

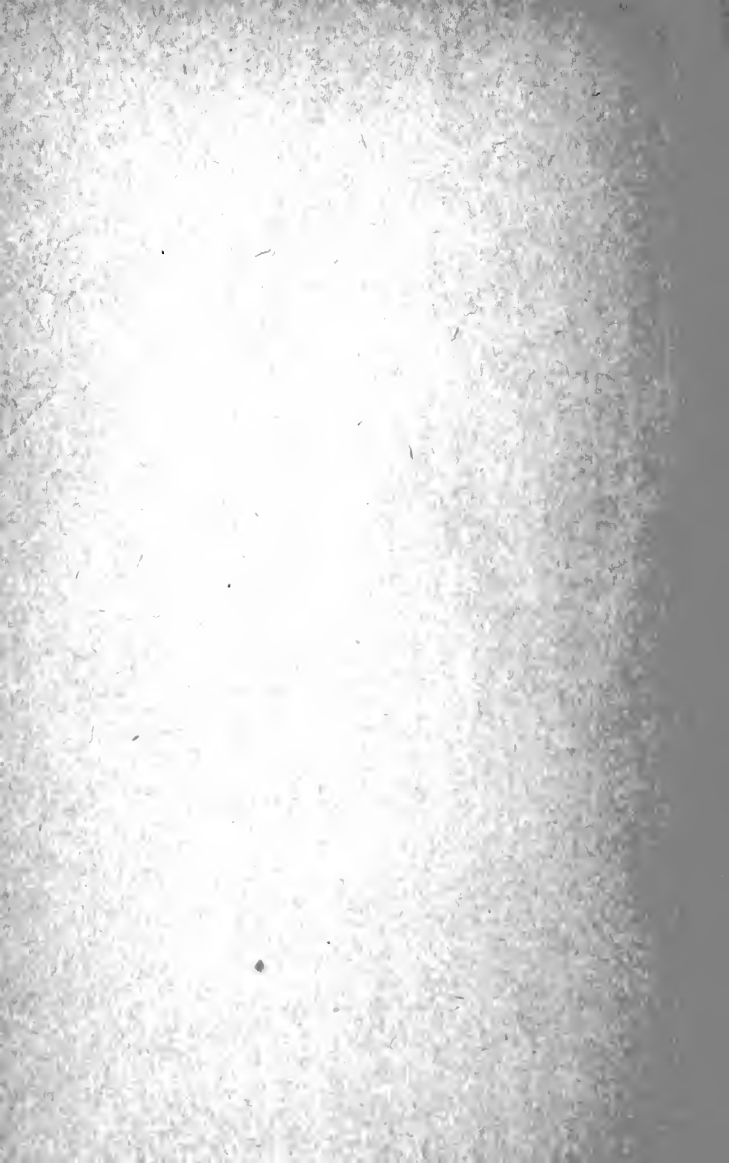
COMPANION TO

BLACKIE'S
TROPICAL
READERS

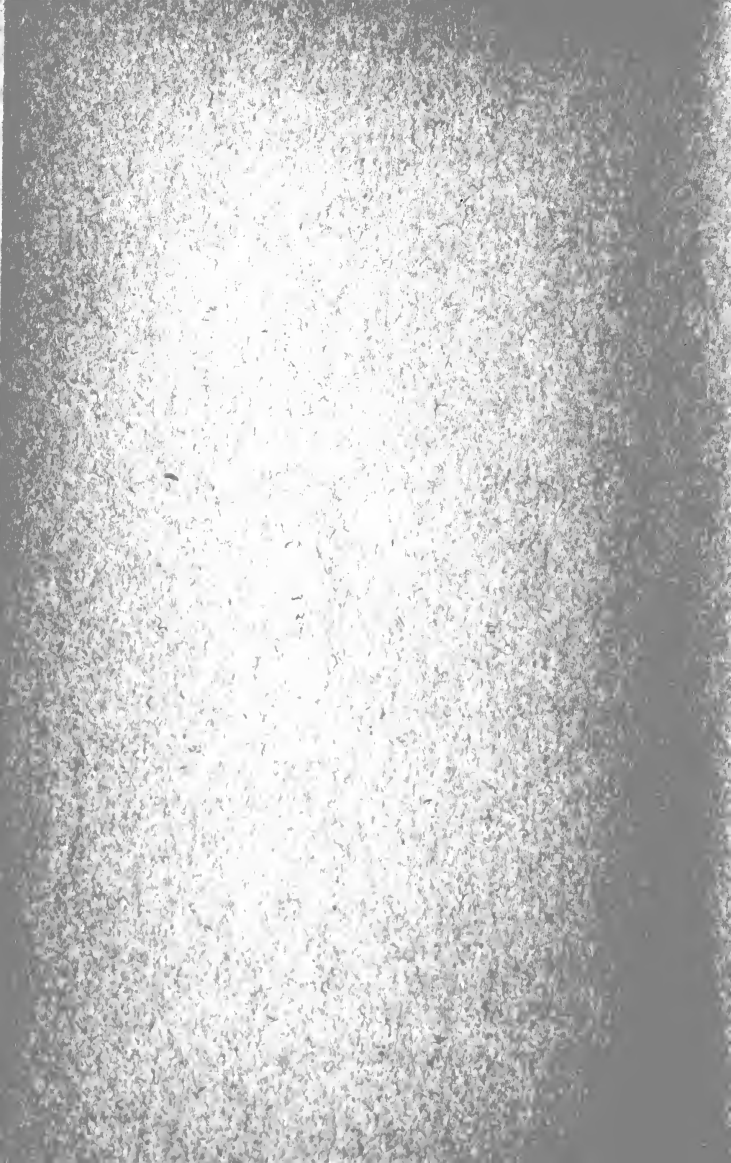
BOOKS i AND ii

WORTLEY

BLACKIE AND SON LIMITED







A COMPANION TO

BLACKIE'S

TROPICAL READERS

BOOKS I AND II

*Containing Suggestions for
Experiments and Practical Work*

BY

E. J. WORTLEY, F.C.S.

LIBRARY
NEW YORK
BOTANICAL
GARDEN

BLACKIE AND SON LIMITED

50 OLD BAILEY LONDON

GLASGOW AND BOMBAY

1911

QH

55

W67

NOTE

The publication of the Tropical Readers was a notable effort to make our Elementary Education more practical, by using, in the instruction of children dwelling in the tropics, what is familiar to them in animal, vegetable, and social life, and so arousing interest and stimulating observation. The books serve their purpose admirably, and it is some testimony to their success that a need for amplification in some directions has been felt. This Supplement will go far to supply this need. It will help to build the bridge—one of the most necessary and difficult of bridges—between schoolroom and text-book teaching on the one hand, and on the other, the outside things on which children need to be trained to exercise observation for the development of their faculties as well as for the increase of their knowledge. There is nothing more common in Inspectors' Reports than the complaint that the "Science Teaching" (which is simple, and liable to be misunderstood by being so grandly named) "needs better practical illustration". This Supplement will greatly assist teachers to meet this demand, by showing how many illustrative experiments can be performed with the limited appliances within the reach and management of Elementary

Schools, how many appliances can be improvised out of articles of daily and domestic use, what are the guiding points to be kept in view in such experiments, and how collections of specimens are to be planned in order to give them real educational value. Mr. Wortley's experience in the teaching of Elementary School Teachers is a guarantee that he appreciates their needs, and he will receive the thanks of all who realize the importance of their work for the very valuable help he has thus placed at their disposal.

J. R. WILLIAMS,

Superintending Inspector of Schools.

KINGSTON, JAMAICA,

December, 1910.

