Polyploidy in Meconopsis
by John Richards

On March 2nd, 2013, Ian McNaughton produced a detailed account of the cytological relationships of the big blue poppies to The Meconopsis Group. This seems to me a very successful explanation of how the various groups of big blue poppies arose, and I am in full agreement with the various suggestions he makes. In the present talk I merely want to add a few highly speculative suggestions to Ian's proposals.

It has generally been assumed that the chromosome count of 2n = 82 for *M. baileyi* is diploid. However, in the context of the genus as a whole, it seems likely that the base number is x = 14, and the diploid count 2n = 28. This would make *M. baileyi* hexaploid.

Table 1. Summary of chromosome counts in the genus *Meconopsis* s.s.

(2n = 14. *M. latifolia)* (Kumar et al., 2012)
2n = 28. *M. robusta, M. napaulensis* (Sugiura 1940)
2n = 56. *M. paniculata, M. regia, M. dhwojii, M. gracilipes, M. longipetiolata, M. latifolia, M. aculeata, M. horridula* s.l. (Ratter 1968)
2n = 74. *M. integrifolia* (Ratter)
2n = 76. *M. simplicifolia*. (McAllister)
2n = 82. *M. baileyi, M. betonicifolia, M. simplicifolia* (Ratter)
2n = 84. *M. simplicifolia, M. quintuplinervia, M. x cookei* (Ratter)
2n = 108-113 *Mm*. 'Slieve Donard', 'Bobby Masterton' (Martini & Geri
2n = 123. M. 'Crewdson Hybrid' (McAllister)
2n = 164. *M. grandis* (McAllister)
M. 'Lingholm' 2n = c 200, 204-235, 235-244, 220-252, >240 (various authors)

Table 2. The level of polyploidy of various 'big blue poppies'

6x hexaploid (2n = 76-84)
baileyi, betonicifolia, simplicifolia
9x nonaploid (2n = 108-130)
'Slieve Donard', 'Bobby Masterton', 'Crewdson Hybrid'
12x dodecaploid (2n = 146-166)
grandis
15x 15-ploid (2n = 184-197)
'Mop-head'
18 x 18-ploid (2n = 219-252)
'Lingholm'

To simplify the following discussion on the origin of 'big blue poppies', I am treating:
Hexaploids as diploids
Nonaploids as triploids
Dodecaploids as tetraploids
15-ploids as pentaploids
18-ploids as hexaploids

Variation at the hexaploid level (e.g. 2n = 82, 84, even possibly 76) and higher 'ploidy levels is very common amongst plants. Such variation may be caused by due to technical difficulties, but it may also be genuine as chromosome loss is buffered by lower gene dosage effects at high 'ploidies.

Table 3. Recorded variation below 'ploidy level in high polyploid Meconopsis.

Hensol Violet'	mean 77	highest 78
baileyi 'Peggy'	78	82
baileyi 'Bolfranks'	80	82
baileyi **2x=84**	77	82
betonicifolia	82	82
grandis ES 239	155	158
grandis EN 245	158	158
grandis **4x = 168**	164	166
grandis ES numbers	146-150	152-156 (seedlings)
'Barney's Blue'	111 (meiosis)	
'Dalemain' **3x=126**	112 (meiosis)	
'Slieve Donard'	110-112	112-114 (meiosis)
'Inshriach'	121	122
'Raspberry'	120-124	124-126
'Bobby Masterton'	128	130

'Lingholm'	mean 230	highest 242
'Lingholm' **6x=252**	240	252
'Lingholm' ex Nelson	240	244
'Lingholm' Nelson seed	235	252
'Lingholm' Linns seed	219	244
'Lingholm' Tromso seed	234	240
'Mop-head' **5x-210**	184-5	186
'Balruddery'	193-5	196-7

Origin of M. grandis.

