CLASSIC LIVING BOOK

FIRST STUDIES OF PLANT LIFE

George Francis Atkinson

COMPLETE AND UNABRIDGED

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First Studies of Plant Life

by

George Francis Atkinson

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FRONTISPIECE.— A Congenial Plant Society, Minnesota
(Photograph, by H. E. Murdock)

INTRODUCTION

FOR a long time botanical science, in the popular mind, consisted chiefly of pulling flowers to pieces and finding their Latin names by the use of the analytical key. All the careful descriptions of the habits of plants in the classic books were viewed solely as conducive to accuracy in placing the proper label upon herbarium specimens. Long after the study of botany in the universities had become biological rather than purely systematic, the old régime held sway in our secondary schools; and perhaps some of us today know of high schools still working in the twilight of that first ray that pierced primeval darkness. However, this has practically passed away, and today life and its problems, its successes and its failures, absorb the attention of the botanist and zoölogist. The knowledge of the name of the plant or animal is simply a convenience for discrimination and reference. The systematic relations of a plant or animal are used in showing present anatomical affinities and past development. The absorbing themes of investigation and study are the life processes and the means by which the organisms living in the world today have climbed upward and placed themselves in the great realm of the "fit."

When the idea of nature study first dawned in the educational world, it was inevitably confused with the sciences on which it was based. Hence in earlier times we tried to teach the nature study of plants by making the children pull the flowers to pieces and learn the names of their different parts. This was as bad nature study as it was bad science, for we were violating the laws of the child's nature. The child cares very little about the forms of things; he is far more interested in what things do.

Today nature study and science, while they may deal with

the same objects, view them from opposite standpoints. Nature study is not synthetic; it takes for its central thought the child, and for its field work the child's natural environment. The child, through nature study, learns to know the life history of the violet growing in his own dooryard, and the fascinating story of the robin nesting in the cornice of his own porch. The differences of this violet and this robin from other violets and other robins in the world he considers not at all.

That the plant as well as the animal in nature study should be regarded a thing of life has long been recognized, and most of our nature study of plants begins with the planting and sprouting of the seed. Unfortunately, it mostly stops here; the life processes of the plant have seemed too complex to be brought within the comprehension of the child. There is much of chemistry in operations of plant growth, and we find very few things in chemistry that are simple enough to be properly a part of nature study.

First Studies of Plant Life has been written with the sole view of bringing the life processes of the plant within the reach of the child and, with the aid of the competent teacher, it will certainly be comprehensible to the pupil of even the lower grades. In this book the plant stands before the child as a living being with needs like his own. To live, the plant must be born, must be nourished, must breathe, must reproduce, and, after experiencing these things, must die. Each plant that is grown in the window box of a schoolroom should reveal to the child the secrets and the story of a whole life. He realizes that the young plant must be fed; it must grow; it is no longer a matter of commonplace; it is replete with interest, because it is the struggle of an individual to live. How does it get its food? How does it grow? It is of little moment whether its leaves are lanceolate or palmate; it is a question of what the leaves do for the plant; it is a matter of life or death.

When the child has once become acquainted with the conditions and necessities of plant life, how different will the

world seem to him! Every glance at forest or field will tell him a new story. Every square foot of sod will be revealed to him as a battlefield in which he himself may count the victories in the struggle for existence, and he will walk henceforward in a world of miracle and of beauty,—the miracle of adjustment to circumstances, and the beauty of obedience to law.

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AUTHOR'S PREFACE

IN presenting these *First Studies of Plant Life* the object has been to interest the child and pupil in the life and work of plants. The child, or young pupil, is primarily interested in life or something real and active, full of action, of play, or play-work. Things which are in action, which represent states of action, or which can be used by the child in imitating or "staging" various activities or realities, are those which appeal most directly to him and which are most forceful in impressing on his mind the fundamental things on which his sympathies or interests can be built up.

There is, perhaps, a too general feeling that young pupils should be taught things; that the time for reasoning out why a thing is so, or why it behaves as it does under certain conditions, belongs to a later period of life. We are apt to forget that during the first years of his existence the child is dependent largely on his own resources, his own activity of body and mind, in acquiring knowledge. He is preëminently an investigator, occupied with marvelous observations and explorations of his environment.