PREFACE

For some time past it has seemed desirable that notes should be prepared amplifying the subject-matter of Blackie's Tropical Readers, and setting out clearly a number of specific examples of what a pupil should draw, collect, prove by experiment, observe, or record. The present Supplement has been written with this in view, and it is hoped that it will prove a lever to the self-activity of the children, and that it will be a means of guiding their work on right lines.

Study of the Jamaica Code will show that no new work is suggested, but that an endeavour is being made to enable teachers to comply more easily with the requirements of the Education Department. The following quotations from the Code will reveal the manner in which it is intended that the "Science Work" should be taught:—

"The lessons must, whenever possible, be illustrated by actual objects, specimens, pictures, diagrams, black-board drawings, or clay models."

"Children should be encouraged to bring with them to the lesson illustrative specimens which they have collected or obtained from friends."

"Children should be encouraged to make simple drawings illustrative of their observations. Those in the Upper Division should be required to write brief weekly compositions in which they may express, in a written form, the ideas which they have acquired through observations and oral instruction, and also through reading."

“Plants in pots, boxes, or glasses, should be grown in the schoolroom for illustrative purposes. As far as possible, knowledge respecting plants should be gained through practical illustrations and simple experiments.”

Much has been written and said about the true aim of education, and it has long been generally conceded that the child is not to be crammed with facts, but rather that his reasoning powers are to be developed. A good teacher will make all subjects educational in the highest sense of the word, but it is claimed, with conviction, that the subjects under the head of Science come *facile princeps* as a means of developing a child's faculties. The mental discipline derived from such training should produce men and women determined to take pains, and capable of doing so—efficient and cheerful workers, able to adapt themselves to new circumstances.

