

A		B	C	D
No.	Size of Instrument.	Forms of Mounting.	Weight to be moved, in lbs.	Force required, acting at a radius of 5 feet.
1. } 2. }	For a 4-feet reflector....	{ English form No. 2.....	45,000	250
		{ German form improved.	19,000	20
3. } 4. }	For an 8-inch refractor..	{ English form No. 2.....	8,000	45
		{ German form improved.	600	1
5. } 6. }	For a 12-inch refractor..	{ English form No. 2.....	16,000	90
		{ German form improved.	1,200	2

In respect to the foregoing Table, it is right to state, that, so far as Nos. 1 and 2 are concerned, the data in columns C and D are the results of calculation; and the same is to be understood of column D in the case of No. 3. The data for No. 5 are taken directly from those of No. 3, while the numbers appended to No. 6 give the result of actual experience.

*Report on the Experimental Plots in the Botanical Garden of the Royal Agricultural College at Cirencester. By JAMES BUCKMAN, F.L.S., F.A.S., F.G.S., &c., Professor of Geology and Botany, Lecturer on Geology, &c. at the Cheltenham Proprietary College.*

THE experimental plots in the garden of the Royal Agricultural College rest partly on a thin bed of forest marble clay and partly on the brashy soil of the underlying Great Oolite, so that, although most of the soil is of a heavy tenacious character, still a large portion is that of the porous Stone-brashes so prevalent in the district, the nature of the geology being readily made out from the following section.

a. Forest Marble Clay.

b. White Freestones of the Great Oolite.

Neither the staple of the land itself, nor any method of cultivation that has as yet been adopted renders this part of the Royal Agricultural College Farm better, if indeed equal, to the land of the best part of the farm; so that the agricultural experiments at least are not likely to suffer in value from being carried on too exclusively under the conditions of garden culture.

The garden is for the most part divided into plots, the greater portion of which are  $2\frac{1}{2}$  yards square—many however are double that size,—whilst small borders are occupied with single specimens of flowering plants, the latter being mostly grown for assisting demonstrations in the lecture room.

With merely agricultural experiments, the method I have adopted is to first use a small plot, and then adopt either a 5-yard plot or four of these united, after which the matter is transferred to the farm; so that as time progresses, and facilities for carrying on these experiments increase, it is hoped that this garden may be the means of introducing new and valuable varieties of crops to the farmer, as well as of elucidating some interesting facts and principles in Botanical science.

The plots for the present year, 1857, are employed in the growth of plants in the following groups:—

	Plots.
1. Meadow and pasture grasses . . . . .	66
2. Cereal grasses—Corn crops . . . . .	16
3. Papilionaceous plants . . . . .	30
4. Green feeding crops . . . . .	20
5. Esculent vegetables . . . . .	9
6. Economic and medicinal plants . . . . .	16
7. Weeds . . . . .	5
8. Flowering, ornamental, and other plants . . . . .	50
	Total 212

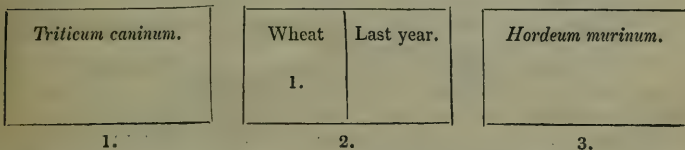
1. THE GRASSES.—These may be very conveniently divided into the following groups.

- a. Grasses of value in meadow and pasture.
- b. Grasses which are but pasture or agrarian weeds.
- c. Grasses which indicate certain conditions of soil, climate, &c.

As regards the plots of grasses generally, I may state that last year these consisted to a great extent of two sets, one planted five years before, and a new lot now just coming to perfection, the difficulty of keeping species unmixed, and other circumstances attendant upon growing specimens in small plots, rendering frequent renewal absolutely necessary. As respects the purity of a crop, the older beds offered some most interesting observations, as they show how in a short period one species may be entirely lost, and the ground be taken possession of by others; hence the following:—

Original Crop*.	Possessed by
Phleum pratense.	Arrhenatherum avenaceum.
Alopecurus pratensis.	Dactylis glomerata.
Lolium Italicum	Poa pratensis.
—— perenne.	Poa pratensis and others.
Cynosurus cristatus.	Holcus lanatus.
Poa trivialis.	Poa nemoralis.

Three beds, side by side, have become mixed in the following manner.



Observations of this nature are interesting in a practical point of view, as, from cultivation or the want of it, meadows are constantly changing their contents, good grasses gaining the ascendant in the former, and bad in the latter. In my plots, bad grasses, that is those of a poor feeding quality, take possession of plots originally sown with better kinds; this arises from the circumstance of the general poverty of the soil, which is assisted by these crops never being depastured like those of meadows, but on the contrary are left to perfect themselves for the teaching of the students, and consequently are annually cut down as ripened or seeded grasses, thus affording a practical example of the injury arising from exhausting crops, besides showing that

\* These and most of the older beds have this year been occupied by totally different crops, the old crops of grasses being gradually destroyed.

many of the grasses only maintain a perfectly perennial habit by being cropped off before they have seeded. This consummation having been attained, many species, such as the *Loliums*, *Hordeums*, *Dactylis*, and *Alopecurus*, die out the same, or at best the second year afterwards; and indeed in cultivation, even when cut before it is ripe, the old plants gradually die out.

Grasses indeed differ so much in the species that prevail and the well or ill doing of these according to circumstances, that the practical observer of them, either in a wild or cultivated shape, or, better, both, may become acquainted not only with the broad features connected with the conditions of soil, but all their inflections, such as its value, the cultivation it has experienced or that should be adopted, mechanical texture, want of draining, and the like.

