# Expression of *det* (determinate) in genotypes $Lf^d$, *Lf*, *lf* and $lf^a$

Murfet, I.C.

Department of Plant Science
University of Tasmania
Hobart, Tas. 7001, Australia

Plants homozygous for the mutant allele *det* (determinate) terminate growth after producing only a small number of reproductive nodes (1, 2, 9, 11). Singer et al. (10) have shown that *det* plants are not botanically determinate because the apical meristem simply ceases growth and the final inflorescence is still formed by an axillary meristem. The interval between the onset of flower initiation and termination of apical activity in *det* plants is markedly influenced by the genotype at the *Lf* (late flowering) locus (8). Plants with genotype *Lf/-* usually produced only one or two normal reproductive nodes, i.e. nodes with a normal pinnate leaf subtending an axillary inflorescence, whereas $lf^a/lf^a$ plants produced 3-6 normal reproductive nodes before terminating. In that study, all *det/det* plants produced at least nine leaves (2 scale leaves + 7 foliage leaves). Thus there is scope for $lf^a$ *det* plants to produce several reproductive nodes since allele $lf^a$ confers the potential for very early flowering (5) and such plants sometimes flower as early as node 5.

Four alleles, $lf^a$, *lf*, *Lf* and $Lf^d$ are known at the *Lf* locus (3, 5) and they determine minimum flowering nodes of 5, 8, 11 and 15, respectively (6, 7). The present study was designed to see whether or not there is a progressive decline in the number of reproductive nodes produced by *det* plants as the sequence $lf^a$, *lf* , *Lf* , $Lf^d$ is ascended.

## Materials and Methods

Two Hobart lines with genotype *lf or* $Lf^d$ and a day neutral (*sn*), indeterminate (*Det*) habit, were crossed with day neutral, *det* segregates with genotype or $lf^a$ *Lf* chosen from the $F_4$ of a cross between Hobart line L69 ($lf^a$ *sn Det*) and John Innes line JI1358 (*Lf Sn det*, see 8). Three crosses were made: cross 771 between line L68 (*lf sn Det*) and an $F_4$ plant with genotype $lf^a$ *sn det*, cross 772 between line L89 ($Lf^d$ *sn Det*) and a plant with genotype $lf^a$ *sn det*, and cross 773 between line L89 ($Lf^d$ *sn Det*) and a plant with genotype*Lf sn det.* Lines 68 and 89 have coloured flowers (*A*) and the *det* parents had white flowers (*a*). The *A* and *Lf* loci are linked (distance about 10 cM; e.g. 3, 5) and the coupling phase arrangement was included to assist with resolution of segregation for the *Lf* alleles. The $F_2$ generation from the three crosses did not contain sufficient *det/det* segregates to permit firm conclusions to be drawn. Hence $F_3$ progenies from all *det/det* $F_2$ segregates were used to provide the data in Table 1 and Fig. 1.

The plants were grown, one per pot, in 14 cm slim line pots in a 1:1 (v:v) mixture of dolerite chips (10 mm) and vermiculite topped with sterilized peat-sand potting mixture. Nutrient (Total Growth Nutrient, R&D Aquaponics, Sydney) was applied once a week. The plants received 8 h of daylight per day at a temperature generally around 18-22°C. They were then moved to 'night' compartments held at 16°C where the photoperiod was extended to 18 h by 10 h of light from a mixed fluorescent (40 W cool white)/incandescent (40 W tungsten bulbs) source providing 55 μmols $m^{-2}$ $s^{-1}$ at pot top.

The data were collected wholly from main shoots. The number of reproductive nodes was taken as the number of nodes to bear a normal pinnate leaf subtending an inflorescence. The cross segregating for the $Lf^d$-$lf^a$ pair of alleles (cross 772) gave a discrete two-class segregation for flowering node. The flowering node distributions in the crosses for the *lf*-$lf^a$ (cross 771) and $Lf^d$-*Lf* (cross 773) pairs were continuous but with obvious minimum frequency regions, and arbitrary cuts were made between the nodes shown in Table 1.

