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BRASSICA CROSSES.

By

ARTHUR W. SUTTON, F.L.S., V.M.H.

A Lecture Delivered
Before the Linnean Society,
January 16th, 1908.

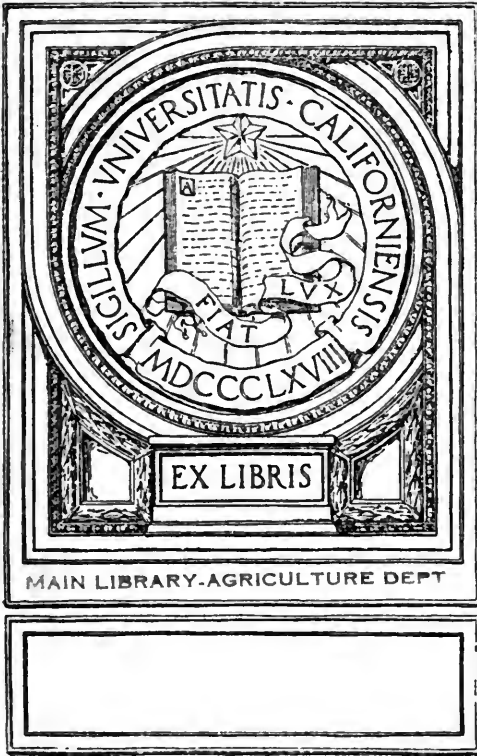
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Results obtained by crossing a Wild Pea from Palestine with Commercial Types. By ARTHUR W. SUTTON, F.L.S., V.M.H.

(PLATES 15-17 and 1 Text-figure.)

[Read 6th February, 1913.]

It has fallen to my lot for very many years past to make a comparative study of all the leading kinds of vegetables grown either in England and on the Continent of Europe, or in America, and in doing so, it has been only natural to try to discover the wild forms from which the present highly developed types have originated. But though in some cases these wild forms, and the stages in their development, may be fairly well known, yet in many others it is not so, and we have to admit that the original wild form is either unknown, or, if known, that we are without any authentic record of the steps which have been taken, and the successive stages reached, in the long process of development. For instance, it is constantly said that the wild *Brassica oleracea* is the original form from which all our garden and farm varieties of Cabbage, Brussels Sprouts, Cauliflower, Savoy, Kale, etc., are descended, but practically all records of the upward stages of development have been lost, and also the names of those by whom this task of development was effected. The Field and Garden Peas are also cases in point. The former—the Field Pea—is well-known as *Pisum arvense*; its flowers are always bicoloured, purple and white, and the seeds have grey or brown seed-coats, and are sometimes spotted. The latter—the Garden Pea—is equally well known as *Pisum sativum*; the flowers are always white and the seed-coats white, yellow, or green, and in form the seeds are either “round” or “wrinkled.”

The Field Peas are never eaten as “green peas,” but are only grown for “corn,” *i. e.*, their seeds are used in the dry state for feeding purposes, and the taste, when green or unripe, is always bitter.

The Garden Peas are generally used as “green peas,” *i. e.* when unripe, although a large quantity are also grown for boiling when ripe, and for producing pea-flour for culinary purposes.

Of the *Pisum arvense*—or Field Pea—many herbarium specimens exist, collected in different parts of the world, but there is no variety in cultivation which has in recent years been raised from any wild form, nor is there any authentic record of the labours of those who presumably spent many years in obtaining the intermediate forms from which the varieties of to-day have originated.

The same is true of the Garden Peas of to-day, with this exception, that, whereas many specimens of the wild *Pisum arvense* have been collected, it is

not possible to-day, so far as I am aware, to find in any locality a plant of *Pisum sativum* in its wild state. The two species, *Pisum arvense* and *Pisum sativum*, are so different in character, that we naturally assume a distinct origin for each, although some authorities claim a common ancestor for both. Under these circumstances it was with very special interest that I noticed in 1904, in a remote part of Palestine, some small Pea plants which were growing in an absolutely wild state, and where there was no possibility of their being "escapes" from previous cultivation.

This wild Pea was in full pod and had lost its blooms, so that I was unable to see whether it was most likely to be a variety of "*Pisum sativum*" or "*Pisum arvense*" but as the form of the pods, though exceedingly small, so

Fig. 1.



The Palestine Pea.

much resembled those of the Garden Pea, I clung to the hope that I had found an original form of that Pea, rather than of the Field Pea, especially as there was no colour in the axils, a character which is invariably seen in every commercial type of "*Pisum arvense*" I have met with, and is always associated with coloured flowers.

