Lessons on Soil

Sir E. J. Russell

CAMBRIDGE

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BY

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LESSONS ON SOIL

Snowdon from Llyn Llydaw, showing the first stage in soil formation.

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PREFACE TO THE NEW EDITION

This little book has had a very long life because it deals with something that never loses its interest and importance—the soil on which we depend for our food, and which carries the flowers and grass and trees that give us so much pleasure. It was written for the scholars at the village school of Wye in Kent, to whom I used to give a lesson each week, at the invitation of the Headmaster, the late Mr W. J. Ashby; it was carefully revised at St George's School, Harpenden, when the Rev. Cecil Grant gave me a class of bright, critical Third Form boys and girls who knew that the lessons were going to be published—they had therefore been well tested before they were offered to other teachers.

Since those days wars and social changes have greatly altered our countryside and have heavily reduced the area of agricultural land left to us. Even during the short lifetime of this book we have added 7 million to our population in England and Wales, and lost 3 million acres of agricultural land, and the losses still go on, more rapidly than ever. Our financial position makes it more and more imperative that we should import less food and either produce more ourselves, or go without. It is now, therefore, supremely important to every one of us that the fullest and best use should be made of our remaining soil, and I hope this book will help in giving a wider understanding of some of its wonderful properties and possibilities.

Many changes have been made in the text to bring it into line with the modern conditions in the countryside, and I wish to thank Dr E. W. Russell for much valuable criticism and help in making the revision. Finally, it is a pleasure to thank Mr Martin Fayers for much friendly help right from the old days at Wye.

E. JOHN RUSSELL

CAMPSFIELD WOOD, WOODSTOCK
November 1949

INTRODUCTION

The following pages contain the substance of lessons given at the village school at Wye to the Fourth, Fifth, Sixth and Seventh Standards (mixed) and at St George's School, Harpenden, to the Third Form. There is, however, an important difference between the actual lessons as given and the book. The lessons had reference to the soils round about the village, and dealt mainly with local phenomena, general conclusions being only sparingly drawn; while in the book it has been necessary to throw the course into a more generalized form. The teacher in using the book will have to reverse the process, he must find local illustrations and make liberal use of them during the course; it is hoped that the information given will help him over any difficulties he may experience.

This necessity for finding local illustrations constitutes one of the fundamental differences between the study of Nature and other subjects of the school curriculum. The text-book in some of the others may be necessary and sufficient; in dealing with Nature it is at most only subsidiary, serving simply as a guide to the thing that is to be studied; unless the thing itself be before the class it is no better than a guide to a cathedral would be without the cathedral. And just as the guide is successful only when he directs the attention of the stranger to the important features of the place, and fails directly he becomes garrulous and distracts attention, so a Nature Study book succeeds only in as far as it helps in the study of the actual thing, and fails if it is used passively and is substituted for an active study. No description or illustration can take the place of direct observation; the simplest thing in Nature is infinitely more wonderful than our best word pictures can ever paint it.

The author recommends the teacher to look through the chapter before it has to be taken in class and then to make a few expeditions in search of local illustrations. It is not strictly necessary that the chapters should be taken in the order given. The local phenomena must be dealt with as they arise and as weather permits, or the opportunity may pass not to return again during the course. In almost any lane, field, or garden a sufficient number of illustrations may be obtained; if a stream and a hill are accessible the material is practically complete, especially if the scholars can be induced to pursue their studies during their summer-holiday rambles. Of course, this entails a good deal of work for the teacher, but the results are worth it. Young people enjoy experimental and observation lessons in which they take an active part and are not merely passive learners. The value of such lessons in developing their latent powers and in stimulating them to seek for knowledge in the great book of Nature is a sufficient recompense to the enthusiastic teacher for the extra trouble involved.

It is not desirable to work through a chapter in one lesson. Scholars unaccustomed to make experiments or to see experiments done, will probably require three or four lessons for getting through each of the first few chapters, and two or three lessons for each of the others.

The pot experiments of chapters VI, VII and VIII should be started as early in the course as possible. Twenty flower pots are wanted for the set; they should be of the same size, about 8 inches being a convenient diameter, and should be kept together in a warm place. Three are filled with sand, seven with subsoil, and the remaining ten with surface soil. Three of the subsoil pots are uncropped, two being stored moist and one dry. Four pots of the surface soil are uncropped and moist, a fifth and sixth are uncropped and dry, one of these contains earthworms (p. 44). Four glazed pots, e.g. large jam or marmalade jars, are also wanted (p. 56). Mustard, buck-

wheat or rye make good crops, but many others will do. Leguminous crops, however, show certain abnormal characters, while turnips and cabbages are apt to fail; none of these should be used. It is highly desirable that the pots should be duplicated.

The plots also should be started in the school garden as early as convenient. Eight are required for the set; their treatment is described in chapter IX. Plots 2 yards square suffice.

