | 0.0083 | | 5.9023 | 0.0895 | 2.2015 | 0.1970 | 24.5978 |  |
| Bupleurum | 16C | 0.0555 | 3.1726 | 0.3711 | 0.5979 | 0.2219 | 1.6112 | 0.0031 | | 0.2894 | 0.0020 | 0.0574 | 0.0001 | 28.7000 |  |
| Calystegia | 16C | 0.0685 | 1.7267 | 0.2238 | 0.2742 | 0.0614 | 1.2252 | 0.0095 | | 3.3945 | 0.0737 | 0.6486 | 0.0478 | 8.8005 |  |
| Caragana | 16C | 0.1010 | 1.6365 | 0.2838 | 0.7686 | 0.2181 | 2.7082 | 0.0110 | | 3.5295 | 0.0758 | 1.8817 | 0.1426 | 24.8245 |  |
| Carex | 16C | 0.0560 | 1.7640 | 0.2278 | 1.5674 | 0.3571 | 6.8806 | 0.0056 | | 4.3126 | 0.0549 | 0.6913 | 0.0380 | 12.5920 |  |
| Celastrus | 16C | 0.0864 | 1.4037 | 0.2400 | 0.2515 | 0.0604 | 1.0479 | 0.0066 | | 4.3871 | 0.0713 | 0.9850 | 0.0702 | 13.8149 |  |
| Ceratophyllum | 16C | 0.0461 | 2.2295 | 0.1747 | 0.5933 | 0.1036 | 3.3961 | 0.0042 | | 8.3776 | 0.0640 | 2.3962 | 0.1534 | 37.4406 |  |
| Chaetanthera | 16C | 0.0941 | 1.9246 | 0.4187 | 0.6564 | 0.2748 | 1.5677 | 0.0105 | | 2.4360 | 0.0378 | 0.5339 | 0.0202 | 14.1243 |  |
| Chloranthus | 16A | 0.0840 | 1.2039 | 0.2340 | 0.2697 | 0.0631 | 1.1526 | 0.0082 | | 3.5542 | 0.0700 | 0.8282 | 0.0580 | 11.8314 |  |
| Circaea | 16C | 0.0107 | 1.7672 | 0.0278 | 0.3132 | 0.0087 | 11.2662 | 0.0029 | | 14.0306 | 0.0760 | 3.2043 | 0.2435 | 42.1618 |  |
| Citrus | 16A | 0.0540 | 1.8426 | 0.1845 | 0.3039 | 0.0561 | 1.6472 | 0.0128 | | 3.5273 | 0.0948 | 0.6563 | 0.0622 | 6.9230 |  |
| Cuscuta | 16C | 0.1205 | 0.8426 | 0.2665 | 0.2163 | 0.0576 | 0.8116 | 0.0197 | | 2.2629 | 0.0596 | 0.2963 | 0.0177 | 4.9715 |  |
| Dahlia | 16C | 0.1179 | 1.1786 | 0.2751 | 0.2016 | 0.0555 | 0.7328 | 0.0060 | | 4.8489 | 0.0619 | 0.8925 | 0.0552 | 14.4184 |  |
| Dendropanax | 16C | 0.0906 | 1.5121 | 0.2877 | 0.1994 | 0.0574 | 0.6931 | 0.0076 | | 3.7171 | 0.0679 | 0.5596 | 0.0380 | 8.2415 |  |
| Draba | 16C | 0.0628 | 1.2530 | 0.1807 | 0.2468 | 0.0446 | 1.3658 | 0.0058 | | 3.7167 | 0.0599 | 0.8904 | 0.0533 | 14.8648 |  |
| Dysosma | 16C | 0.0588 | 2.1229 | 0.1999 | 0.6986 | 0.1397 | 3.4947 | 0.0044 | | 8.5151 | 0.0688 | 3.2285 | 0.2221 | 46.9259 |  |
| Epimedium | 16A | 0.0916 | 1.9280 | 0.3797 | 0.6330 | 0.2404 | 1.6671 | 0.0333 | | 1.5572 | 0.1213 | 0.5557 | 0.0674 | 4.5812 |  |