The height of the plant, as I saw it growing in Palestine, was perhaps two feet or a little less, the growth was by no means robust, and the pods were very small, slightly curved and obtuse.

The most interesting feature, however, was that the stipules and leaflets, the latter being very small, were deeply serrated (see fig. 1), a character so far found, as I am aware, in no other form of either "*Pisum sativum*" or "*Pisum arvense*," although in some types of Peas there is a slight serration in the stipules.

I was able to bring home several plants and pods of the wild Pea from Palestine, and since 1904 I have grown a pure stock from the seeds which ripened, and have also made a great number of crosses with various types of culinary Peas.

After bringing home the original plants, I removed the seeds from the pods, and was surprised to find that instead of being white, yellow, or green as I had hoped, the seed-coats varied from olive-green, mottled with brown, to a dark colour (Pl. 17. fig. 9), thus proving that my plant was certainly not *Pisum sativum*, but presumably a form of *Pisum arvense*.

The seeds were duly sown in my greenhouse, and I allowed the plants to mature under glass. The "habit" of the plants was much as I had seen it in Palestine; the stems were very slender, but when the flowers opened I found they were *self-coloured* of a shade much resembling magenta (Pl. 15. fig. 2D), and quite different from the blooms of any Peas I had previously grown, thus confirming my conclusion that I was not dealing with a form of "*Pisum sativum*," but more likely with a form of "*Pisum arvense*," even though all cultivated varieties of "*Pisum arvense*" invariably have *bi-coloured* and not *self-coloured* flowers, as in this instance. Besides this, although the flowers of the Palestine Pea were coloured, there was *no colour whatever* in the axils of the leaves or stems of the plant, which, as I have already mentioned, is characteristic of varieties of "*Pisum arvense*." Another striking character was that the pods of the Palestine Pea were lined inside with a white woolly substance similar to that found in the pods of Broad Beans, but never seen, so far as I am aware, in any other variety of *Pisum* *.

* I may here say that Dr. Stapf has very kindly investigated the question of the identity of the Palestine Pea for me, and examined the various herbarium specimens of *Pisum* at Kew, and is of the opinion that although the Pea I found in Palestine somewhat resembles in general characteristics "*Pisum humile*" described by Boissier in the 'Flora Orientalis,' p. 623, from the Huleh Plain of Palestine, it appears to differ chiefly in the colour of the blooms, which in "*Pisum humile*" are said to be "standards dirty lilac" and "wings dirty purple," whilst those of the Pea I found are, as already mentioned, *self-coloured* and magenta. The seed of "*Pisum humile*" also is described as being slightly rough, whilst those of the one in question are fairly smooth. As to whether "*Pisum humile*" lacks the colour in the axils, and has a woolliness in the pod, there appears to be no evidence to show.

Chief characters of the Palestine Pea.

- Weak or slender habit of growth. (Pl. 15. fig. 1 B.)
 Self-coloured magenta blooms. (Pl. 15. fig. 2 D.)
 Serration of the stipules and leaflets. (Fig. 1, also Pl. 15. fig. 3 F.)
 Seeds, olive-green, mottled with brown, and no black hilum.
 (Pl. 17. fig. 9.)
 Pods produced singly or in pairs. (Pl. 15. fig. 3 F.)
 Absence of colour in the axils.
 Woolliness in the interior of pod.
 No fasciation in stems of plants.

I made 24 matings between this Palestine Pea and a corresponding number of forms of the white flowering "*Pisum sativum*," and 16 matings between the Palestine Pea and various forms of the coloured flowering "*Pisum arvense*." In some cases the Palestine Pea was used as the pollen parent, and in others as the seed-bearing parent.

- 36 out of the 40 matings either failed to germinate, or flowered but were sterile, or produced seeds in F_2 , which then failed to germinate. 4 only did I find it possible to continue to F_3 or further, and of these 4 I propose to describe one only, as follows:—

(The reason I have chosen this cross is because it is the only instance in which one of the parental types was umbellate with fasciated stem, the parents thus affording greater contrast than could otherwise have been the case.)

PARENTAL FORMS

- Pisum sativum umbellatum*. (Pl. 15. fig. 1 A.)
 (Crown-flowered or so-called Mummy Pea.)
 The Palestine Pea. (Pl. 15. fig. 1 B.)