As regards particular Botanical facts that have received illustration from my experiments, I would shortly comment upon the following genera:—*Alopecurus*, *Dactylis*, *Agrostis*, *Poa*, *Festuca* and *Bromus*\*. Of the first two genera, I received packets of seed from the seedsman with the following names:—

*Alopecurus pratensis*.  
 „ *nigricans*.

*Dactylis glomerata*.  
 „ *gigantea*.

The *A. nigricans* I take to be but a variety of *A. pratensis*; and indeed, after three years of growth, it may almost be pronounced as identical. Both do well; and I can see no reason for preferring the one to the other, so alike are they in growth and habit.

As regards the two names of *Dactylis*, for they are nothing more, they are here inserted to note with reprehension a practice too often adopted by seeds-men, of giving a new name from some accidental enlargement of form perhaps arising from suitable soil—or other unimportant distinctions; and thus disappointment results to the cultivator, while works are burdened with synonyms.

*Agrostis*.—The last year's plots of this were as under:—

Plot A. *Agrostis vulgaris*.

Plot B. *Agrostis stolonifera*.

These were sown in 1855, and at the last meeting they presented the following appearances:—

A. “Presents the usual delicate *A. vulgaris* of the grass meadows with a few plants of *A. stolonifera* intermixed.”

B. “The general plant is *A. vulgaris* having a few *A. stolonifera* intermixed; and these latter present more of the *A. alba* form than of the congested inflorescence and true stolon growth of the *A. stolonifera*.”

This seems to favour the view that the three forms are all referable to a single species†, as when cultivated in a like position their broader features of distinction are lost, and the seed of one, though for the most part coming true, will still send up exceptional examples of each of the others; but the diversity of conditions under which the three forms occur in nature seems sufficient to account for the different aspect which they assume, such as—

*A. vulgaris*, common to upland meadows.

*A. alba*, in ditches and damp places.

*A. stolonifera*, in stony brakes, mostly an accompaniment of agrarian conditions.

\* *Avena* and *Ægilops* to be noticed in the Cereal list.

† This is more strongly confirmed in the present year, 1857, as now

Plot A is attaining the size and appearance of *A. alba*.

Plot B is nearly all *A. alba*. These plots are on a thin clay bed.

POA.—Of this genus, among other species the two following were sown side by side.

*P. aquatica* (*Glyceria*).      *P. fluitans* (*Glyceria*).

These were sown in the autumn of 1855. During 1856 stiff and sturdy short-and rigid-leaved plants were forming; these leaves were so harsh as to cut the flesh on the slightest touch. During the present year, 1857, they have flowered, and to my utter astonishment the plants of both plots are the same; the culms were as much as a yard in height, and the flowers so small and ovate as quite to justify the retaining of the generic name of *Poa* for the whole group.

While these grasses were flowering, I watched them from day to day with great interest, as in all their parts they differed so much from any known species; the short rigid leaves with the angular sheath, and the elegant panicle of flowers from their size, and the rigidity of the whole plant removed these far from the *P. pratensis*, and the whole details differed so much from the forms whose seed was sown as well as from all other recognised forms, that while it showed me I could not have mistaken my seed, it also was convincing that I had obtained a new and singular variety. This indeed is not to be wondered at when we consider that both the forms, the *aquatica* and *fluitans*, absolutely grow in the water; but here I had got them to grow in an upland situation, and to manage like other upland grasses with only water from rain. Still the change was so curious, that I was anxious to re-examine the seeds as sown; and fortunately some of the packets were saved, and I can pronounce them true as named\*.

Here then I cannot help concluding that even such dissimilar grasses as the typical forms of *P. aquatica* and *P. fluitans* are not specifically distinct; and though the former in its wild state bears a large and diffuse panicle of flowers, and the latter is almost as spicate as a *Lolium*, yet we may, I think, connect the evidence here presented to us with that obtained in the growth of the *Festuca loliacea pratensis* and *elatior* presently to be detailed.

However, I shall not conclude my experiments upon this subject without sowing some new plots with seeds of the hitherto supposed species gathered by myself for the express purpose; not that I in the least doubt these experiments, but in order, if possible, to note the changes more clearly †.

FESTUCA.—The species to be communicated upon I shall divide into two groups.

a. *Festuca ovina*.

    "  $\beta$  *duriuscula*.

    "  $\gamma$  *rubra*.

    "  $\delta$  *tenuifolia*.

b. *Festuca loliacea*.

    "  $\beta$  *pratensis*.

    "  $\gamma$  *elatior*.

a. These were sown six years since in three distinct plots, and they soon established themselves in a separate tufted method of growth. The first two years they were readily distinguishable; now, however, the following facts are observable.

*F. ovina* is about eighteen inches high; *F. tenuifolia*, *duriuscula* and *rubra* differ but slightly in size, and scarcely in details, and the creeping habit of root of the latter is entirely lost ‡.

It may be remarked that the *F. rubra* is not amongst our wild forms at Cirencester, but I have occasionally met with specimens of *F. duriuscula* in

\* The two packets were sent for examination.

† Specimens of the new Poas are sent for examination.

‡ Certainly not so much as regards the width and length of the leaves, as the same form takes on in bushes when compared with the open ground.

the road dirt with which the tops of our stone walls are frequently capped, having a decidedly creeping habit which, if shown as a tendency "in light sandy pastures near the sea" which is given by Hooker as the habitat of the *F. rubra*, may account for the difference.

As respects the varieties *F. ovina*, *tenuifolia* and *duriuscula*, it may be remarked that poor uplands present the first, the bushes and hedgerows around these the second, and meadows examples of the latter; but seldom are they greatly intermixed, which, perhaps, may be taken as an argument that these forms are but varieties induced by different circumstances. From long observation and experiment I can only so consider them; and had I a choice of names for the typical form, I should choose that of *duriuscula*, as the departure seems to be from that type, of which *F. ovina* is a mountain form, and *F. rubra* a seaside or arenaceous one.

