

ELEMENTARY SCIENCE

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BOTANICAL DEPARTMENT

STUDY OF BEANS AND PEAS BEFORE
AND AFTER SPROUTING

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AGRICULTURAL COLLEGE, MICHIGAN
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This is the first of a series of bulletins on elementary science, which will be published at the Agricultural College. While they are prepared especially with the view of helping teachers in the common schools, they should interest every enterprising farmer and horticulturist, or any other wide-awake citizen. Enquiries for bulletins or information regarding this work should be addressed to

THE SECRETARY,

Agricultural College, Mich.

OBSERVING AND COMPARING BEANS AND PEAS BEFORE AND AFTER SPROUTING.

The habit of observing plants, animals and other things in detail will be useful to any person in any occupation all through life, and it will also frequently be a source of great satisfaction.

The reason for suggesting the work mentioned below, is to induce pupils of the common schools of Michigan to become better observers. No one can make a person an observer by telling him all about many things. The pupil must learn for himself, if he ever learns at all.

For over thirty years the author has been teaching Botany to large numbers of young persons from the age of five years and upwards, and he has invariably met with best success by giving each, one or more specimens to be studied without assistance from person or book. After each has had a chance to tell what he has discovered, then perhaps some hints are given for future work, and very likely some questions are asked and some are answered. This mode of teaching stimulates inquiry, originality and independence, though indolent pupils like to have the teacher explain everything from the start. It is so much easier and saves time and effort of the pupil. If the intention were merely to impart information, short lectures or book-lessons about botany might possibly be the proper way, but the author believes the power of observing accurately and quickly to be of far more lasting benefit to any one than information acquired during a few weeks or a few terms at school.

For the present, I shall take it for granted that the teacher has never studied botany in the ordinary acceptance of the term. If she possess little knowledge of the subject, let her have no fears on that account, for she will not be expected to tell the pupils much of anything about the work. We hope she may become interested and learn more than any of her pupils. The exercise here described is laboratory work for the children, not necessarily for the teacher. My plan was to make it an object lesson, detailing some things to be done, not to serve as is too often the case, a subject for a short lecture to the school. Far better results are attained when the topic is worked out by the scholars, than could be reached by any number of interesting talks with no effort on the part of the classes.

To some extent we think this exercise will be found to be in the line of recreation, and with the study such as here suggested, the pupils will make just as rapid progress in arithmetic, geography, grammar, spelling and penmanship as they would if this seed-study were omitted. We hope you

will give the plan a good trial, and then by all means let me hear from you, stating any difficulties encountered and noting successes as they occur to teacher or pupils.

In learning to observe, it is a most excellent plan to place two objects side by side in similar position, taking notes of differences and points of resemblance. For this first lesson I have selected beans and peas, because they can be easily obtained and because they are of good size. Let some members of the school make a winter garden, not for the purpose of raising large crops to fill barn or cellar, but for the purpose of study in learning to see accurately many little things. The work of preparation may be divided, but you will need a box or pan about one foot across, nearly filled with three inches of nice garden soil or sand suitable for making mortar; fifty to one hundred common white beans, and the same number of peas of almost any kind. Ten or more beans and ten or more peas may be placed in water over night and then planted about an inch and a half apart each way, and an inch deep. In another part of the same box or in a separate box, five soaked beans and five soaked peas may be left on top of the moist, loose soil, and five of each on soil that has previously been pressed smooth. The seeds placed on top of the soil must be covered with a deep saucer or something of the kind, to prevent them from becoming dry. A little water should be added occasionally that the planted seeds may be kept moist, but not soaking wet.

While the seeds are slowly begining to grow, each member of the class will carefully compare several dry beans with each other, several that have been softened with each other, the dry beans and the soft beans with each other. In like manner they will study several peas and then compare the beans with the peas to discover in what respects they differ from each other and in what respects they resemble each other.

The suggestions above made with reference to the best way to become a good observer, will not be followed in this, the first bulletin of the kind from the Agricultural College, for fear pupils may become discouraged and not be able to perform creditably what is expected of them.

For these reasons, a plain statement will be made of some things that can be discovered, and in this way the text and illustrations will serve to prepare young persons for independent work suggested by future bulletins.

It will be well for you to keep pencil and paper handy for notes, drawing and dates, each keeping his own account.

These are rather small and short white beans now before us. As they rest on the table while I poke then about, you observe that all of them lie on one side, but some are considerably more flattened than others. If we try to find a couple that are an exact match, we fail. They differ in size, color and shape in some respects. The seed-coats of a few are more or less wrinkled, while most of them are very smooth. They are all longer one way than they are the other. Some of the shortest have both ends rounded much alike, while most of them have one end more or less flattened, slanting across. There is a little one over there with its back considerably rounded.

On one edge is an oval spot more or less sunken, and in the middle of this depression there is a little bunch or scar, and near one end of the scar is a small pimple of a brownish color, and at the opposite end from the scar, if the bean is held in a very strong light, some bright eyes may possibly discover a little hole.