Why then should we not encourage a continuance of this kind of knowledge-seeking on the part of the child? The young pupil cannot, of course, be left entirely to himself in working out the relation and meaning of things. But opportunities often present themselves when the child should be encouraged to make the observations and from these learn why the result is so. No more excellent opportunities are afforded than in nature study. The topics most suitable are those which deal with the life, or work, or the conditions and states of formation.

To the child or young pupil a story, or the materials from

which a story can be constructed, is not only the most engaging theme, but offers the best opportunity for constructive thought and proper interpretation.

In the studies on the work of plants some of the topics will have to be presented entirely by the teacher, and will serve as reference matter for the pupil, as will all of the book on occasions. The chapter dealing with the chemical changes in the work of starch-making is recognized by the author as dealing with too technical a subject for young pupils, and is included chiefly to round out the part on the work of plants. Still it involves no difficult reasoning, and if young children can appreciate, as many of them do, the "Fairyland of Chemistry," the pupils may be able to get at least a general notion of what is involved in the changes outlined in this chapter.

The chapters on Life Stories of Plants the author has attempted to present in the form of biographies. They suggest that biographies are to be read from the plants themselves by the pupils. In fact, this feature of reading the stories which plants have to tell forms the leading theme which runs through the book. The plants talk by a "sign language," which the pupil is encouraged to read and interpret. This method lends itself in a happy manner as an appeal to the child's power of interpretation of the things which it sees.

Many older persons will, perhaps, be interested in some of these stories, especially in the Struggles of a White Pine.

The story on the companionship of plants also affords a topic of real interest to the pupil, suggesting social conditions and relations of plants which can be read and interpreted by the young.

Nearly all of the line drawings are original, and were made expressly for this book by Mr. Frank R. Rathbun, Auburn, N.Y. Figs. 64, 79, 215, 216, 260 were reproduced from Bergen's "Botany," and Fig. 84, from Circular 86, United States Department of Agriculture, by Mr. Chesnut. The author desires to acknowledge his indebtedness to the following persons,

who have kindly contributed photographs: Mr. H. E. Murdock, for the Frontispiece; Prof. Conway MacMillan, University of Minnesota, for Figs. 220, 249, 257; Professor Gifford, Cornell University, for Figs. 87, 183, 285, 290, 293, 295; Mr. Gifford Pinchot, Division of Forestry, United States Department of Agriculture, for Figs. 280, 282, 289, 292; Prof. W. W. Rowlee, Cornell University, for Figs. 279, 281, 304; Miss A. V. Luther, for Figs. 200, 296, 302; Prof. P. H. Mell, for Fig. 278; Prof. William Trelease, Missouri Botanical Garden, for Fig. 307; Professor Tuomey, Yale University, for Fig. 306. Fig. 221 is reproduced from photographs by Mr. K. Miyake; Fig. 77, from photograph by Mr. H. Hasselbring; Figs. 76, 288, from photographs by Dr. W. A. Murrill. The remaining photographs were made by the author. Some of the text-figures were reproduced from the author's "Elementary Botany," while the photographs of mushrooms are from some of those published in Bulletins 138 and 168 of the Cornell University Agricultural Experiment Station, and from the author's "Mushrooms, Edible, Poisonous, etc."

GEO. F. ATKINSON.
CORNELL UNIVERSITY, March, 1901.

PART I.

THE GROWTH AND PARTS OF PLANTS

CHAPTER I.

How Seedlings Come up from the Ground

The life in a dry seed. For this study we shall use seeds of beans, peas, corn, pumpkin, sunflower, and buckwheat. You may use some other seeds if they are more convenient, but these are easy to get at feed stores or seed stores. If you did not know that they were seeds of plants, you would not believe that these dry and hard objects had any life in them. They show no signs of life while they are kept for weeks or months in the packet or bag in a dry room.