Results and Discussion

The results (Table 1 and Fig. 1) show that $lf^a$ *det* plants had more reproductive nodes than any of the other three *Lf* genotypes. Comparison between data for two different crosses is not strictly valid because the genetic background differs among the crosses. Nevertheless, there was no significant difference in number of reproductive nodes among the three genotypes *lf*, *Lf* and $Lf^d$, or any indication of progressive change from *lf*, through *Lf* to $Lf^d$. These three genotypes mostly produced no more than two reproductive nodes before terminating, although cross 773 (Fig. 1C) produced a few plants with three reproductive nodes. In contrast, $lf^a$ plants generally produced at least three reproductive nodes (Fig. 1A and B). Three out of 22 $lf^a$ plants produced 9 leaves before terminating while the remaining 19 plants (86%) produced 10 or 11 leaves. These results confirm the previous observation (8) that *det* plants always produce at least 9 leaves. In contrast to data obtained previously from cross L69 x JI1358 (8), there were no examples of $lf^a$ *det* plants with 5 or 6 reproductive nodes, but neither were there any plants flowering as early as nodes 5 or 6.

The $lf^a$ allele breaks the usual relationship between the onset of flower initiation and the termination of meristem activity in *det* plants. However, it is not clear whether the extended interval between initiation and termination results from an interaction with $lf^a$ itself or whether it is a consequence of very early flower initiation in the $lf^a$ material tested (background *sn Dne*) and a fixed minimum node limit for expression of *det*. This question should be resolved by examining *det* expression in genotype $lf^a$ *e Sn Dne hr* where flower initiation may commence well above the apparent 9-node-limit for expression of *det* (7). An aberrant $F_3$ plant from cross 771 was excluded from the analysis in Table 1 and Fig. 1, but it may provide information relevant to the above issue. This plant had an abortive flower bud at node 10, a vegetative bud in the leaf axil at node 11, and normal leaves with flowers in their axils at nodes 12, 13 and 14; flower colour was white (*a*). This aberrant plant probably represents one of the rare $lf^a$ "escapes" from the 5-8 node region reported previously (6). If so, $lf^a$ *det* plants flowering above node 9 may also express an extended interval between the onset of flower initiation and meristem termination. This aberrant plant also raises a further issue. Is expression of the *det* program irrevocably triggered by the laying down of the first flower initial or does reversion to the production of vegetative axillary buds reset the clock? If the former situation holds, are intervening vegetative nodes counted by the *det* program? The occurrence of vegetative reversion in peas is well known in certain circumstances, e.g. in early photoperiodic (EI) and impenetrant late types (3), and in late genotypes induced to flower early by grafting to promotive stocks (4). Examination of the expression of *det* in such plants could help resolve these questions.