Chief characters of *Pisum sativum umbellatum*:—

- Strong habit of growth, about 6 feet in height. (Pl. 15. fig. 1 A.)
 White flowers produced in umbels terminally instead of axillary.
 (Pl. 15. fig. 2 C.)
 Pods produced in clusters. (Pl. 15. fig. 3 E.)
 White round seeds, no black hilum. (Pl. 17. fig. 10.)
 Absence of serration in the leaflets.
 Absence of colour in the axils.
 Stems of plants very much fasciated.

Between these two forms 6 crossings were made, using several plants of each parental form, but only one succeeded, and this gave one seed only.

The following is a brief history of the cross:—

- | | | |
|---------------------------|---|--|
| F ₁
Plants. | { | <p>The cross gave one seed only. This was round, greenish in colour, and with no black hilum.</p> <p>The hybrid plant grew about 2 feet in height, was of normal growth and not umbellate, the foliage was rather small with some leaflets serrated, the colour of the blooms was bi-coloured and not self-coloured (the standards being pink with wings dark purple). This plant produced five seeds, which were much like those of the parental Palestine seeds in colour, but varied in size.</p> <p>No fasciation in stem.</p> |
| F ₂ . | { | <p>The five seeds were sown and all germinated, and grew sufficiently to show that they varied in character. Four of them, however, did not produce a single seed, and only one could be continued beyond F₂. The plant which matured was of fairly strong habit of growth, not umbellate, the leaflets had very little trace of serration, and the blooms were bi-coloured. No fasciation in stem. The seeds were small, brown mottled, with black hilum.</p> |

The seeds from this plant were sown the next year, the new types Nos. 1, 3, 4, and 5 appearing in F₃ and Nos. 2 and 6 in F₄.

New type No. 1. (Pl. 15. fig. 4 G.)

A dark bi-coloured flowering form of the parental umbellate type, appearing in F₃. Previously, so far as I am aware, this dark-flowered umbellate form did not exist, the only umbellate forms hitherto known being (1) a white-flowered form (*Pisum arvense umbellatum*, Pl. 15. fig. 4 H), and (2) a rose- and white-flowered form (*Pisum arvense umbellatum*, Pl. 15. fig. 4 I).

The seeds of this new type (Pl. 17. fig. 13) also differed from those of the parental umbellate form (Pl. 17. fig. 10), and of the rose- and white-umbellate form (Pl. 17. fig. 15). It will be noticed that the seeds of this new type are small and have a black hilum.

Apart from the colour of the blooms and the seed, the hybrid much resembles the parental umbellate form.

New type No. 2. (Pl. 16. fig. 5.)

This is the nearest approach in general appearance I could find to an umbellate form of the Palestine Pea (although the flowers were white), and appeared in F₄ from New type No. 1. It was much weaker in growth than the parental umbellate form. The chief characters were as follows:—

Flowers white.

No serration in the leaflets.

No colour in axils.

Seeds smaller than the parental umbellate or crown-flowered Pea, but with a black hilum. (Pl. 17. fig. 16.)

New type No. 3. (Pl. 16. fig. 6.)

This plant is perhaps the most remarkable of all, being a *non-umbellate* form of a white flowering Pea, which resulted from a cross between the Palestine Pea (a coloured flowered, brown-seeded type) and the *Pisum sativum umbellatum* (white-flowered, white-seeded *umbellate* form). It appeared in F₃.

We have here, therefore, an instance of two types, so different from each other that they might be looked upon as specifically distinct, uniting to give a fertile hybrid. Crosses may, and probably have been made previously between types of the Garden Pea (*Pisum sativum*) and the Field Pea (*Pisum arvense*), but I may confidently say that there is no variety of Pea in commerce to-day, either amongst the Field Peas or culinary Peas, which has arisen in such a manner.

The chief characters were as follows :—

Fairly strong habit of growth.

Flowers white.

Non-umbellate.

Absence of serration in leaflets.

Absence of colour in axils.

Seeds yellow, with small black hilum. (Pl. 17. fig. 17.)

New type No. 4. (Plant not illustrated.)

This plant somewhat resembled the last in growth, but differed in the colour of the bloom. It appeared in F₃. The chief characters were as follows :—

Non-umbellate.

Fairly strong habit of growth.

Flowers bi-coloured.

Absence of serration in leaflets.

Seeds, brownish in colour, mottled, with small black hilum.

(Pl. 16. fig. 18.)

New type No. 5. (Pl. 16. fig. 7.)

This plant is really a more robust and stronger growing form of New type No. 4, and also appeared in F₃. The chief characters were as follows :—

Non-umbellate.