But plant the seeds in damp soil in the garden or field during the warm season, or plant them in a box or pot of damp soil kept in a warm room. For several days there is no sign that any change is taking place in the seeds. But in a few days or a week, if it is not too cold, some of the surface earth above the buried seeds is disturbed, lifted, or cracked. Rising through this opening in the surface soil there is a young green plant. We see that it has life now, because it grows and has the power to push its way through the soil. The dry seed was alive, but could not grow. The plant life was dormant in the dry seed. What made the plant life active when the seed was buried in the soil?

Fig. 1. Bean seedlings breaking through the soil.

How the corn seedling gets out of the ground. One should watch for the earliest appearance of the seedlings coming

through the soil. The corn seedling seems to come up with little difficulty. It comes up straight, as a slender, pointed object which pierces through the soil easily, unless the earth is very hard, or a clod or stone lies above the seedling. It looks like a tender stem, but in a few days more it unrolls, or unwinds, and long, slender leaves appear, so that what we took for a stem was not a stem at all, but delicate leaves wrapped round each other so tightly as to push their way through the soil unharmed. What would have happened to the leaves if they had unfolded in the ground?

Fig. 2. Corn seedlings coming up.

How the bean behaves in coming out of the ground. When we look for the bean seedling as it is coming up we see that the stem is bent into a loop. This loop forces its way through the soil, dragging on one end the bean that was buried. Sometimes the outer coat of the seed clings to the bean as it comes from the ground, but usually this slips off and is left in the ground. Soon after the loop appears above ground it straightens out and lifts the bean several inches high. As the bean is being raised above ground the outer coat slips off. Now we see that the bean is split into two thick parts (*cot-y-le'dons*), which spread farther and farther apart, showing between them young green leaves, which soon expand into well-formed bean leaves.

Fig. 3. The "loop" of the bean seedling.

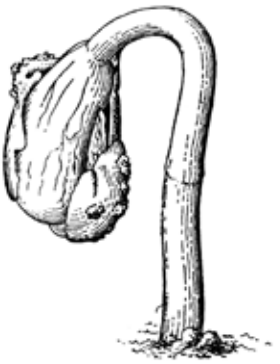

Fig. 4. Germinating bean shedding the seed coats.

The pea seedling comes up in a different way. The stem of the pea also comes up in a loop. As it straightens up we look in vain for the pea on the end. There are small green leaves, but no

thick part of the pea which was buried in the ground. This part of the pea, then, must have been left in the ground. When we have seen how the other seedlings come up, we can plant more seeds in such a way as to see just how each seed germinates, and learn the reason for the different behavior of the seedlings in coming from the ground.

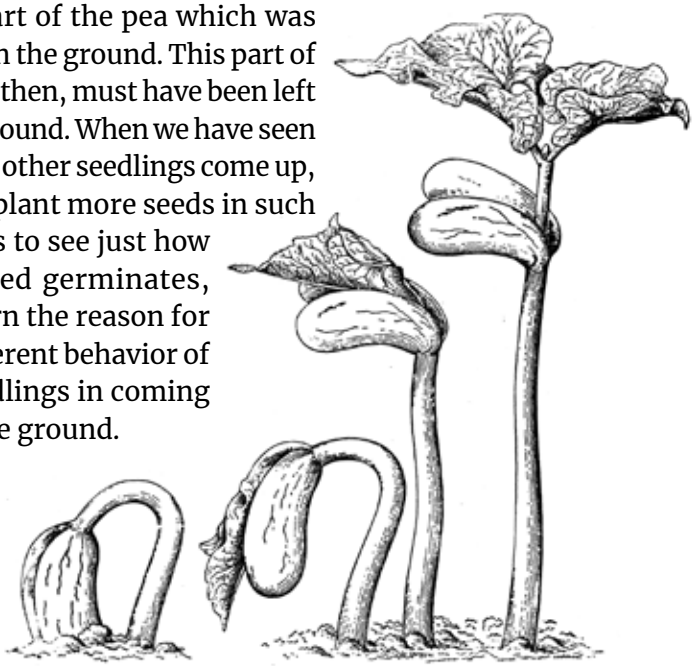

Fig. 5. Bean seedlings straightening up; the plumule and spreading leaves showing from between the cotyledons.