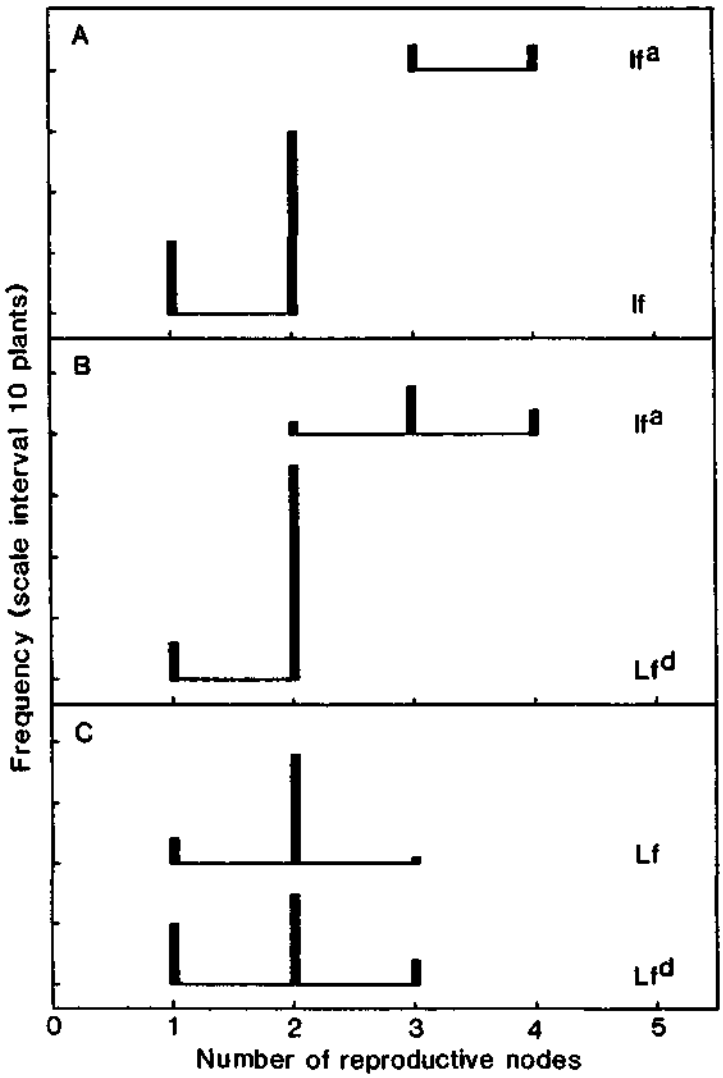


Fig. 1. Distribution of number of reproductive nodes (A) for $lf^a/lf^a$ and *lf*/- segregates in the $F_3$ of cross 771, (B) for $lf^a/lf^a$ and $Lf^d$/- segregates in the $F_3$ of cross 772, and (C) for *Lf/Lf* and $Lf^d$/- segregates in the $F_3$ of cross 773. All plants *det/det sn/sn.* Photoperiod 18 h.

Table 1. The effect of segregation for *lf*-$lf^a$ (cross 771), $Lf^d$-$lf^a$ (cross 772) and $Lf^d$-*Lf* (cross 773) on the number of reproductive nodes produced by *det/det* plants.

| Cross | Genotype | No of reproductive nodes | | | Node of flower initiation (range) |
|---|---|---|---|---|---|
| | | Mean | SE | n | |
| 771 $F_3$ | $lf^a$ *det* | 3.50 | 0.19 | 8 | 7-8 |
| | *lf det* | 1.71 | 0.07 | 42 | 9-13 |
| 772 $F_3$ | $lf^a$ *det* | 3.14 | 0.18 | 14 | 7-8 |
| | $Lf^d$ *det* | 1.85 | 0.06 | 41 | 16-23 |
| 773 $F_3$ | *Lf det* | 1.87 | 0.10 | 23 | 13-17 |
| | $Lf^d$ *det* | 1.79 | 0.13 | 29 | 18-23 |

*Acknowledgements.* I thank Dr Susan Singer for comments on the manuscript and the Australian Research Council for financial support.

1. Makasheva, R.Kh. and Drozd, A.M. 1987. Pisum Newsl. 19:31.
2. Marx, G.A. 1986. Pisum Newsl. 18:45-48.
3. Murfet, I.C. 1971. Heredity 27:93-110.
4. Murfet, I.C. 1971. Aust. J. Biol. Sci. 24:1089-1101.
5. Murfet, I.C. 1975. Heredity 35:85-98.
6. Murfet, I.C. 1978. Pisum Newsl. 10:48-52.
7. Murfet, I.C. 1985. *In* Handbook of Flowering Vol. 4. Ed A.H. Halevy, CRC Press, Boca Raton, pp. 97-126.
8. Murfet, I.C. 1989. Pisum Newsl. 21:44-47.
9. Popova, I.A. 1975. Trudy po selektsii i semenovodstvu ovoshchnykh kultur VNIISSOC 3:66-72.
10. Singer, S.R., Hsiung, L.P. and Huber, S.C. 1991. Am. J. Bot. 77:1330-1335.
11. Swiecicki, W.K. 1987. Pisum Newsl. 19:72-73.