Strong habit of growth.

Flowers bi-coloured.

Absence of serration in leaflets.

Seeds much paler in colour than last named, and with a well-marked hilum. (Pl. 17. fig. 19.)

New type No. 6. (Pl. 16. fig. 8.)

This plant is practically identical in all characters with the parental umbellate type (Pl. 15. fig. 2 C), except that the seeds (Pl. 17. fig. 20) are

entirely distinct from those of the parental umbellate type (Pl. 17. fig. 10), each seed of the New type No. 6 having a well defined black hilum which is entirely wanting in the parent. This appeared in F_4 and came from New type No. 5.

It will be seen by reference to the Plates that in F_3 the umbellate character reappeared in New type No. 1; but as mentioned, the blooms of this umbellate type were dark and bi-coloured, and not pink and white as in the only existing form of "*Pisum arvense umbellatum*" in cultivation. Fasciation in the stem reappeared.

None of the other plants were like the parental Palestine Pea, all being stronger in growth and without serration in the leaflets.

N.B.—It has been quite impossible to test any Mendelian ratios, owing to the marked sterility of the hybrids in the earlier stages.

General Notes on the Crosses.

I should like especially to note that the parental Palestine Pea has not reappeared in its true form with self-coloured flowers, neither has there appeared an exact counterpart of the Palestine Pea bearing white flowers, as might reasonably have been expected. I am inclined to think, however, that both may have been produced, and that if so they died off soon after germinating, being of too delicate habit to grow freely in the open ground. The parental white umbellate form, however, reappeared as before mentioned, but with seeds carrying a black hilum.

I have not yet found a magenta self-coloured umbellate type, nor an umbellate type with serrated leaflets, in fact these two characters, *i. e.*, magenta flowers and serrated leaflets, seem to have entirely disappeared.

I found that coloured flowers were dominant over white. Non-serration of the leaflets appeared in the one plant in F_2 , and has continued.

The pods of the hybrids in F_1 were generally very small, sometimes smaller than those of the Palestine Pea itself, badly developed, and in most cases lined with a woolly substance inside, and the seedlings were generally sterile. Those which were fertile were only comparatively so, although in the plants which I have been able to keep growing the sterility has to a certain extent been overcome, and in these cases the woolliness in the pod has practically disappeared.

When the Palestine Pea was used as the pollen parent, the resulting seeds of the hybrids in F_1 were much smaller in size than those of the seed-bearing parent, and frequently the cotyledons were so badly developed as to make

the seed-coat appear almost empty. In the reverse crosses when the Palestine Pea was used as the seed-bearing parent, the resulting seeds of the hybrid in F_1 were very similar to those of the Palestine Pea, but sometimes of a larger size.

The main purpose of the experiments was to ascertain, if possible, the relationship of the wild Palestine Pea to the cultivated forms, and although, as the result shows, it cannot be claimed that the Palestine Pea is certainly the forerunner either of the present day Garden Peas or Field Peas, yet the fact that some of the hybrids are now fertile does not preclude such a possibility.

EXPLANATION OF THE PLATES.

PLATE 15.

- Fig. 1. Parental types of the cross.
 (A) *Pisum sativum umbellatum*.
 (B) The Palestine Pea.
- Fig. 2. Inflorescence of the two parental forms.
 (C) *Pisum sativum umbellatum*.
 (D) The Palestine Pea.
- Fig. 3. Pods of the two parental forms.
 (E) *Pisum sativum umbellatum*.
 (F) The Palestine Pea.
- Fig. 4. (G) Inflorescence of New type No. 1 and inflorescences of existing *umbellatum* types for comparison.
 (H) *Pisum sativum umbellatum*, white-flowered.
 (I) *Pisum arvense umbellatum*, rose- and white-flowered.

PLATE 16.

- Fig. 5. Plant of new type No. 2.
 6. Plant of new type No. 3.
 7. Plant of new type No. 5.
 8. Plant of new type No. 6.

PLATE 17.