*b. Festuca loliacea* varieties.

Six years since, I sowed the seeds of the three forms as below, and in the following order.

<i>Festuca loliacea.</i>	<i>Festuca pratensis.</i>	<i>Festuca elatior.</i>
1.	2.	3.

These plots the first year of flowering presented appearances as under:—

1st. *Festuca loliacea*.—Most of the plants of the true spicate type, but sparingly mixed with paniculate flowers: the herbage of which was of the rich green which characterizes *F. loliacea*.

2nd. *Festuca pratensis*.—All true, but with a tendency to a rigidity of leafage.

3rd. *Festuca elatior*, scarcely distinguishable from (2).

In three years great changes had been wrought as under:—

1st. *F. loliacea*.—No spicate flowers.

2nd. *F. pratensis*.—More rigid and larger, in fact none of the true meadow type.

3rd. *F. elatior*.—A little larger, but otherwise not distinguishable from (2).

In the fifth year the *F. elatior* prevailed in all the beds.

These plots are destroyed, as in 1855 the same experiments were recommenced in another part of the garden, the plots, however, being placed at a distance apart; and the present year they were plainly observed to be taking the same course as the others.

Here then, I think it satisfactorily proved by experiment that these three forms are all of them referable to a single species, as the changes indicated have taken place in individuals; they, however, maintain their distinctive characters under the following circumstances.

In meadows by the sides of rivers subject to occasional floods, as the Isis at Oxford, or irrigated meadows, as on the banks of the Churn at Cirencester, *F. loliacea* is constant in its characters, and is a most valuable grass for hay or pasture.

In rich meadow flats, as in the Vale of Berkeley—the celebrated country of the "double Gloucester cheese,"—the *F. pratensis* is a common and valuable denizen, and any meadow where it maintains its character may be considered as of good quality.

On the alluvial sandy clay banks by the seaside, or poor siliceous clays inland, the *F. elatior* rears its tall coarse form. In Gloucestershire the banks of alluvial mud thrown up to prevent the encroachments of the water in the Severn estuary are always occupied by this grass, which I look upon only as the extension of the *pratensis* from the rich flats within this boundary.

The *F. pratensis* is a grass which is usually recommended for admixture in forming new pastures, on which account there can be but little doubt that it was used in the glades laid down within the last few years at the entrance of Oakley Park, the seat of the Earl Bathurst. When first sown it came up true enough, though with a disposition to reediness; the last four years it has become wholly *F. elatior* in all its features, and is now in such large coarse "hassocks" as to be dissightly as a lawn, and much impairs the hay or pasture. The secret of all this appears to be that here it was sown on the forest marble sandy clays, the texture of which as a soil is similar to that in the favourite habitat of this form of grass, and this too, though in a less degree, no doubt, favoured the changes as observed in my botanical garden.

Here then we see, in these forms of Fescue, plants which assume what have been taken as specific characters, not only from change of circumstances giving rise to varieties which have been obtained from different generations by seeding, but these have assumed the form of *varieties* from the same seed and plants, and absolutely becoming *F. pratensis*, and afterwards *F. elatior* from the typical *F. loliacea*: and so certain is this in my experimental garden, that the result of twice sowing these three forms from seed from different seedsmen has been the permanent establishment of *F. elatior* in all three plots.

#### *Bromus mollis* varieties.

My experiments and observations upon the annual forms of Brome, though still in progress, yet seem to warrant a diminution in specific names; for example, *B. mollis* and *B. racemosus* of authors are sure to be intermixed to a greater or less extent from the same seed; thus the seed of the *B. mollis* will have a sprinkling of the *racemosus*, whilst seed of the latter will present exceptional examples of the former; and, besides, all distinction is lost in every shade of intermediate form by which the hairy and smooth varieties are connected.

Again, as regards *B. commutatus*, this is by far too common a grass in pastures subject to floods and in irrigated meadows, in which situation the *B. mollis* is quite exceptional. Now, as I have watched the laying out of poor pastures as irrigated meadows, I have always observed that two or three years is often sufficient to change the *B. mollis* which was alone before into *B. commutatus*. Of course it may be considered that this was in virtue of that law of substitution of one species for another which so universally occurs on a change of soil and other conditions; but I incline to the belief that much of this is after all due to a change of form and specific character, and as regards the grass under consideration our chain of evidence is nearly complete when it is stated that the *B. commutatus* from the irrigated meadows, most certainly in experiments in my garden, has resulted in fine examples of *B. secalinus*, a form not before known there, and therefore not liable to have led me into error, as would be the case where the different varieties are wild natives near the spot.

I have not been able to experiment upon the whole of the forms of what I would term the *B. mollis* group, but I suspect that the *B. arvensis* which I this year found so abundantly on the chalk about Avebury, in Wiltshire, is but a form of the same; and though in all probability a foreign one introduced with "seeds," yet its individuality may have been implanted by

growth in a foreign soil, as I observed when in America most of the naturalized British plants had, to say the least, a different expression from the same grown at home.