Three 'diploids' (2n <84) are known in the 'big blue poppies', *M. betonicifolia, M. baileyi* and *M. simplicifolia. M. grandis* (2n <168) has features of both *M. simplicifolia* and *M. baileyi* agg. It is reasonable to suggest that it arose from hybridisation between *M. simplicifolia (SS)* and the sympatric *M. baileyi (BB)*in south-east Tibet where the species are sympatric. The potentially sterile diploid hybrid *SB* would have doubled its chromosomes and become fertile as what we now know as *M. grandis SSBB.* Most polyploids are alloploids, i.e. hybrids which have regained fertility by doubling their chromosome number.

Origin of hybrids

As far as is known, M. *grandis* does not today occur together with *M. baileyi* in nature. However, when they were brought together in cultivation, the next occurrence was the backcrossing (in part intentional) of *M. grandis* to *M. baileyi*. This is the known origin of M. 'Slieve Donard', which as expected is 'triploid', as is M. 'Crewdson hybrid' which we can assume has the same origin.

These triploids *SBB* are completely sterile, because the S genome has no pairing partner at meiosis and will not disjoin regularly. It seems likely that the George Sherriff group, also sterile, which were raised from newly introduced *M. grandis*, have a similar constitution. Most polyploids are alloploids, i.e. hybrids which have regained fertility by doubling their chromosome number.

It is known that *M. grandis SSBB* was backcrossed to *M. baileyi (BB)* rather than *M. simplicifolia (SS)* in the case of *M. x sheldonii* and *M*. 'Slieve Donard', so that the hybrids were *SBB*, not *SSB*. Because of the rarity of *M. simplicifolia* compared to *M. baileyi* in cultivation, it is assumed that all the primary triploid hybrids were of this type.

However, William Clark claimed to have hand-pollinated *M. grandis* with *M. simplicifolia* to give rise to a perennial 'William Clark, of which this was a sterile division. If correct, this would have had the genomic constitution *SSB*.

Origin of 'Lingholm'

As a hexaploid (2n < 246), M. 'Lingholm' will have the genomic constitution *SSBBBB*, having arisen from a sterile triploid (probably 'Slieve Donard') *SBB* with 2n = 123. With the genome *SSBBBB,* each set of chromosomes has a pairing partner at meiosis, so that disjunction will be regular and the plant fertile. Fertility may not be quite so great as in the tetraploid *M. grandis SSBB*, because there will be some multivalent formation amongst the *BBBB* chromosomes

M. 'Lingholm' is a variable fertile strain which arose from sterile plants at Lingholm garden near Brampton in Cumberland. The sterile parent may have been 'Slieve Donard', or another triploid primary cross (originally called *M. x sheldonii*). Lingholm has between 200 and 240 chromosomes. If it arose by a sterile triploid 2n <123 doubling its chromosomes, it should be hexaploid with 2n = 246. However it is usual for high polyploids to lose chromosomes, and to vary in chromosome number.

Later hybridisation

As 'Lingholm' is fertile, it is likely to have crossed with other fertile lines.

Lingholm *SSBBBB x M. grandis SSBB* > pentaploid hybrids *SSBBB*. These are likely to be intermediate betwen *M*. 'Lingholm' and *M. grandis,* and slightly fertile with about 2n = 200. E.g. 'Mophead', 'Louise'.

Lingholm *SSBBBB x M. baileyi BB* > tetraploid hybrids *SBBB*
Likely to resemble *M. baileyi* quite closely, but to be sterile (S has no pairing partner at meiosis) E.g. 'Mrs Jebb', 'Barney's Blue'.

Because 'Lingholm' (*SSBBBB*) and presumptive pentaploids such as 'Mophead' (*SSBBB*) are both fertile to some extent, it is likely that they have hybridised. Such offspring will approach 'Lingholm' more and more closely. They should have a level of fertility approaching that of 'Lingholm', and will have chromosome numbers varying between 200 and 240. Probably such plants are already considered to be within the variability accepted for 'Lingholm'. It is noteworthy that although falling between 5x and 6x levels, ancestrally such plants are between 15x and 18x. With such levels of polysomy and gene redundancy, chromosome number variation is commonplace and has very little effect on phenotype or fertility.

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