The pumpkin seedling also comes up in a loop, and on one end of the loop, as it is being lifted through the soil, we see two flat, rather thick parts. Together they are about the size of the pumpkin seed. By looking carefully we may sometimes find the old shell, or seed coat, still clinging to the tips of these parts of the seed; the shell is split part way down only, and so pinches tightly over the tips. Usually, however, it is left empty in the ground.

Fig. 6. Pea seedlings coming up.

It will be interesting later to see how this little pumpkin plant gets out of its shell. It usually escapes while still buried in the soil. As the loop straightens out, these two thick portions spread wide apart in the light and become green. There are little lines on them resembling the

"veins" on some leaves. Are these two parts of the pumpkin seed real leaves? Look down between them where they join the stem. Very young leaves are growing out from between them.

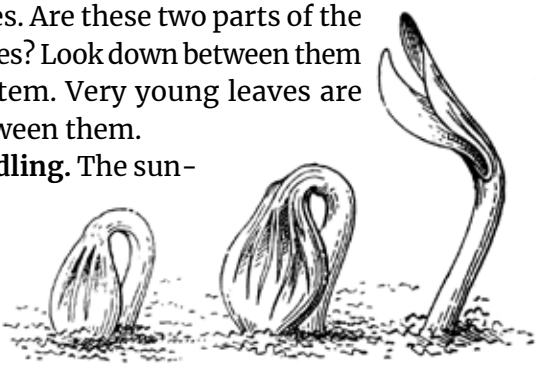

Fig. 7. Pumpkin seedlings coming from the ground, showing loop and opening cotyledons.

The sunflower seedling. The sunflower seedling comes up with a loop, dragging the seed on one end. The shell, or seed coat, is sometimes left in the ground, because it splits farther through when the root wedges its way out. But often the seed coat clings to the tips of the cotyledons until the plant straightens. Then the cotyledons usually spread far apart. The seed coat of the pumpkin sometimes clings to the tips of the cotyledons until the sunlight pries them apart.

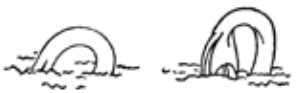

Fig. 8. Loop on stem of sunflower as it comes from the ground.

The buckwheat seedling. This also comes up with a loop, and we begin to see that this way of coming up is very common among seedlings. The seed coat of the buckwheat is often lifted above ground on one end of the loop. It is split nearly across. Through the split in the seed we can see that there are leaves packed inside very differently from the way in which the cotyledons of the pumpkin and sunflower lie. The buckwheat

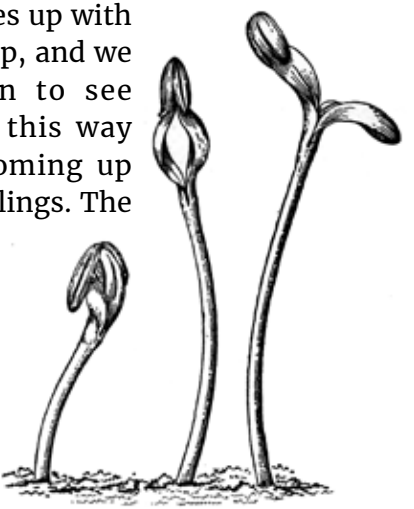

Fig. 9. Seedlings of sunflower casting seed coats as cotyledons open.

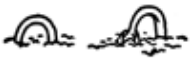

Fig. 10. Loop of buckwheat seedlings coming through the surface of the soil.

cotyledons are twisted or rolled round each other. As the seedling straightens up they untwist, and in doing this help to throw off the coat.

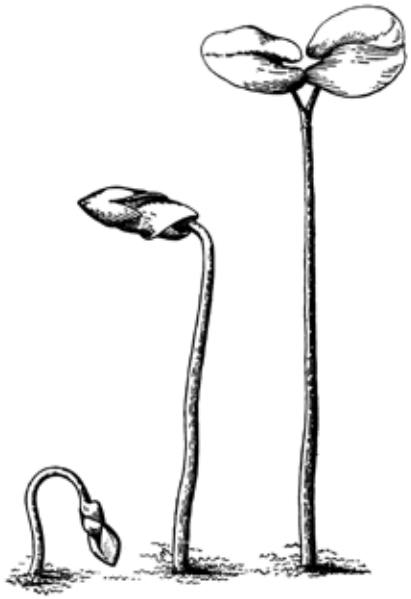

Fig. 11. Cotyledons of buckwheat seedling untwisting and casting seed coats.