2. CEREAL GRASSES—CORN CROPS.—The experiments in this list to which I would direct attention are as under :—

	Plots.
a. Peruvian Barley succeeding Swede Turnips—manured with different manures . . . . .	6
b. Sowing of wheat at different depths . . . . .	2
c. Transmutation of oats . . . . .	5
d. Experiments with <i>Ægilops</i> . . . . .	3

a. The Peruvian Barley was sown on account of the interest of this variety, and also to occupy six large plots which were last year planted with Swede Turnips: five plots with different manures, and one without manure for comparison. The whole of the Turnip experiments, when complete, will form a substantive report, I hope, next year. It may be enough here to state that the result in the Turnips was widely different, but I could trace no difference in the Barley.

b. For two autumns past I have sown wheat at different depths, from one to seven inches. My crop of 1856 came up tolerably regular, and that from two to four inches in depth was certainly the best, the deeper sown being thin, and tillering but indifferently: this year, however, the deeper sown is very thin, and consequently with fine large ears, whilst that at less depth is still more irregular and weaker, probably arising from injury caused by wire worms. These experiments will be again repeated, and they are now only noted, not to show any conclusions that have been arrived at, but to point out how unsafe it is in agricultural experiments to generalize from a single set of experiments, as these are so liable to be interfered with by insects, climate, and a variety of causes.

c. When last year I had the pleasure of laying my notes upon these experimental plots before the Section of the British Association, the early period at which we met and the general lateness of the season prevented my being enabled to report upon some experiments in oat transmutation which the ripening of my crops subsequently showed to be of great interest; and as the interest consists in the fact that the *Avena fatua* has been made to assume the forms of different varieties of cereal or cultivated oats, I shall now detail the steps taken in bringing about this change\*.

It is now six years since on a neighbouring farm, in a patch of seeding man-gold wurtzels grown on forest marble, I observed an abundance of *Avena fatua*; and as this wild grass is a great pest, especially in clay districts, such as those on the Lias of the Vale of Gloucester and the Oxford Clay in Wilts, but comparatively rare on the Oolite brashes, I took a class of students to examine it and gather specimens for the Herbarium, at the same time giving them a field lecture upon this pest, in which I adverted to a tradition among the farmers of the Vale of Gloucester, that "they were prevented from growing oats because they degenerated into wild oats;" and it was with a view of determining if possible from experiment whether this notion was correct, that I afterwards gathered some of the ripe seed of the wild oat, which in the following spring I sowed in one of my plots. It came up very well, and the process was repeated the following season in another part of the garden, and in the autumn of 1855 I thought I remarked the following changes :—

1. A lighter-coloured fruit.

\* Specimens of these changes accompanied the Report.

2. A less degree of hairiness when compared with the fruits of the true *A. fatua*.

3. A greenish coloured, straight and slight awn, instead of the black, bent at right angles, and twisted at the lower part of the very rigid awn of the wild plant.

4. The fruits were more frequently two than three perfect ones to each glume.

5. The fruits were much more plump, arising from a greater development of grain than in *A. fatua*.

6. The ripe fruits separated from the floral envelope less readily than in *A. fatua*.

In following out the experiments in the spring of 1856, the best specimens having been selected for seed were again sown; and in the month of September following, when this crop was gathered, the results were as under.

1st. *Avena fatua*, tolerably true, though perhaps not so coarse and strong as is usual on heavy clays.

2nd. *Avena fatua*, var. *sativa*, with a diffuse, spicate, pyramidal panicle, allied to the form called "Potatoe Oat," by farmers.

3rd. *Avena fatua*, var. *sativa*, with a compact panicle of flowers tending to one side, allied to the agricultural form known as "Tartarian Oats."

The two latter presented various shades of advance; a few of the more changed were awnless, but most of them possessed awns which were very coarse and rigid for what we may term "tame oats;" and the grain was by no means so plump as (when compared with its thick envelope) to entitle it to be called a good oat. However, it was sufficiently striking, and, on the whole, much more sudden in its advance than I had calculated upon. But to proceed.

In the present year, 1857, I planted the sorts, carefully separated, in separate patches of larger size, with the following result as to the crops.

a. The plot of *Avena fatua* is again mixed with many examples of the Potatoe form of oat, but none of the Tartarian type.

b. The Potatoe oats have a plumper seed and are much less awned; some examples are however still rigidly awned.

c. The Tartarian form is much larger than is usually grown in the best cultivation, its grain very fine, some awned, but mostly awnless.

Thus far then have these curious experiments proceeded. Next year they will be transferred to the field, in the hope of perpetuating these new varieties, as they promise to be much more vigorous than the older ones; and this indeed is one of the advantages in agriculture of new sorts, as, for a time at least, they usually succeed better than the older ones. But this is a matter I must not stop now to discuss.

It should be remarked that the shed seeds of the plot of 1856 were carefully dug in, in the hope that, by being allowed to deposit their seeds as in nature, the whole may again degenerate into wild oats; but only one specimen, and that of *A. fatua*, came up, for, having been so long submitted to cultivative processes (and the gathering and storing of seed previously to sowing is a very important one), they have little disposition to come up wildly afterwards, a fact which is more observable in some situations than in others; and acting upon this hint, I am not quite sure whether the best way to get rid of some weeds would not be to carefully cultivate them.

These experiments are of interest as showing what may be done in this direction towards elucidating some curious facts in vegetable physiology. They are no less so to the agriculturalist, as the remark of the old farmer, which was never a favourite one with the botanist, is now known to be true;



for if we can by experiment advance the wild oat to the cultivated state, so the cultivated by degenerating may relapse into the wild state. That the latter position is true, I had long known from an examination of the produce of shed oats around ricks and in fields, as some of these in a single year will be seen to possess a few hairs at the base of the fruit\*, the awn will get longer and more rigid with a darker colour, and the seed much smaller. It would, however, take too long to pursue an inquiry into the agricultural speculations which these experiments might illustrate, and this perhaps may be better done when our crops are still further advanced; and I need therefore only to advert to such subjects as those involved in the growth of new sorts, the reasons for their value, and the facts connected with their maintenance, to prove this position.

*d. Ægilops.*—My three plots of this grass may be described as follows:—

1st. A permanent plot that is allowed to seed itself and *grow sporadically*, which it does with great freedom.

2nd. A plot of carefully picked seeds sown in autumn.

3rd. The same seeds sown in spring.