| Erysimum | 16C | 0.0310 | 1.4746 | 0.1078 | 0.5476 | 0.0590 | 5.0798 | 0.0084 | | 3.0730 | 0.0747 | 1.3998 | 0.1046 | 18.7390 |  |
| Flaveria | 16C | 0.1243 | 1.2637 | 0.3371 | 0.3933 | 0.1326 | 1.1667 | 0.0074 | | 3.1926 | 0.0608 | 1.1848 | 0.0720 | 19.4868 |  |
| Fraxinus | 16C | 0.0747 | 0.8917 | 0.0006 | 0.0008 | 0.0000 | 1.3333 | 0.0011 | | 0.0001 | 0.0000 | 0.0000 | 0.0000 | None |  |
| Garrya | 16C | 0.0362 | 6.2534 | 0.4203 | 0.9886 | 0.4155 | 2.3521 | 0.0004 | | 8.8738 | 0.0059 | 1.4293 | 0.0084 | 242.2542 |  |
| Goodyera | 16C | 0.0596 | 1.7100 | 0.1742 | 0.4567 | 0.0796 | 2.6217 | 0.0056 | | 6.5416 | 0.0688 | 1.9089 | 0.1313 | 27.7456 |  |
| Gossypium | 16C | 0.0887 | 1.7485 | 0.2632 | 0.5754 | 0.1514 | 2.1862 | 0.0035 | | 9.4075 | 0.0664 | 3.6528 | 0.2425 | 55.0120 |  |
| Habenaria | 16C | 0.1166 | 1.2170 | 0.3093 | 0.3431 | 0.1061 | 1.1093 | 0.0053 | | 4.1922 | 0.0583 | 1.4124 | 0.0823 | 24.2264 |  |
| Hemsleya | 16A | 0.0210 | 4.2504 | 0.1703 | 1.3910 | 0.2369 | 8.1679 | 0.0052 | 5.7743 | | 0.0584 | 1.9114 | 0.1116 | 32.7295 |
| Holcoglossum | 16C | 0.0978 | 1.7067 | 0.2980 | 0.2540 | 0.0757 | 0.8523 | 0.0055 | 5.8144 | | 0.0670 | 1.0233 | 0.0686 | 15.2731 |
| Hypericum | 16C | 0.0954 | 1.4357 | 0.3019 | 0.4257 | 0.1285 | 1.4101 | 0.0149 | 2.5257 | | 0.0725 | 0.6533 | 0.0474 | 9.0110 |
| Kadsura | 16A | 0.0848 | 1.9645 | 0.3376 | 0.2095 | 0.0707 | 0.6206 | 0.0393 | 2.8556 | | 0.2235 | 0.2991 | 0.0668 | 1.3383 |
| Ligustrum | 16C | 0.1026 | 1.8013 | 0.3908 | 0.5399 | 0.2110 | 1.3815 | 0.0016 | 11.0025 | | 0.0394 | 3.5912 | 0.1415 | 91.1472 |
| Lithospermum | 16C | 0.1190 | 1.3270 | 0.3341 | 0.2771 | 0.0926 | 0.8294 | 0.0044 | 5.4547 | | 0.0587 | 1.3200 | 0.0775 | 22.4872 |
| Malus | 16A | 0.0934 | 1.3890 | 0.3030 | 0.2810 | 0.0851 | 0.9274 | 0.0300 | 2.7570 | | 0.1568 | 0.4523 | 0.0709 | 2.8846 |
| Meconopsis | 16C | 0.1223 | 1.2301 | 0.3560 | 0.3559 | 0.1267 | 0.9997 | 0.0210 | 1.5704 | | 0.0729 | 0.4246 | 0.0310 | 5.8244 |
| Melampodium | 16A | 0.1200 | 1.2276 | 0.3647 | 0.1657 | 0.0604 | 0.4543 | 0.0222 | 2.3624 | | 0.1078 | 0.2642 | 0.0285 | 2.4508 |
| Meliosma | 16A | 0.0547 | 1.8146 | 0.2252 | 0.7080 | 0.1594 | 3.1439 | 0.0097 | 3.6280 | | 0.0793 | 1.4089 | 0.1117 | 17.7667 |
