Table 3. Estimates of correlations between effects and/or parental means

	Pods per plant	Seeds per 5 pods	100 seed weight	Seed yield
GCA vs. parental means in F_1	0.75*	0.88**	0.81**	0.93**
GCA vs. GL_1[1/] in F_1	-0.45	-	0.24	0.27
GCA in F_1 vs. GCA in F_2	0.92**	0.96**	0.94**	0.93**
GCA vs. parental means in F_2	0.84**	0.97**	0.91**	0.92**
GCA vs. GL_2[2/] in F_2	0.32	0.08	0.17	-0.12
GL_1 vs. GL_2	-0.63*	-	-0.35	-0.25

[1/] GL_1 = GCA x year effects
[2/] GL_2 = GCA x spacing effects
* Significant at .05
** Significant at .01

BRANCHING IN PISUM: EFFECT OF THE FLOWERING AND LENGTH GENES

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Several flowering genes are reported to influence branching in peas, Photoperiodic lines have a much greater tendency to produce basal laterals than day neutral lines (1) and this holds whether they initiate flowers at a high or low node. The ability to respond to photoperiod is conferred by genotype Sn *Dne* (2) and the effect of this gene combination on both flowering and branching is further increased by gene jir (3,10). Compared with Sn *Dne* stocks, day neutral *Pisum* stocks of genotype sn Dne or Sn dne reduce outgrowth of basal laterals from photoperiodic Lathyrus odoratus scions (11). The Sn Dne combination also delays the appearance of aerial laterals from the upper nodes in veg plants (8). It is suggested the Sn Dne system may achieve these effects by producing in short days a graft-transmissible substance whose primary role is to direct assimilate flow (4,8,11). contrast, flowering genes Lf-d and veg have a less basic effect. Both result in increased production of aerial laterals (6,8). By delaying (Lf-d) or preventing (*veg*) flower initiation they increase the number of potential sites for lateral outgrowth and the underlying changes which take place during this delay result in lateral outgrowth. In lf sn segregates seed yield was found to be derived wholly from pods borne on the main shoot while in the latest Lf-d sn segregates yield was derived partially or wholly from pods on lateral branches (6).

The genes Le/le, La/la, *Cry*/*cry-c* /*cry-s* and Na/na determine several internode length classes ranging in size from the extremely short nana type through dwarf, cryptodwarf , tall and slender (reviewed 9). The present study was designed primarily to examine the effect of these length genes on branching by the use of segregating progenies and near iso-lines. However, some additional data on the effect of flowering genes is also presented. Several other length loci have been established including lk and ls (7). Gene lk results in the erectoides phenotype characterized by short Internodes, thick brittle stems, and other features including increased apical dominance while gene ls results in a nana phenotype (7). A nana line carrying ls (line K202) was included in this study but it should be noted that K202 also differs from its initial line 'Torsdag' in respect of a second unnamed length mutation (7).

All plants were grown in the phytotron, one plant per 14 cm pot, in a 1:1 mixture of vermiculite and dolerite chips. Nutrient solution (Hoaglands) was applied once a week. Temperatures were approximately 20-26C day and 17C night. The short day (SD) photoperiod consisted of 8h of natural light. A long day (LD) photoperiod of 24h was obtained by use of the natural day extended by light from a mixed fluorescent/incandescent source giving approximately 10 Wm at pot top.

Effect of flowering genes. All photoperiodic (Sn *Dne*) lines studied produced more basal laterals in SD than LD. In many such lines a 24h photoperiod completely suppressed outgrowth of basal laterals, e.g. in Torsdag (Table 1) or WL1770 (Table 2). Other photoperiodic lines with a very strong tendency to form basal laterals in SD also produced some basal-laterals in a 24h photoperiod, e.g. WL 1766 (Table 2). SD also caused a marked upward shift in the zone of aerial laterals in Torsdag (Table 1). We attribute this upward shift and increased basal lateral production in SD to activity of the Sn Dne system. In continuous light, activity of this system is suppressed (5). Again in K218 (Sn dne) a day neutral isoline to Torsdag (see 2), activity of the system is largely blocked by dne (2) and basal lateral production did not occur in 8h or 24h conditions. K218 also was devoid of significant aerial laterals.