In reporting upon *Ægilops* last year, I remarked upon the difficulty of ripening the seeds. However, this is obviated, as the present condition of Plot 1 shows it to have become perfectly acclimatized. I had last year some reason to think I had made an advance towards proving the truth of M. Fabre's statement as to this being the parent of the cultivated wheat; but this year my examples have, if anything, retrograded. I shall therefore repeat the experiments in my own private garden, which is a distance from the College, and on a perfectly different soil. If M. Fabre's views be correct, I should have little hope of success where the plant grows so well and the circumstances seem so suitable for its maintenance in a wild condition, cultivation indeed consisting in the growing of plants in soils and situations unsuitable for them in their wild nature.

3. PAPILIONACEOUS PLANTS.—As regards this family, my experiments tend to show that many species may be made available for agricultural feeding purposes more than are at present employed; these however need not now be commented upon. I shall therefore confine myself to an account of experiments and observations on the following:—

<i>Vicia angustifolia.</i>	Narrow-leaved vetch.
<i>Trifolium pratense.</i>	Broad-leaved clover.
„ <i>medium.</i>	Ziczac clover.
<i>Melilotus officinalis.</i>	Common melilot.
„ <i>Taurica.</i>	Cabool clover.

In 1852 I collected seeds of *Vicia angustifolia* from the neighbourhood of Cirencester, which I sowed in a plot. In the spring of 1853, it came up well; but on flowering, only a few plants could be said to present the characters of the species as laid down in books, or indeed as afforded by the parents of these very specimens. The chief differences were much larger foliage, a greater length of stem, a tendency to two flowers in the axils of the leaf instead of a solitary one, and a great increase of size in the seeds. Now these distinctions did not exist in more than 20 per cent. of the plants; and as regards the difference in the seed, it may be remarked that it is rare to get a sample of seed of the *cultivated vetch* but will be very variable.

In 1854, I planted the seeds that were largest and most changed from

\* I this year gathered a specimen from an old oat field on the Royal Agricultural College Farm with four white hairs at the base, and the seeds had a tendency to separate with the oblique scar, the grain still being plump.

the original, the resulting crop being in all particulars the *Vicia sativa* of authors.

In the autumn of the same year was planted a plot of the like selected seed and with the same result, affording stems as much as  $2\frac{1}{2}$  feet in length, with leaflets half an inch broad, its original size being about 6 inches long, with leaflets a little more than the eighth of an inch broad.

From 1855, I have kept up a plot of each set, thus developing a *winter* and *spring* variety of *V. sativa* from *V. angustifolia*, whilst at the same time I have a plot in which the crop is permanently maintained by self-sown seeds; these, though larger than in wild nature, still preserve the rounded pods and small seeds with but little variation. The spring- and autumn-sown varieties are about as distinctive in appearance as are the agricultural forms of these.

*Trifolium pratense*.—This form in cultivation undergoes great changes, particularly in size and colour; it becomes many times larger, and its heads of flowers increase in size but are less bright in colour. This plant is found wild in all rich meadows and pastures; its place however in poor sandy soils where lime is absent is supplied by the *Trifolium medium*, on which account the latter plant was some few years since introduced into agriculture, to ensure a crop where the *T. pratense* usually failed. The seedsmen used to supply it under the name of *Trifolium medium*, its proper botanical designation; but it is a curious circumstance that all the samples of this seed now in the market are only those of a variety of *T. pratense*, and hence at present the best-informed seedsmen no longer send it out under the original designation of *T. medium*, the "cow grass" of the farmer, but with the name of *Trifolium pratense perenne*, the fact being now well established that we have two varieties of broad clover in cultivation, whilst the true *T. medium*\* has been lost to agriculture until it be again introduced from wild plants; and the whole evidence with regard to this subject tends to show that it has not been lost from neglect, as it has been in constant cultivation; but it has gradually merged into the *T. pratense*; and at this present moment the so-called "broad clover" on the one hand and cow grass on the other are scarcely distinguishable, and seedsmen are constantly threatened with actions for supplying the wrong seed. This therefore remains as a matter for experiment, not only on account of the practical advantage of reviving the lost form to the farmer, but in order to settle the botanical question, as hitherto the botanist has never had a doubt of the distinctness, as species, of the *T. pratense* and *T. medium*†.

*Melilotus*.—Of these the *M. officinalis* and *M. Taurica* are kept up from self-sown seeds, as well as a plot of each drilled in rows the latter; I received some years since under the name of "Cabool clover," and I have since obtained the same from the seedsman with the designation of "Buchara clover;" they are probably only exotic forms of *M. leucantha* of the British flora.

The Melilots among the Papilionacea and the *Anthoxanthum odoratum* in the list of British grasses are alike remarkable for containing a peculiar aromatic principle, to which as it occurs in the latter the sweet smell of

\* It may be well here to note that during the past week I have received some "cow-grass" from Cheshire, which has more of the details of the true *T. medium* than any I have yet seen: this case proves my position, because a great part of Cheshire has a subsoil of marine sand, the bottom of the old strait which separated England from Wales, and on this it continues; and hence I view it only as an arenaceous form of *T. pratense*. But this fact points out the propriety of getting cow-grass seed from the Cheshire sands.

† Seeds of *T. medium* from different localities would be highly valued by me. No seedsman can now supply the true form.

meadow hay is due, and is probably the cause of the superior quality of pasture hay when compared with that of the irrigated meadow, where this grass is seldom present, as also with hay of artificial grasses technically called seeds.

If flavour and, with this, superior quality, be imparted to hay by the presence of an aromatic species, would it not be well to mix a portion of melilot with clover and seeds? Cattle are exceedingly fond of it, and it is a plant which will grow readily and yield a large return in produce. To this end I have cultivated the common melilot, and should prefer it to the *M. Taurica*, on account of its less woody structure when mature.

