with the "purposeful behaviour" of the female: it led her towards the blue sky and above the green foliage to where, in the browsing zone of the grasshopper, the longer wavelengths would stimulate egg laying. However, so far as I am aware, hæmoglobin has not, as yet, been found in an organ of a sensory nature, and it would therefore be of interest to re-examine the matter before accepting Cobb's interpretation. Although mature females are not easily found when sought, they are not infrequently encountered accidentally, particularly after heavy summer rain. I would be grateful for the supply of any living worms.

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[1] Cobb, N. A., *J. Wash. Acad. Sci.*, **19**, 159 (1929).
[2] Pearse, A. G. E., *Histochemistry*, 998 (Churchill, London, 1961).
[3] Cobb, N. A., *J. Parasitol.*, **8**, 66 (1926).

Separation of the Effects of Gibberellic Acid on Leaf and Stem Growth of Dwarf French Bean

Gibberellins are the most promising chemicals for controlling leaf expansion, but their effects on different plants differ for unexplained reasons. Thus, although dwarf bean and potato have the same endogenous gibberellin, probably A_5 (ref. 1), they behave differently when sprayed with gibberellic acid (GA). Spraying whole plants increased the rate at which the leaves of both species grew initially, but whereas the primary leaves of dwarf bean stop growing sooner than leaves of unsprayed plants and are no larger when mature[2], leaves of sprayed potato plants continue to grow and when mature are larger than on unsprayed plants[3–5]. The results of the experiment described here, which compares the effect of applying GA to the primary leaves and to the stems of dwarf bean, suggest that the different effects of GA on leaf growth depend on the fact that it moves less readily in dwarf bean stems than through potato stems.

Dwarf French bean plants (*Phaseolus vulgaris*) were grown from uniform seeds in a mixture of sand and peat in a glasshouse during summer. Nutrients were supplied by watering the pots with half-strength Hoagland's solution. After 11 days, when the folded primary leaves were visible between the cotyledons, the apical growing point was removed from half of the plants and 2 μl. of ethanolic GA, containing 2 μg GA, was applied with a micrometer-syringe, either to the epicotyl or shared between a pair of primary leaves. Axillary buds were removed when they appeared on plants without apical growing points. The plants were gathered when the primary leaves of intact untreated plants had stopped growing, and primary leaf areas estimated from length and breadth measurements[2].

Fig. 1 shows that GA applied to epicotyls of intact plants increased primary leaf growth only transiently, whereas applied to the primary leaves it continued to increase their growth and produced larger mature primary leaves than in the controls. GA did not affect hypocotyl extension but lengthened epicotyls and higher internodes (Table 1). GA applied to the epicotyls increased internode extension twice as much as GA applied to the primary leaves. Removing the apical growing point prolonged the time primary leaves continued to expand and produced larger mature primary leaves than in intact plants[6], but, as with intact plants, GA produced larger mature primary leaves only when applied directly to them (Fig. 1). Removing the apical growing point shortened hypocotyls but not epicotyls (Table 1).

Table 1. Effect of GA on Extension of Dwarf French Bean Internodes after 42 days. (Mean internode length mm)

		Hypocotyls	Epicotyls	Others
Apex intact	Untreated	61	45	244
	GA on leaves	63	69	418
	GA on epicotyls	59	94	647
Apex excised	Untreated	56	45	0
	GA on leaves	53	69	0
	GA on epicotyls	55	93	0
S.E.		3·1	2·5	19

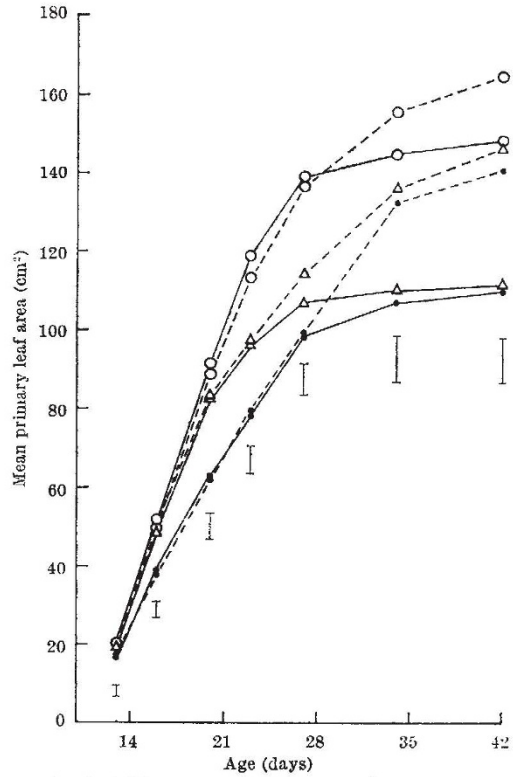

Fig. 1. Effect of GA on expansion of primary leaves of dwarf French bean plants, intact (———) or with apical growing point excised (– – – –). Plants were untreated (●) or GA applied to primary leaves (○) or epicotyl (△). Vertical lines are three times standard error of the mean

When both leaves and stems of potato plants were sprayed with dilute aqueous GA their internodes extended only slightly but they produced larger mature leaves[3], whereas internodes of similarly sprayed dwarf French bean plants extended greatly[2] and their primary leaves grew larger only when they received GA directly. The preferential growth of treated stems or leaves indicates that GA moves little within dwarf French bean plants. By contrast, the temporary proliferation of tubers when haulm of potato was sprayed suggests that GA moves in potato[3].

GA can increase either leaf or stem growth of bean but usually does not do both, which could imply that leaf and stem compete for growth substances or photosynthate. Removing the apical growing point produced larger primary leaves which contain more gibberellin than primary leaves of intact plants, demonstrating that the apex and primary leaves compete for gibberellin[7]. However, suppressing stem growth by removing the apical growing point should eliminate this competition, but when plants without the apical growing point were treated with GA on their epicotyls, the growth of the primary leaves was still only increased transiently, indicating that inability of GA to move freely was more important than competition in preventing expansion of the primary leaves.

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[1] Wheeler, A. W., *J. Exp. Bot.*, **13**, 36 (1962).
[2] Humphries, E. C., *Nature*, **181**, 1081 (1958).
[3] Humphries, E. C., *Ann. App. Biol.*, **46**, 346 (1958).
[4] Humphries, E. C., and French, S. A. W., *Ann. App. Biol.*, **48**, 177 (1960).
[5] Humphries, E. C., and French, S. A. W., *Ann. App. Biol.*, **49**, 331 (1961).
[6] Vyvyan, M. C., *Ann. Bot.*, N.S., **38**, 59 (1924).
[7] Wheeler, A. W., *Rep. Rothamsted Exp. Sta. for 1960*, 100 (1961).