Segregation for the flowering gene pair E/e in cross (8 x I_3) F2 in SD gave 15 tall early photoperiodic (E) and 6 tall late photoperiodic (e) segregates with mean flowering nodes of 13.9 and 23.8, respectively. The late plants produced over ten times as many aerial laterals as the early plants (Table 2). Thus the greater potential for aerial lateral production in plants with a high flowering node can be realized, at least partially, and gene e, in these specific circumstances, achieves an end effect on aerial branching similar to Lf (6) or veg (8). The underlying mechanism is of course quite different.

Effect of the length genes. From a comparison of the pairs slender/dwarf, tall/dwarf, cryptodwarf/dwarf, tall/nana, and dwarf/nana (Table 2) it is clear that the shorter internode type generally displays the stronger tendency to produce basal laterals. The tendency was so strong in the na nana types that they often bore basal laterals on basal laterals while the first order laterals on average exceeded the main shoot in total length. The one marked exception to the general pattern concerns the nana line K202 which displays a much lower tendency to produce basal laterals than its tall initial line Torsdag, although their lengths differed by a factor of 9. The lack of branching in K202 cannot be attributed to poor growth since vigor in K202 was comparable with that of na nana lines or to gene ls alone since a second length mutation is also present in K202 (see 7). Moreover, the _ls type line, M26 (nana habit), shows profuse basal branching (J. B. Reid, personal communication) in accord with the pattern established for the *na_* nana plants (Table 2).

No general trend was apparent for the effect of the length differences on aerial laterals except for the paucity of such laterals in nana types (Table 2).

We suggest that the length genes may influence branching in Pisum by altering the level of available nutrients. One thing is certain, the flowering and length genes have major effects on branching and the background for these genes and environmental factors such as photoperiod should be taken into account in any study of branching per se although some genes with specific effects on branching may be expressed regardless of these factors.

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Table 1. Effect of photoperiod on the distribution of lateral branches equal to or exceeding 20 cm in length for the late photoperiodic cultivar Torsdag (genotype Lf E Sn Dne hr). The data are summed for 6 plants in each photoperiod.

	Node of origin of lateral													
Photoperiod	1 2	4	6	8	10	12	14	16	18	20	22	24	26	27 28
24 h	-	-	3	3	5	2	-	-	-	-	-	-	-	-
8 h	9	-	-	-	-	-	-	-	1	0	2	2	3	3

Node of flower initiation: 24 h 15.8; 8 h 27.3

Table 2. Effect of genetically determined differences in flowering node or internode length on the occurrence of basal (B) and/or aerial (A) laterals. Comparisons are based on segregating progenies or pairs of near isolines. Photoperiod 8 h except for the WL1770/WL1766 plants indicated.

Comparison	Basal or aerial	Laterals per plant						Genetic backround	Cross or lines
		Mean	s.e.	n	Mean	s.e.	n		
Early (*E*)/Late (*e*)	A***	0.47	0.24	15	5.17	0.91	6	*Le La cry*^{c} *Na Sn Dne hr lf*	(8xI$_3$) F$_2$
Tall (*Le*)/Dwarf (*le*)	B***	0	0	21	1.30	0.15	10	*La cry*^{c} *Na Sn Dne hr*	(8xI$_3$) F$_2$
Cryptodwarf (*la*)/Dwarf (*La*)	B*	0	0	15	0.32	0.14	22	*le cry*^{c} *Na Sn Dne hr*	(8x53) F$_3$
Slender (*la*)/Dwarf (*La*)	B***	0	0	18	0.80	0.17	20	*le cry*^{s} *Na Sn Dne hr*	(8x81) F$_4$
Dwarf (*Na*)/Nana (*na*)1/	B***	1.00	0.19	19	2.60	0.22	10	*le La cry*$^{c/s}$ *Sn Dne hr*	(8x81) F$_3$
	A***	1.11	0.25	19	0	0	10		
Tall (*Na*)/Nana (*na*)1/	B***	1.00	0	5	4.50	0.56	6	*Le La Cry Sn Dne Hr*	WL1770/WL1766
(24 h photoperiod)	B**	0	0	4	0.83	0.17	6		
Tall (*Ls*)/Nana (*ls*)2/	B**	1.50	0.22	6	0.33	0.21	6	*Le La Cry Na Sn Dne hr*	Torsdag/K202

*, **, *** Difference significant at the 0.05, 0.01, and 0.001 level, respectively

1/ Nana plants produced some second order basal laterals but only first order laterals are included in the count

2/ Line K202 also differs from the initial cv Torsdag in respect of a second, unnamed length mutation (7)

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