These plants may be considered as biennial; however, by frequent cutting they may be made to last many years; and the following experiments in reference to this subject may be interesting, as showing the evil to the farmer of letting clovers (for it is the same with the *Trifolia*) remain too long before cutting.

A plot of *M. Taurica* of two years last summer had one-half of its rows kept cut down and not allowed to seed, the other half was seeded; and on the 4th of September, 1856, I made the following note:—

“*Cabool Clover*.—The cut-down rows about 18 inches high, fresh and green, and fit for cattle food; the rest in seed.”

On the 1st of May, 1857, I made the following note:—

“*Cabool Clover*.—The cut portion a fine succulent plant, 8 inches high; the seeded part very thin, 3 inches high.”

This year each of my clover plots will perform double experiments, as in them I am carrying on the same observations.

4. GREEN FEEDING CROPS.—In this list I would only advert to the *Symphytum*, and *Sanguisorba officinalis*.

The *Symphytum asperrimum* was introduced to this country as an ornamental plant from the Caucasus, by the Messrs. Loddige, as long ago as 1811, since when it has been recommended as a profitable green feeding or soiling crop for cattle, for which it seems adapted from its luxuriant growth and good feeding properties. It is a handsome plant, growing as much as 4 feet high, with an abundance of bright-blue bell-shaped flowers.

While experimenting on the growth of this plant, it struck me that the *Symphytum officinale* of our ditches would be equally valuable if it could be made to grow away from its natural habitat. With the view of testing this, I introduced an example of the white form of *S. officinale* from the River Churn in Cirencester, into my garden, which year by year has so nearly approached the *asperrimum* in its details, as to induce me to communicate the experiment to the British Association at a former meeting; and it was again commented upon in my notes of last year before this Section, when it was elicited from the Rev. J. L. Jenyns that “the *S. asperrimum* and *S. officinale* were growing together near Bath, and that it was now impossible to distinguish the one from the other.” Here then I think I am justified in now saying that there can be no doubt of the specific identity of these two forms of plant.

*Sanguisorba officinalis*, on account of its astringent properties, may perhaps be considered as a useful plant for admixture with sainfoin and clovers, and to this end I have for years been anxious to try it as one of my experiments; but it is a curious fact as showing the position of the seed trade, that with as many as a dozen trials to procure it from as many seedsmen, and always under its botanical designation, I have never been able to obtain it, and all my plots have turned out *Poterium sanguisorba*, a plant of a different character, and which can only be considered as a weed: indeed the buyer of foreign sainfoin seed should be careful as to this plant, as in some samples

a large per centage of *Poterium* will be present. Three plots are now occupied with *Poterium*, the seed in all cases being labeled *Sanguisorba officinalis*, a circumstance showing either a great want of knowledge or a wilful substitution of the one for the other on account of a similarity of aspect and English name.

5. ESCULENT VEGETABLES.—A constant change in vegetable diet has always appeared to me to be a matter of such great importance, that I seldom miss an opportunity of making myself acquainted with the growth and capabilities of any new kind that may be introduced, as well as such as have nearly passed away on account of the favouritism shown from time to time towards new introductions; and as examples of what I am doing in that way I would notice the following:—

Potato Yam ( <i>Dioscorea Batatas</i> ) . . . . .	} Among new introductions to this country.
A wild Potato . . . . .	
The Yellow Lima Potato . . . . .	
Salsafy . . . . .	} Among the all-but ex- ploded vegetables.
Schorzonera . . . . .	
Cardoons . . . . .	

The potato yam is so much like our *Tamus communis*, as almost to lead to the inference of specific identity, judging from the vine and foliage, for I have not yet seen it in flower, much less in fruit. Its yearly increase of tubers seems to me too small to warrant its displacing the potato, for which it was recommended in the height of the disease of the latter plant. My plot in the Botanical Garden is not nearly so luxuriant as some specimens in my private garden, the latter being so much warmer and the soil considerably better. Here my plants of this year are climbing up sticks and are as much as 2 yards high; what the tuber will be remains to be seen; however, from my present experience I can only recommend it as an addition to the list of our culinary vegetables.

Last winter I was gratified at receiving a box of potato tubers which had been sent me by my friend Jenkin H. Thomas, Lieut. R.N., consisting of tubers of a "wild potato," and also some of a "Lima potato." The former appears to be a *Solanum*; but if of the species *tuberosum*, it is very different in all particulars from our cultivated form, the tubers of the latter are more like small kidney potatoes. But from the leaves and the slight indication of flower, I do not think it can be a *Solanum* at all; but I am informed that they are usually sold in Lima, so that I must make further inquiries into their previous history. I would now remark that a plot of them in my experimental garden has got on very badly, not more than five per cent. of the tubers growing, and that in a feeble state; however, three tubers planted in my private garden, though they were a long time coming up, are now very large plants, and in full vigour of growth.

As regards the wild potato, Lieut. Thomas writes as follows:—"I procured them from the top of a small island called San Lorenzo, opposite the anchorage of Callao and town of Lima, in Peru, and I have not the slightest doubt in my own mind but that they are the original potatoe, as the island is uninhabited, and fertile only at the top (an elevation of about 900 feet), where these potatoes grew: there is generally a mist over the top, and I think the temperature from 68° to 70°. The blossom is the same as our domestic one, but the leaf is prickly and rough; I cooked several of them when I was in Peru, but found them bitter and strong, but expect that cultivation and a couple of years' trial will totally eradicate that."—In a letter to the author of this report, Aug. 17, 1857.