CHAPTER II.

How the Seeds Behave When Germinating

To prepare the seeds for observation. We could not see how the seeds planted in the ground behaved while they were germinating, for they were hidden from sight. To watch the behavior of the different kinds, the seeds are put where there is warmth and moisture under glass, or they are covered with damp paper or moss, which may be lifted at any time to see what is going on. They may be grown in tumblers, or in shallow vessels covered with glass, with wet moss or paper inside. The best way to plant them for easy observation is to put them in a lamp chimney filled with wet peat moss or sawdust, as shown in Fig. 12. Or a box may be made with glass doors on the side. This may be filled with wet moss or sawdust, the seeds put in place, and the door then closed. If desired, some soft manila paper may be placed on the moss or sawdust, and the seed placed between this and the glass. If the lamp chimney is used, roll the paper into a tube smaller than the chimney and slip it in. Now put the peat moss inside, not very tight. The seeds may be started between the glass and paper, and with a blunt wire may be pushed into any position desired.

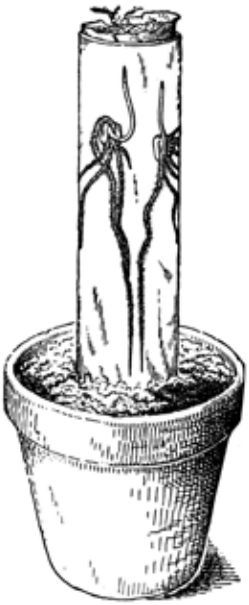

Fig. 12. Corn seedlings growing in lamp chimney.

The seeds first absorb water and swell. Before the seeds

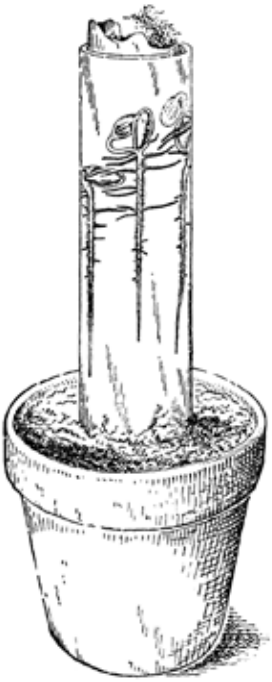

Fig. 13. Pumpkin seedlings growing in lamp chimney.

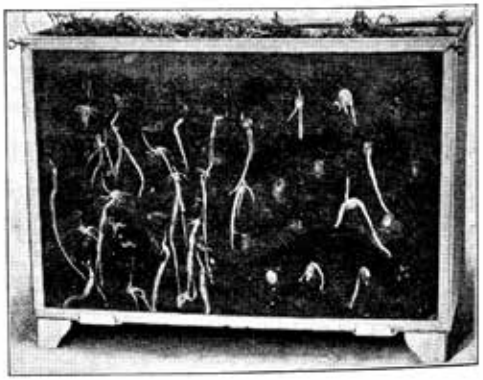

Fig. 14. Box with glass door on side for growing seedlings.

are planted for this study they should be soaked from twelve to twenty-four hours in water. Then they may be placed in the germinator for observation. Look at the seeds in the water several times during the day, and see what changes take place in them. All of them become larger. After they have been in the water for a day, cut one, and also try to cut one of the dry seeds. The seeds that have been soaked in water are softer and larger than the dry seed. Why is this so? It must be that they have taken in water, or have absorbed water, as we say. This has increased their size, made them wet inside, and soft.

How the pea and bean seeds swell. The pea and bean swell in a curious way, as can be seen by looking at them at short intervals after they have been placed in the water. The water is taken in at first more rapidly by the coat of the seed than by the other parts. The coat becomes much wrinkled then, as if it were too big for the seed. First the wrinkles begin to appear round one edge.