| Morus | 16C | 0.1014 | 1.2986 | 0.1894 | 0.1550 | 0.0294 | 0.8184 | 0.0072 | 6.0995 | | 0.0820 | 0.9488 | 0.0778 | 11.5707 |
| Myricaria | 16C | 0.0442 | 1.5011 | 0.1167 | 0.3023 | 0.0353 | 2.5904 | 0.0074 | 4.6479 | | 0.0737 | 1.1335 | 0.0835 | 15.3799 |
| Nepenthes | 16C | 0.0499 | 1.6814 | 0.1749 | 0.4595 | 0.0804 | 2.6272 | 0.0148 | 2.3262 | | 0.0748 | 0.6609 | 0.0494 | 8.8356 |
| Nymphaea | 16C | 0.1057 | 1.2819 | 0.3550 | 0.3623 | 0.1286 | 1.0206 | 0.0099 | 2.2502 | | 0.0534 | 0.5846 | 0.0312 | 10.9476 |
| Oreocharis | 16A | 0.0932 | 1.1383 | 0.1615 | 0.3172 | 0.0512 | 1.9641 | 0.0240 | 2.8587 | | 0.1544 | 1.1798 | 0.1822 | 7.6412 |
| Paeonia | 16C | 0.0554 | 2.1585 | 0.2013 | 0.4250 | 0.0856 | 2.1113 | 0.0085 | 4.7377 | | 0.0735 | 1.0137 | 0.0745 | 13.7918 |
| Panax | 16C | 0.0827 | 0.7699 | 0.1155 | 0.1607 | 0.0186 | 1.3913 | 0.0123 | 4.7354 | | 0.0643 | 0.6007 | 0.0386 | 9.3421 |
| Paphiopedilum | 16C | 0.0535 | 3.2422 | 0.4283 | 1.0791 | 0.4622 | 2.5195 | 0.0025 | 0.3135 | | 0.0020 | 0.1051 | 0.0002 | 52.5500 |
| Paris | 16C | 0.1382 | 1.0259 | 0.3296 | 0.2264 | 0.0746 | 0.6869 | 0.0060 | 4.3879 | | 0.0575 | 0.9160 | 0.0527 | 15.9304 |
| Parnassia | 16C | 0.0653 | 1.3763 | 0.2151 | 0.2580 | 0.0555 | 1.1994 | 0.0170 | 1.9839 | | 0.0662 | 0.3042 | 0.0201 | 4.5952 |
| Persicaria | 16A | 0.0505 | 2.7517 | 0.3034 | 0.7582 | 0.2300 | 2.4990 | 0.0333 | 2.0318 | | 0.1365 | 0.5178 | 0.0707 | 3.7934 |
| Peucedanum | 16C | 0.0474 | 1.8282 | 0.1834 | 0.3386 | 0.0621 | 1.8462 | 0.0119 | 3.3471 | | 0.0587 | 0.4330 | 0.0254 | 7.3765 |
| Pinellia | 16A | 0.0159 | 3.5618 | 0.1139 | 0.9634 | 0.1097 | 8.4583 | 0.0224 | 3.6242 | | 0.1282 | 0.7677 | 0.0984 | 5.9883 |
| Plantago | 16C | 0.0729 | 1.9779 | 0.3054 | 0.5041 | 0.1540 | 1.6506 | 0.0134 | 2.0311 | | 0.0598 | 0.5347 | 0.0320 | 8.9415 |
| Potentilla | 16C | 0.0705 | 2.7507 | 0.4070 | 0.4047 | 0.1647 | 0.9943 | 0.0032 | 0.1874 | | 0.0013 | 0.0277 | 0.0000 | 21.3077 |
| Pulmonaria | 16C | 0.1416 | 0.9163 | 0.1886 | 0.1940 | 0.0366 | 1.0286 | 0.0055 | 6.7049 | | 0.0852 | 2.2595 | 0.1925 | 26.5200 |
| Rhodiola | 16C | 0.0679 | 1.2368 | 0.0065 | 0.0072 | 0.0000 | 1.1077 | 0.0022 | 0.0018 | | 0.0000 | 0.0004 | 0.0000 | None |