The experiments with these in my garden at the College have been a comparative failure—however, about a tenth of them have come up,—whilst in my private garden the six tubers which I planted all came up well, and flowered and fruited too freely to expect much advance in the tubers; they came up quickly, and were in flower before the “Lima potatoes” (planted at the same time) showed above ground. They are now before me, and present the following appearance:—the original tuber has much enlarged, and small and imperfect young tubers stud the sides of the old one; they are very rough externally, and of a decidedly bitter taste. I have preserved the roots, and also a quantity of seeds, in order to carry on further experiments, as I see no reason why, in a short time, I should not procure a new variety of cultivated potato from this stock; but if these should afterwards present pinnate and bipinnate leaves, it will be interesting to mark the progress of change from the curious lobate leaf it now possesses.

The arriving at fresh potatoes from this source may do much to settle some questions regarding potato disease. It has been recommended to grow new varieties of this tuber from the apple or seeds, in order to procure a sound stock; but this in practice has failed, as seedling potatoes have been found to be as prone to disease as others. It is, however, possible that this may arise from the fact that the apples after all contain the seeds of an unsound race; and I shall therefore look with great interest to the result of the next few years in the growth and advance of this wild potato, and I hope I shall have two races going, one derived from the tubers, and another from the seeds.

*Salsafy and Schorzonera* are two capital roots, easy of cultivation, and which readily store during the winter. They are not, perhaps, so productive as carrots and parsnips; but they offer a good variation to these, both as a change of crop and also as food: formerly they were highly esteemed, but, like several other vegetables, they are now only found in the gardens of the curious.

*Cardoons*.—This is a vegetable very little grown in England, and yet it is of excellent quality, and not difficult of cultivation. Professor Lindley, in his ‘Guide to the Orchard and Kitchen Garden,’ p. 535, says, “The Cardoon (*Cynara Cardunculus*,) is greatly admired by many, and ought to have a place in every gentleman’s garden; and yet it is curious how few of even gardeners have ever seen it.” It progresses well on my plots, and I hope to experiment largely upon it in another season.

It may be well in this place to refer to some experiments which I have now been carrying on for nearly ten years in the ennobling of the wild parsnip. Of course it was known that our garden esculent was derived from the *Pastinaca sativa* of our fields; but the progress of the experiments has been marked by some interesting facts relating to malformations of roots known as finger-and-toe, and which will be found detailed in the ‘Journal of the Royal Agricultural Society;’ and at the same time it was a matter of no small interest to myself and pupils to note the great changes that took place as the experiments proceeded. The result has been the production of a good-sized parsnip of a regular shape, but containing more flavour than is perhaps desirable\*; but, inasmuch as some people complain of the want of flavour in the ordinary cultivated parsnip, time may tone down my specimens to the requisite degree. I would remark that I sadly want a change of soil for continuing the experiments, and I have this year grown a quantity of seed; I

\* During the time that my experiments have been in progress, I have been enabled to watch the downward progress of parsnips left from an abandoned garden; and though these have not even yet lost all traces of their civilization, they are essentially wild parsnips.

shall be happy to forward some to any members of the Association on application, only asking for the sake of information, any notes that may be made on its progress.

It is not a little curious that experiments of a like kind with the carrot have resulted in a failure. Upon reporting upon this last year, it was stated by Mr. Bentham, that Villemain had succeeded in advancing the carrot and some others, but had failed in all his experiments with the parsnip. This is curious, as showing that we cannot always command success in experiments of this nature—some circumstance or other may be wanting, and therefore we must not pronounce a thing impossible that we have tried ourselves without success; and at the same time it shows us that there are certain laws which operate to produce the changes we have noted, so that from a repetition of experiments of this kind we may hope to become acquainted with some new facts connected with vegetable growth.

An observation of some practical importance may be here noted. As a rule it may be laid down that neither parsnips nor carrots yield good roots in field cultivation in a district where these plants abound as wild natives, as they usually grow small and very much forked, digitated, “finger-and-toed;” and therefore, if grown as an agricultural crop under such circumstances, a much more careful preparation of the soil, even than that usually employed, will be necessary to ensure success; and thus it is that success is much more general with these roots in garden than in field culture.

But, besides, this own-grown seed tends much to degeneracy, especially in the field crop; and in the choice of seed we should always, if possible, choose that from a poorer soil and backward climate rather than in poor root soils to introduce a seed that had been grown in a district so much richer. These, indeed, may almost be considered as general laws.

6. ECONOMIC AND MEDICINAL PLANTS.—The success which has attended my growing of many useful plants of this list in rough bits of ground, and otherwise waste corners of my garden, as well as in poor unmanured plots, is a matter of great interest, inasmuch as it shows that every bit of what is too frequently waste ground may be turned to account, and made to yield at least sufficient to pay the expenses, if not an overplus of profit; one item, however, the mere one of not losing, is gain, as cropping tends to get the land in workable condition.

In the economic class, such plants as flax, hemp, teasels, chicory and sunflower are all worthy of attention as being capable of yielding a good return, and often in most unpromising positions. I shall now, however, in this department only dwell upon some experiments in the growth of *Linum perenne* (perennial flax).

In 1854 I sowed one of my plots with seed of the *L. angustifolium* gathered at Hele in Cornwall. It came up very well, and in 1855 might have been seen its plants in rows with branches a few inches long trailing along the ground, some with light, others with dark-blue coloured flowers somewhat small when compared with the *L. usitatissimum* or *L. perenne*; in this state it presented little to recommend it as a cultivated plant. In the past year it had advanced to a strong and vigorous upright plant somewhat more than two feet in height, with handsome dark-blue flowers, indeed rivalling the *L. usitatissimum* in size and beauty. As regards its fibre I have as yet had no opportunity to make experiments; but if in this respect it should equal the annual flax, I cannot help thinking that we shall have in the *Linum perenne* a plant of great economic value.