- Fig. 9. Seeds of the parental Palestine Pea.
 10. Seeds of the parental *Pisum sativum umbellatum*.
 11. Seeds of various forms of "*Pisum sativum*" for comparison.
 12. Seeds of various forms of "*Pisum arvense*" for comparison.
 13. Seeds of new type No. 1 (dark-blossomed bi-coloured umbellate form. (Plant shown on Pl. 15, fig. 4 G.)
 14. Seeds of existing white-flowered umbellate form (the parental *Pisum sativum umbellatum*, same as fig. 10).
 15. Seeds of existing rose-and-white umbellate form.
 16. Seeds of new type No. 2. (Plant shown on Pl. 16, fig. 5.)
 17. Seeds of new type No. 3. (Plant shown on Pl. 16, fig. 6.)
 18. Seeds of new type No. 4. (Plant not illustrated.)
 19. Seeds of new type No. 5. (Plant shown on Pl. 16, fig. 7.)
 20. Seeds of new type No. 6. (Plant shown on Pl. 16, fig. 8.)



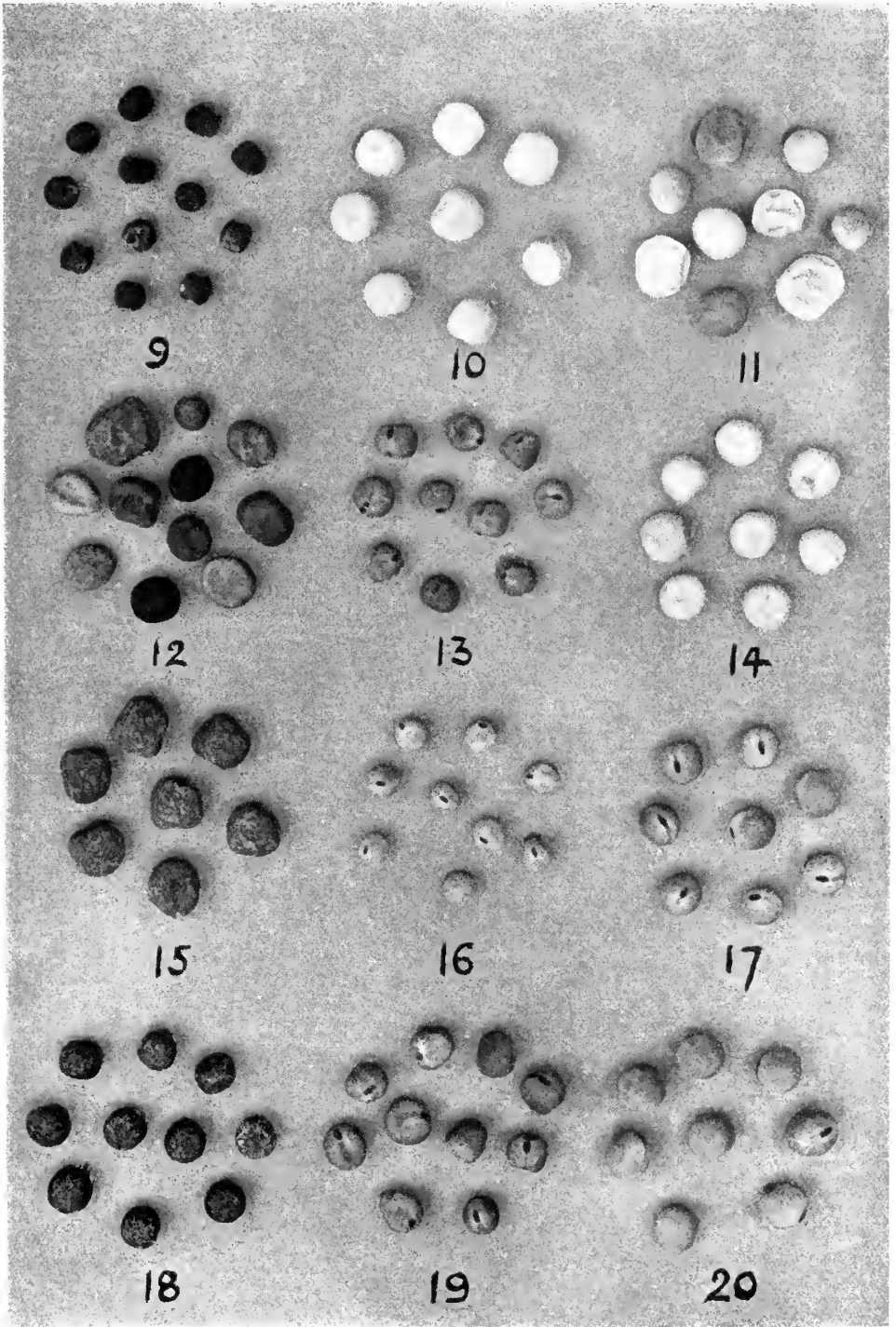
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