Fig. 15. Bean seed before soaking in water.

Fig. 16. Bean seeds with coats wrinkling as they soak in water.

Fig. 17. Bean seed after soaking in water, larger, and now smooth.

Then they become more numerous, and extend farther over the surface, until the entire coat is strongly wrinkled, as shown in Fig. 16. This loosens the coat from the bulk of the seed, and perhaps is one reason why this coat slips off so easily while the loop of the stem is pulling the inside of the seed out of the ground. Finally the inside parts swell as they take up water. They fill out the coat again so that it is smooth, as shown in Fig. 17.

Fig. 18. Corn seeds germinating under glass, the left-hand seed upside down.

The first sign of the seedling. In a very few days, now that the seeds are thoroughly soaked with water, the signs of life begin to appear. The root grows out of the seed as a small, white, slender, pointed object. It comes from the same spot in every seed of one kind. In the sunflower, pumpkin, buckwheat, and corn it comes from the smaller end of the seed. In the bean it comes out from the hollowed, or concave, side. As soon as the root comes out it grows directly downward, no matter which way the seed happens to lie.

Fig. 19. Later stage of Fig. 18.

When the seeds are placed in the lamp chimney, or in a box with a glass side, they can be easily held in any position desired. It will be interesting to watch seeds that have been placed in different positions. When the roots have grown an inch or more in length,

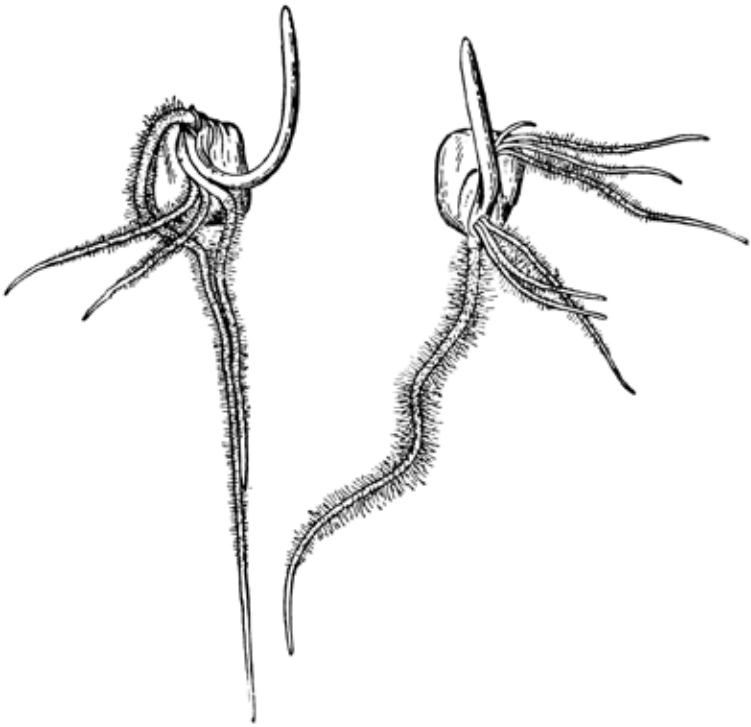

Fig. 20. Still later stage of Fig. 18.

sketch some of the different positions. Is there any advantage to the plant in having this first root grow downward?

How the pumpkin plant gets out of the seed coat. As the root grows out of the small end of the seed, it acts like a wedge and often splits the shell or seed coat part way, but not enough for the rest of the plant to escape. The little plant develops a curious contrivance to assist it in getting out. There is formed on one side of the stem a "peg" or "heel." This is formed on the underside of the stem, when the seed is lying on its side, at the point in the opening of the seed. This peg presses against the end and helps to split the seed coat further open. The stem now elongates above this peg, presses against the other half