Fig. 1. Edge of a swollen bean showing seed-scar between a small pimple and a minute hole.

are so smooth and so nearly the shape of a ball that they can hardly lie still; some have one or more dimples, and others are more or less wrinkled. They are mostly cream-colored. The scar, unlike that of the bean, has a little slit lengthwise through the middle, and the depression about it is narrower than the one we saw in the beans. The little shiny pimple of the pea is much farther from its scar than it was on the bean and no hole can be discovered at the opposite end of the scar.

We will suppose that some of the youngest boys and girls became tired at this point, and began to look out of the window, or they had lessons to learn or it was most time for recess or for dinner, and we informally put the beans and peas out of sight.

Last night in preparing for this second lesson, the teacher was thoughtful enough to put some beans and peas in water, and a few minutes ago she put another lot in water. How queer! The beans that were in water for a few moments are much wrinkled in every direction as though their jackets were too large, but the peas are still smooth as when put into the water.



Fig. 2. Bean soaked in water for a few minutes. The seed coat enlarges before the thicker portions inside.

In a little while the peas will show irregular wrinkled patches and by that time the wrinkles on some of the beans will begin to disappear. Perhaps some of the pupils observed that the wrinkles on beans and peas, which had been wet only for a short time may be explained in this way: the covering became soft and enlarged before the thicker portion inside had swollen.

Let us look at the beans and peas that were in water over night. You see they are all smooth without a dimple or wrinkle and they have swollen considerably, but they still differ in color, shape and size. On the edge of the bean near where the small hole was found, a little ridge appears, and the corresponding part of the pea shows a conspicuous ridge of a lighter color than the rest of the pea.

On carefully removing the seed-coat from a bean, the depression which was beneath the scar, is still seen, and near it is a rounded part which made the ridge in the seed-coat, and this ridge is fastened to the two large seed-leaves of the bean. This small rounded object holding the seed-leaves together is the first stem the plantlet has and its behavior in future is to be carefully watched.

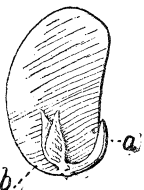


Fig. 3. Bean split in two; a. the first stem, b. the first true leaves slightly enlarged.

Between the seed leaves is a white flat, two-pointed object, to be noticed in sprouting beans.

On removing the seed-coat from a soft pea, the rounded light-colored point is more prominent than it was in the bean, and there is a little thing (bud) between the seed-leaves.

Let us again turn our attention to the seeds placed in and upon the earth in the boxes. If the school-room is likely to become very cold during the night,

some scheme has been devised to cover them, boxes and all, with other boxes or blankets. It may be noticed that peas endure the cold better than beans.



Fig. 4. Sprouting bean bursting through the soil.

the ground.



Fig. 5. The young stem of the seedling bean pulling the seed-leaves out of the ground.

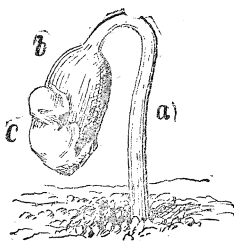


Fig 6. a. First young stem of a bean-plant, b. seed-leaves, c. seed-coat.

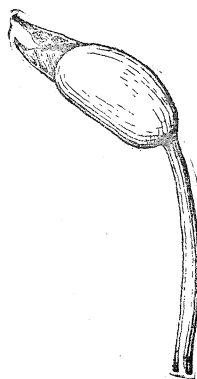


Fig. 7. The seedling bean with seed-leaves above ground showing two true leaves that pushed off the seed-coat.

If we examine these green leaves we shall see that each one is folded with one-half facing the other half and then the two leaves as folded in this way overlap each other. The leaves are placed opposite each other and are shoved outward and upward by the growth of a short stem. When several inches high, one or more pupils will discover a tender bud between the two rough leaves and about it are four little slender pieces. Still later the leaves open more or less and the lower part is seen to be in the shape of a section of a heart as usually seen in drawings.

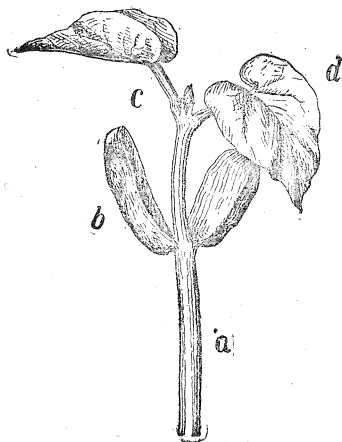


Fig. 8. a. First stem of bean-plant, b. a seed-leaf, c. bud, d. heart-shaped leaf.

A pea buried in the soil also pushes up an ox-bow much like that of a bean, but the seed-leaves instead of showing themselves, like those of the bean, remain covered where they were planted. The fact is the stem below the seed-leaves of the bean, between seed-leaves and roots, grows to be four to six inches high, while the corresponding part of the pea fails to stretch out much, if any, remaining very short, thus permitting the seed-leaves to remain below. The portion of the stem of the pea making the ox-bow, appears above the seed leaves and not below them as in case of

the bean. The small bud between the seed-leaves of the pea does not come straight out, point foremost, but doubles up and pushes hard with its back bursting the seed-coat, leaving a small hole, and then the arch keeps moving or pushing its way out of the soil.

