CCLVII. THE ANTISCORBUTIC POTENCY OF APPLES. V.

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CULTIVATED varieties of apples fall into two groups as regards the chromosome number of their nuclei, the so-called diploids with 34 and triploids with 51 chromosomes respectively. Preliminary experiments [Crane and Zilva, 1931] have shown that triploid apples reveal a tendency to possess a higher vitamin C content than diploids. The number of varieties tested in the experiments mentioned was, however, small and it was felt desirable to extend it. In this communication the results of tests carried out with a further number of triploid varieties are given and are compared with those previously obtained with triploid and diploid apples.

EXPERIMENTAL.

The following are the cultural details of the varieties tested.

Gennet Moyle and Ribston (East Malling).

We wish to thank Mr R. G. Hatton and Mr A. C. Painter of the East Malling Research Station, East Malling, Kent, for kindly offering this material and for supplying the cultural details connected with it.

(a) Age of trees—9 years.

(b) Stock—No. 5 (Doucín Amélioré).

(c) Soil—light loam over Kent ragstone—known as Hythe beds (lower greensand series).

(d) Manurial treatment—early years alternate dressings of London stable manure and shoddy. Later years sulphate of potash 3 cwt. per acre *plus* 6 cwt. meat and bone meal. In 1931 received 3 cwt. of sulphate of potash per acre only.

Reinette du Canada.

The bulk of this material was obtained from the Royal Horticultural Society's Gardens, Wisley, Ripley, Surrey, and we wish to thank Mr R. L. Harrow and Mr F. J. Chittenden for their help in supplying it and for the following cultural details in connection with it.

(a) Age of trees—approximately 25 years.

(b) Stock—crab stock.

(c) Soil—light loam over gravel.

(d) Manurial treatment—dressing of superphosphate of lime in the spring at the rate of approximately $\frac{1}{2}$ lb. to the square yard. Garden refuse and a dressing of sulphate of potash (2 oz. to the square yard) were forked in in 1930.

(e) Crop—"moderate."

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As the quantity of material obtained from this source was not quite sufficient to complete the experiment, a further small supply was obtained from a nursery at Slough, Bucks. The cultural details for this material are as follows:

- (a) Age of trees—5 years.
- (b) Stock—English broadleaf.
- (c) Soil—heavy loam.
- (d) Manurial treatment—liberal stable manure.
- (e) Nature of crop—generally medium.

Warner's King.

The material was obtained from a fruit farm in Kent. The cultural details are as follows:

- (a) Age of trees—very old trees severely pruned.
- (b) Stock—probably seedling crabs.
- (c) Soil—medium light soil on ragstone.
- (d) Manurial treatment—sheep-cropped but inclined to be in starved condition. Annual application of about 4 cwt. of potash salts.

Ribston (Canadian); Baldwin 1931 and Gravenstein 1931.

We have to thank Dr W. S. Blair of the Dominion Experimental Farm, Kentville, Nova Scotia, Canada, for this material and for the following cultural details:

- (a) Age of trees—planted in 1912.
- (b) Stock—French stock imported from France. Propagated in Nova Scotia at a local nursery in 1909.

(c) Manurial treatment—the trees since coming into bearing have been supplied with approximately a 5-9-7 fertiliser. This was used at the rate of 5 lbs. per tree in 1924, 1925 and 1926 and 7 lbs. per tree in 1927 and 1928. The fertiliser after 1928 was increased in nitrogen and a fertiliser made up of 200 lbs. of nitrate of soda, 200 lbs. of sulphate of ammonia, 300 lbs. of superphosphate and 100 lbs. of muriate of potash was applied at the rate of 8 lbs. per tree and this mixture was used at the same rate in 1930 and 1931. No farmyard manure was used. This was applied broadcast about the 10th of May, extending about 3 ft. beyond the area of the branches and on the grass as well as on the cultivated areas.

(d) Soil—sandy loam. These trees were clean cultivated until 10 years of age and then a strip of grass was left under the tree, varying from 2 to 8 ft. wide with trees in centre of strip, until the present. This strip of grass was clipped 2 to 3 times during the season, grass was not more than 6 ins. in height at any time. The cut material was evenly spread as a mulch under the trees. The area between this and the next tree was cultivated. The ground was fall ploughed. This cultivation was continued to July 1st at intervals of 2 weeks from the 8th May.

The rows are 40 ft. apart, every other tree is a Wagner. The above varieties are 40 ft. each way with a Wagner filler between, making all trees 20 by 40 ft.

Baldwin 1930.

One barrel ("grade 1") of this material was obtained from the United Fruit Co., Nova Scotia. No cultural details were obtained.

Gravenstein 1930.

One barrel ("grade 1") of these apples was obtained from the United Fruit Co., Nova Scotia, at the same time as the Baldwin 1930 material. In this case also no cultural details were available.

The vitamin C tests were carried out by the procedure already described [Bracewell, Hoyle and Zilva, 1930], except that owing to shortage of experimental material animals dying from intercurrent diseases could not be replaced. We are, however, of the opinion that the assessment of the degree of protection from scurvy in these cases did not suffer much in accuracy. Tables I, II and III set out the origin, the chromosome number and antiscorbutic potency respectively of the above varieties as well as of the varieties previously tested.

Table I.