| Rhododendron | 16C | 0.0447 | 1.9059 | 0.1610 | 0.4432 | 0.0714 | 2.7528 | 0.0031 | 8.6741 | | 0.0590 | 2.3158 | 0.1366 | 39.2508 |
| Sagittaria | 16C | 0.1147 | 1.6209 | 0.4040 | 0.4346 | 0.1756 | 1.0757 | 0.0055 | 2.5036 | | 0.0331 | 0.7413 | 0.0245 | 22.3958 |
| Senecio | 16A | 0.1293 | 1.4753 | 0.4329 | 0.5971 | 0.2585 | 1.3793 | 0.0454 | 1.5697 | | 0.1524 | 0.5983 | 0.0912 | 3.9259 |
| Sinosenecio | 16A | 0.1335 | 1.3754 | 0.4051 | 0.3777 | 0.1530 | 0.9324 | 0.0201 | 2.2270 | | 0.1169 | 0.7235 | 0.0846 | 6.1891 |
| Solanum | 16A | 0.0513 | 2.3861 | 0.2801 | 0.2313 | 0.0648 | 0.8258 | 0.0110 | 2.1478 | | 0.0452 | 0.1733 | 0.0078 | 3.8341 |
| Stachyurus | 16C | 0.0252 | 1.6376 | 0.0892 | 0.1605 | 0.0143 | 1.7993 | 0.0184 | 1.9722 | | 0.0891 | 0.2194 | 0.0195 | 2.4624 |
| Staphylea | 16C | 0.0338 | 3.0047 | 0.2129 | 0.8789 | 0.1871 | 4.1282 | 0.0070 | 4.0327 | | 0.0623 | 1.2377 | 0.0771 | 19.8668 |
| Stewartia | 16C | 0.0988 | 1.5407 | 0.3330 | 0.2421 | 0.0806 | 0.7270 | 0.0041 | 5.7981 | | 0.0614 | 1.0854 | 0.0666 | 17.6775 |
| Swertia | 16A | 0.1024 | 1.1927 | 0.3062 | 0.3895 | 0.1193 | 1.2720 | 0.0339 | 2.1605 | | 0.2085 | 0.8003 | 0.1669 | 3.8384 |
| Symphytum | 16A | 0.0480 | 1.8054 | 0.1769 | 0.4375 | 0.0774 | 2.4731 | 0.0029 | 3.3795 | | 0.0257 | 1.0369 | 0.0266 | 40.3463 |
| Tripterospermum | 16C | 0.0821 | 1.4007 | 0.2058 | 0.2573 | 0.0530 | 1.2502 | 0.0032 | 10.2325 | | 0.0708 | 2.3039 | 0.1631 | 32.5410 |
| Urtica | 16C | 0.0576 | 3.4058 | 0.4278 | 0.4456 | 0.1906 | 1.0416 | 0.0049 | 0.2750 | | 0.0031 | 0.0381 | 0.0001 | 12.2903 |
| Viburnum | 16A | 0.0777 | 0.9647 | 0.0008 | 0.0006 | 0.0000 | 0.7500 | 0.0058 | 0.0002 | | 0.0000 | 0.0000 | 0.0000 | None |
| Vicia | 16A | 0.0839 | 2.9499 | 0.5548 | 1.3428 | 0.7450 | 2.4203 | 0.0016 | 0.1345 | | 0.0005 | 0.0614 | 0.0000 | 122.8000 |
| Zelkova | 16A | 0.0650 | 1.0018 | 0.1338 | 0.0694 | 0.0093 | 0.5187 | 0.0374 | 1.8240 | | 0.1495 | 0.1345 | 0.0201 | 0.8997 |
| Average |  | 0.0755±0.0309 | 1.8846±0.9522 | 0.2569±0.1220 | 0.4426±0.3093 | 0.1264±0.1186 | 2.0091±1.8360 | 0.0107±0.0098 | 3.8632±2.9374 | | 0.0668±0.0439 | 0.9760±0.8763 | 0.0684±0.0610 | 22.50778±32.4633 |