Why do you suppose peas and beans in growing out of the soil, come out double in form of a bow, instead of sending the tip of the seed-leaves or the stem



Fig. 9. Young seedling pea as it appears above ground, the seed-leaves remaining below.

straight out? Very likely this is the correct explanation. It enables the young seedling the better to break through a hard soil without injury to the tender plant.



Fig. 10. The first tender bud of the pea backing out from between the seed-leaves.

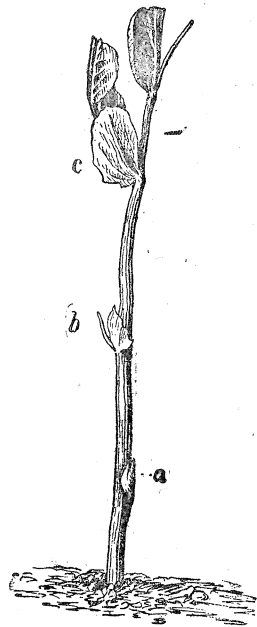


Fig. 11. Seedling pea: a. first leaf, b. second leaf showing a small tendril, c. third leaf and a fourth just appearing to the left.

As the young plant grows older the seed-leaves become smaller and withered, as their substance is carried out to nourish young roots, stems and tender leaves. Half an inch or more above the seed-leaves of the pea appears a single three-pointed scale, and above this and part way around the stem is another scale rather larger and more or less green.

In this, the second scale, there are two pieces facing and matching each other as they press against the stem, and between them curling outward is a small, slender, green object. At the third step up the stem, are seen two rather large, flat and green objects, between which spread out from the main stalk a small stem about an inch long with a groove on the upper side, and at the end of this are two more flat green objects with a little, slender tendril between them. All of the first or lowest three-pointed scale on the main stem represents or really is a small leaf, and the same is true of the second three-pointed scale; likewise of all that appears in the third place as above described. Such a leaf is called compound, as it is composed of more than one piece. If the pupils were to pursue the subject further, they would see some of the other leaves containing a larger number of parts, and the little, slender curl become longer and branching and ready to curl about and cling to any straws and sticks that happen to be within reach.

Kept on moist soil, sand or fine gravel, peas were seen to send out a root, which curved about more or less, usually keeping its tip to the ground. In some cases this tip found its way into some little crevice and kept on its way downward, but in other cases on the smooth surface with nothing to bear down and hold it, the peas tilted over, and again the root-tip turned toward the soil. After continuing and wandering about perhaps for two inches with a curve high in the air, several side roots branched out, grew to the soil and came to the rescue. If kept well moistened continually, the main root and its smaller branches beginning a little way back of the tips, were seen to have all over the surface for half an inch, the appearance of white velvet caused by immense numbers of root-hairs.

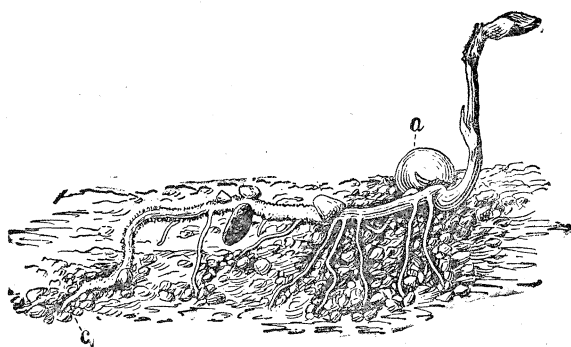


Fig. 12. Seedling pea stilted up on roots as it behaves on coarse wet sand. *a*, remains of the seed, *c*, tip of the first root. The root-hairs lifted up a few small stones which stuck fast.

hairs to wilt and die, and none will ever appear in their places.

The roots of beans kept on wet soil, behave much the same as roots of peas, but the seed-leaves and main stem, how different! There is not only one bow or arch in the stem below the seed-leaves, but often two of them.

Children, young or older, may be questioned as to the various uses of the beans and peas, not overlooking the fact that the main object of the production of seeds is to grow more plants to produce more seeds and thus keep up the stock for many generations.

If so disposed, numerous experiments can be tried with profit; such as cutting off all of one seed-leaf, before or after sprouting, and see what follows. Split some beans and peas and see if each half can be made to grow. Cut off the stem that comes out between or above the seed-leaves of the bean or pea, and see one or more branches appear below to take its place. After it gets pretty well rooted, cut off the stem of a bean-plant below the seed-leaves and give it good care and wait to see if buds can be made to appear. Beans may be pushed into damp soil but little below the surface, some with one end up, some the other end up, some with the seed-scar or eye-edge up, some with the seed-scar below, and see how they behave.

The hints given in this short bulletin by no means exhaust the subject, for there is enough remaining to occupy the entire time of the best botanist continuously for many weeks.

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December 25, 1897.

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