A supply of sand, of clay, and of lime will be wanted, but it is not necessary to have fresh material for each lesson. The sand may be obtained from a builder, a sand pit, the seashore or from a dealer in chemical apparatus. The clay may be obtained from a brick yard; it gives most satisfactory results after it has been ground ready for brick making. Modelling clay is equally satisfactory. A supply of rain water is desirable.

For a class of twelve pupils working in pairs at the experiments the following apparatus is wanted for the whole course:

Six tripods and bunsen burners or spirit lamps [2].
Twelve pipe-clay triangles [4].
Twelve crucibles or tin lids [3].
Sixteen gas jars [4].
Twelve beakers 250 c.c. capacity [4].
Two beakers 500 c.c.
Two beakers 100 c.c.
Six egg-cups [2].
Twelve funnels [3].
Six funnel stands [1].
Six perforated glass disks [3].
Two tubulated bottles 500 c.c., four corks to fit.
Cork borers.
4 lb. assorted glass tubing.
Pestle and mortar.

Twelve Erlenmeyer flasks 50 c.c. [3].
Six saucers.
Twelve flat-bottomed flasks 100 c.c., six fitted with india-rubber stoppers bored with one hole [3], and six with ordinary corks [3].
Box as in Fig. 13.
Six glass tubes $\frac{1}{2}$ inch diameter, 18 inches long [2].
Six straight lamp chimneys [3].
Six test-tubes, corks to fit.
Three Factory thermometers with stems 6 inches long.
Soil sampler (p. 78).
Balance and weights.
Two retort stands with rings and clamp.
Soil acidity indicator (p. 54).

The figures given in square brackets are the quantities that suffice when the teacher alone does the experiments, it not being convenient for the scholars to do much. They are the figures given at the head of each chapter.

CONTENTS

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CHAPTER I

WHAT IS THE SOIL MADE OF?

APPARATUS REQUIRED.* Soil and subsoil from a hole dug in the garden. Clay. Two tripods and bunsen burners or spirit lamps. Two crucibles or tin lids and pipe-clay triangles. Four jars or gas cylinders. Two beakers.

If we talk to a farmer or a gardener about soils he will say that there are several kinds of soil—clay soils, gravel soils, peat soils, chalk soils, and so on—and we may discover this for ourselves if we make some rambles in the country and take careful notice of the ground about us, particularly if we can leave the road and walk on the footpaths across the fields. When we find the ground very hard in dry weather and very sticky in wet weather we may be sure we are on a clay soil, and may expect to find brick yards or tile works somewhere near, where the clay is used. If the soil is loose, drying quickly after rain, and if it can be scattered about by the hand like sand on the seashore, we know we are on a sandy soil and can look for pits where builder's sand is dug. But it may very likely happen that the soil is something in between, and that neither sand pits nor clay pits can be found; if we ask what sort of soil this is we are told it is a loam. A gravel soil will be known at once by its gravel pits, and a chalk soil by the white chalk quarries and old lime kilns, while a peat soil is black, sometimes marshy and nearly always spongy to tread on.

We want to learn something of the soil round about us, and we will begin by digging a hole about 3 feet deep to see what we can discover. At Harpenden this is what the scholars saw: the top 8 inches of soil was dark in colour and easy to dig; the soil below was reddish brown in colour and very hard to dig; one changed into the other so

* The numbers represent the requirement when the experiments are done by the teacher alone or by one group of scholars.

quickly that it was easy to see where the top soil ended and the bottom soil began; no further change could, however, be seen below the 8-inch line. A drawing was made to show these things, and is given in Fig. 1. You may find something quite different: sand, chalk, or solid rock may occur below the soil, but you should enter whatever you see into your note-books and make a drawing, like Fig. 1, to be kept for future use. Before filling in the hole, some of the dark-coloured top soil, and some of the lighter coloured soil lying below (which is called the SUBSOIL), should be taken for further examination; the two samples should be kept separate and not mixed.

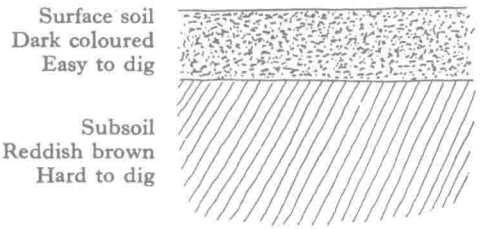

Fig. 1. Soil and subsoil in St George's school garden.

First look carefully at the top soil and rub some of it between your fingers. We found that our sample was wet and therefore contained water; it was very sticky like clay and therefore, presumably, contained clay; there were a few stones and some grit present and also some tiny pieces of dead plants—roots, stems or leaves, but some so decayed that we could not quite tell what they were. A few pieces of a soft white stone were found that marked on the blackboard like chalk.* Lastly, there were a few fragments of coal and cinders but, as these were not a real part of the soil, we supposed they had got in by accident. The subsoil was also wet and even more sticky than the top soil; it contained stones and grit, but seemed almost free from plant remains and from the white chalky fragments.

* Later on we found other soils that did not contain these white fragments.

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