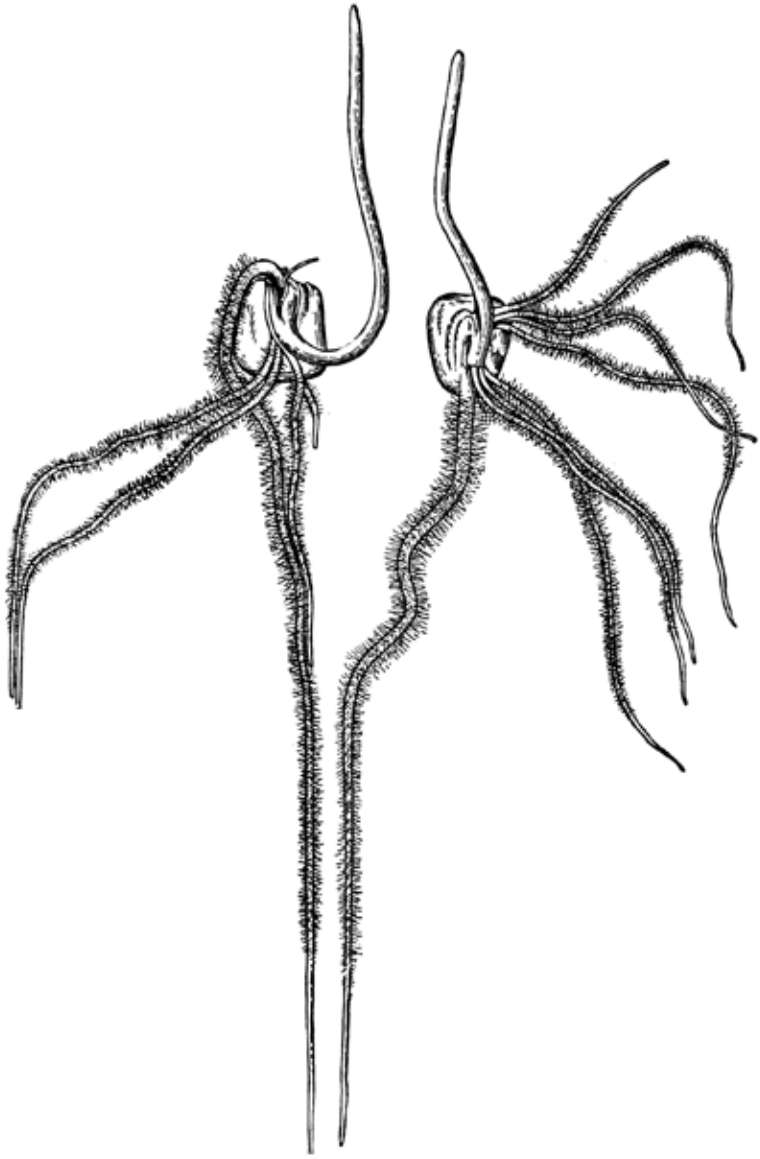

Fig. 21. Still later stage of Fig. 18. Note root hairs in all.

Fig. 22. Pumpkin seedlings casting the seed coats (note the "peg").

of the seed coat, and pries the two halves far apart so that the plant readily slips out, as shown in Fig. 22.

Germination of the bean. After the root comes out of the bean on the concave side, the two halves of the bean swell so that the outer coat is cracked and begins to slip off. We can then see that the stem is a continuation above from the root, joined to one end of the two thick parts or cotyledons. This part of the stem now grows rapidly, arches up in a loop, and lifts the bean upward.

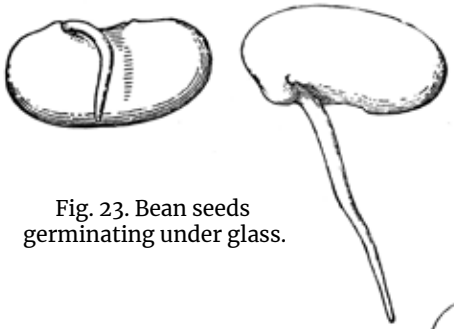

Fig. 23. Bean seeds germinating under glass.

Fig. 24. Pea germinating under glass.

Fig. 25. Sunflower seed germinating.

The pea. The pea germinates in a different way. After the root begins to grow the pea swells, so that the thin coat is cracked. The stem, just as in the bean, is joined at one side to the two thick cotyledons of the pea. But this part of