Variety	Parentage	Origin
Bramley's Seedling	Not known	Raised by Mr Bramley of Southwell, Notts. Introduced in 1876
Belle de Boskoop	"	Originated at Boskoop in Holland in 1856
Gennet Moyle	"	Not known
Reinette du Canada	"	Uncertain. Known in France in the eighteenth century
Blenheim Orange	"	Raised at Woodstock near Blenheim by Mr Kempster. Introduced about 1818
Warner's King	"	Found at Weaving in Kent at the end of the eighteenth century
Ribston Pippin	"	Raised at Ribston Hall, Knaresborough, about 1709, from seeds brought from Rouen
Baldwin	"	Originated about 1740 as a chance seedling on the farm of Mr Ball, Wilmington, Massachusetts
Gravenstein	"	Said to have been found at the castle of Grafenstein, in Schleswig-Holstein. Introduced about 1760
Lane's Prince Albert	"	Found in a garden at Berkhamstead and introduced by Messrs Lane of that town in 1857
Newton Wonder	"	Raised by a Mr Taylor of Kings Newton, Derby, and introduced by Messrs Pearson and Co. about 1887
Cox's Orange Pippin	Alleged to be a seedling from Ribston Pippin	Raised about 1830 by a Mr Cox of Colnbrook Lawn, near Slough, and introduced by Mr Chas. Turner
King Edward VII	Said to be Blenheim Orange $\times$ Golden Noble	Introduced by Messrs Rowe of Worcester about 1908
Worcester Pearmain	Alleged to be a seedling from Devonshire Quarrenden	Originated at Swan Pool, near Worcester, by a Mr Hale. Introduced by Messrs Smith of Worcester in 1874

Table II.

Variety	Chromosome numbers ($2n$)				
	Kobel	Crane and Lawrence	Nebel	Darlington and Moffett	Rybin
Bramley's Seedling	—	51	—	51	—
Belle de Boskoop	ca. 46	—	51	—	—
Gennet Moyle	—	51	—	51	—
Reinette du Canada	38-40	—	51	—	51
Blenheim Orange	—	51	51	51	—
Warner's King	42	—	—	—	—
Ribston Pippin	42	—	51	51	—
Baldwin	48-49	—	51	51	—
Gravenstein	45-46	—	51	—	—
Lane's Prince Albert	—	34	—	34	—
Newton Wonder	—	34	—	34	—
Cox's Orange Pippin	34	34	—	34	—
King Edward VII	Not cytologically examined but resembles a diploid in characters				
Worcester Pearmain	—	34	—	34	—

Table III.

Daily dose of apples g.	3	5	10	20
Bramley's Seedling. Triploid	+++ $\perp$	++++	++++	++++
Belle de Boskoop "	+++ $\perp$	+++ $\perp$ to ++++	++++	++++
Gennet Moyle "	+++	+++ $\perp$	++++	Not tested
Reinette du Canada "	+ $\perp$	++	+++ $\perp$	Not tested
Blenheim Orange "	$\perp$	+++	+++ $\perp$	++++
Warner's King "	$\perp$	+++ $\perp$	+++ $\perp$	++++
Ribston, East Malling "	+	+ $\perp$	+++ $\perp$	Not tested
Ribston, Canadian "	0 to $\perp$	$\perp$	+	+++ $\perp$
Baldwin 1930 "	$\perp$	+	+++ $\perp$	++++
Baldwin 1931 "	0	$\perp$	+++	++++
Gravenstein 1930 "	0	0	0	$\perp$
Gravenstein 1931 "	0	0	0	$\perp$ to +
Lane's Prince Albert. Diploid	$\perp$	+++	++++	++++
Newton Wonder "	$\perp$	+ $\perp$	+++ $\perp$	Not tested
Cox's Orange Pippin "	$\perp$	+	+++ $\perp$	+++ $\perp$
King Edward VII "	0	$\perp$	+++ $\perp$	+++ $\perp$
Worcester Pearmain "	0	0	$\perp$	+++

CONCLUSIONS.

As in the case of the diploid, the triploid apples show a variation in anti-scorbutic activity amongst the varieties tested. Of these at least three, Bramley's Seedling, Belle de Boskoop and Gennet Moyle, stand out as exceptionally active, and four varieties, namely Reinette du Canada, Blenheim Orange, Warner's King and Ribston Pippin are roughly of the same order of potency as Lane's Prince Albert, an outstandingly active variety of the diploid group of apples. The Gravenstein variety, although a triploid, is the least active apple registered in this investigation. It is clear that the results, although suggesting that some connection may exist between the chromosome number and the antiscorbutic activity of the apple, do not supply incontrovertible evidence to that end.

It must however be stressed in this connection that nothing of real value is known of the parentage of the apples used in this investigation, nor is there available any definite knowledge concerning the origin of the triploid form of apple in general. Triploids commonly originate from the crossing of tetraploids with diploids, but since a tetraploid form of the cultivated apple is unknown one is forced to consider the probability that triploid varieties of apples arose from diploids by the accidental functioning of an unreduced gamete. Rybin [1927], moreover, has actually reported triploids arising from diploid parents and, further, triploid forms have arisen in a similar way in other fruits [Osawa, 1920].

It is probable that a triploid derived from "selfing" a diploid with a high vitamin C content or from crossing two very active diploids would yield a triploid variety richer in vitamin C than either diploid parent and that triploids derived from low content diploids would be correspondingly less active. A similar variation in the distribution of other characters among apples is known. Vigour of growth may be cited as an example. Although triploids are

in general more vigorous than diploids this property varies amongst the individual triploid and diploid varieties.

Conclusive evidence could only be obtained by comparing the vitamin C content of triploid forms with that of the diploid apples from which they were derived. This would entail the production of the corresponding triploid forms artificially, a task which is fraught with almost insuperable difficulties. The path for further experiments obviously lies in the direction of other fruits or vegetables in which polyploidy occurs, or can be induced with greater ease, and in which strictly comparable diploid and polyploid forms can be obtained.

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