As regards the specific distinction of the *L. angustifolium* and *L. perenne*, I must after these experiments express great doubts; nay, I am almost inclined

to think that *L. usitatissimum* is but an annual form of *L. perenne*, so that this year I shall collect the seeds of my perennial patch with a view of commencing an annual cultivation. At all events, should I fail in proving this point, we may fairly expect other changes of great interest, seeing that so much has already been done in bringing a little straggling linseed from its wild habitat, and cultivating in a different soil and climate, not by imitating its wild conditions, but by making for it a new soil, and planting in rows so that one row has the effect of inducing the upright growth to its neighbour,—a fact readily seen in examining the growth of my plant as its shoots first start in a trailing method—a circumstance which shows that in order to test the capabilities of some plants for a crop, we can only do so not by growing single specimen examples, but by planting a quantity side by side.

As subjects for experiment, it fortunately happens that the linseeds are readily affected by cultivative processes, so that we possess in them subjects capable of affording much information as the result of carefully conducted experiments, which leads me to remark that, as there are some tribes of plants which we cannot so easily act upon, permanency of our appointed species must not be concluded from the failure of our limited experiments, though, on the other hand, species must give way in those cases where as the result of properly conducted experiment the seed of one plant can be made to produce what has been considered as a distinctly specific form.

As regards medicinal plants, such specimens as *Hyoscyamus*, *Datura*, *Papaver album*, *Coriander*, and *Caraway* seem to do remarkably well in a not over-good soil and with but little trouble, so that where a market can be got for the produce, it might be worth while to attend to their cultivation, especially in corners.

I shall here only remark upon experiments with the *Datura Stramonium* and *D. Tatula*. A plot of each of these species was sown side by side, the former from seed grown in the district; the latter from seed kindly communicated by Mr. Savory the eminent apothecary and chemist, of New Bondstreet. Of the former not one seed came up, whilst of the latter several plants at the time of my writing are in great perfection. I am informed by Mr. Savory that this species is highly valuable as a remedial agent, it being much more active and uniform in its action than the *D. Stramonium*; and he recommends it in the shape of cigars. Though these plants have been referred to under distinct names, there can, I think, be but little doubt that they are only varieties. The flowers of my specimens are but very slightly tintured with purple. These plants are very abundant in the United States, the tintured variety being much more common towards the South than in the Northern States, and it is not at all improbable that the want of colour in my specimens is the result of the cold, exposed climate of my garden, and poor soil in which I have planted them\*.

7. WEEDS.—In this class I would notice the following plots:—*a. Allium vineale*; *b. Carduus acaulis* and others.

*a.* A plot was planted in the spring of 1856 with young plants of *Allium vineale* with the view of showing my class its method of growth, I pointing out to them how to get rid of so direful a pest. In the summer it had grown to good flowering heads, when, fearing lest it should overrun the garden, I had them pulled up and put into a weed fire to burn. The plot was left untouched until the spring of 1857, when to my astonishment young plants shot up, and the rows of this plot were as complete as in the former season. Upon reflection I saw in this a lesson which I had not my-

\* Beck in his 'United States Botany' gives the *D. Tatula* as a variety of *D. Stramonium*. The former is called the Indian, and the latter the American thorn-apple.

self sufficiently studied; in order to explain which it will be necessary to point out that around the bulb of this plant, will be found from one to four bulblets, which at the time the plants begin to dry are easily separable from the parent: it therefore happened that upon pulling up the stem, the bulblets became detached and caused a thicker plant to spring up where I had thought it destroyed. This shows how even the pulling of a plant of this character is inefficacious for its destruction; and it may further be appealed to as one of those accidental experiments which almost every plot presents, for it may be observed that in these plots many facts (of agricultural interest especially) are daily unfolded by the College Garden experiments, that I have not commented upon in this report.

As regards the *Carduus acaulis*, it will here only be necessary to say that having found a new locality in Wilts. for *Carduus tuberosus*, I have brought a few specimens into my garden, and as will be seen from a separate paper which I have laid before the Section on this discovery, I have an idea that the *C. tuberosus* is but a hybrid. I am cultivating the *C. acaulis* and *C. acanthoides* side by side, in the hope of being able to prove this by experiment.

8. FLOWERING AND ORNAMENTAL PLANTS.—These for the most part consist of such specimens as may be of use for teaching, or ornament in the lecture-room; and many of them afford interesting examples of departure from recognized typical forms as to be of value in teaching, whilst others seem to grow wildly and lose their whole cultivative characters. As yet I have not attended to the cultivation of flowers merely as illustrations of transmutation of species; but I am convinced that such genera as *Primula*, *Viola*, *Myosotis*, and *Malva*, &c., would furnish a vast amount of interesting matter as the result of time and attention bestowed on their investigation.

Here then, for this meeting, must end my notes; if, however, the Section should deem them, or the class of experiment they have reference to, worthy of continuation, the subject offers a field sufficiently wide, and, I think, important for much future investigation and description, as it appears to me that it is upon the noting and collecting such facts as can only be obtained where the subjects of them are under constant observation, that we can hope for much light being thrown upon the at present obscure subject of specific distinctions; and here, whilst experiments are being made upon this matter, it is not too much to state that other facts of great interest are constantly presenting themselves, so that while we are collecting evidence of a scientific kind we may also expect to make experiments tending to useful practical and economic discovery.

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### *On the Resistance of Tubes to Collapse.*

By WILLIAM FAIRBAIRN, F.R.S.

AT the joint request of the British Association and the Royal Society, a series of experiments was undertaken to determine the laws which govern the resisting powers of cylindrical tubes exposed to a uniform external pressure, and from them to determine their strength, and deduce rules for proportioning the internal flues of boilers and similar vessels.

Hitherto it has been considered as an axiom of boiler-engineering, that a cylindrical tube placed in the position of a boiler flue, was equally strong in every part when subjected to a uniform external pressure, the length not