This may seem a great deal to claim for any subject, but there is sufficient evidence to warrant such hopes. Further, it has long been noticed that the teacher who habitually pays special attention to “Science” and “Nature Study” will form the habit of devoting more time to orderly thought about, and careful preparation for, all his subjects.

There are difficulties in the way of carrying out the suggestions made—difficulties that are not peculiar to Jamaica,—but they will disappear when serious and persistent endeavours are made to overcome them, as has been already proved in some cases.

I gratefully acknowledge my indebtedness to those who have assisted me in preparing this little work.

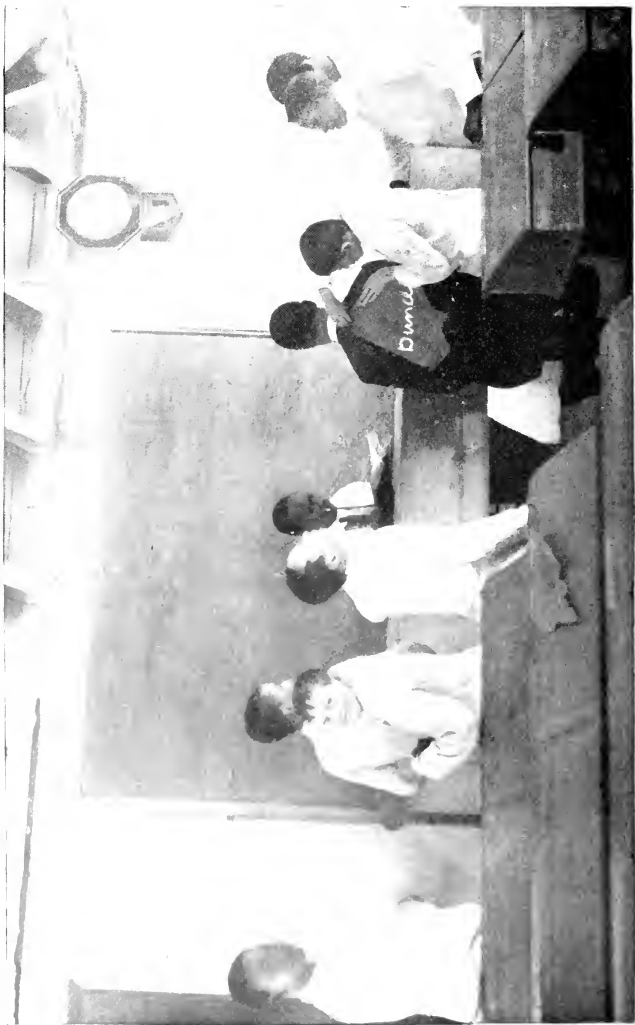
E. JOCELYN WORTLEY.

GOVERNMENT FARM SCHOOL,
KINGSTON, JAMAICA.

CONTENTS

	Blackie's Tropical Readers.	Companion.	
		Experiments.	Page
I. INTRODUCTION			
Hints to Teachers.	—	—	9
Hints to Pupils.	—	—	10
The Use of Apparatus.	—	—	12
II. STUDY OF ANIMAL LIFE	{ Bk. 1, Pt. I. Bk. 2, Pt. I. }	{ — }	19
III. STUDY OF ECONOMIC PLANTS	{ Bk. 1, Pt. II. Bk. 2, Pt. III. }	{ — }	24
IV. EXPERIMENTS AND PRACTICAL WORK			
1. <i>Animal Life</i> .	Bk. 1, Pt. I.	—	30
2. <i>Plant Life</i> .	Bk. 1, Pt. II.		
Plants.	Page 68.	1-5	30
Roots, I and II.	,, 72.	6-16	31
Stems and Shoots, I and II.	,, 78.	17-32	33
Leaves, I and II.	,, 86.	33-41	38
Flowers, I, II, and III.	,, 93.	42-48	42
Fruits.	,, 101.	49-55	43
Seeds.	,, 105.	56-59	46
The Bamboo, Corn, &c.	,, 108.	—	46
V. EXPERIMENTS AND PRACTICAL WORK			
1. <i>Animal Life</i> .	Bk. 2, Pt. I.	—	47

	Blackie's Tropical Readers.	Companion.	
		Experiments.	Page
2. <i>Plant Life and Soils.</i>	Bk. 2, Pt. II.		
The Parts of a Flower.	Page 53.	60-63	47
Flowers and Seeds (Fertilization), I and II.	} " 56.	64-71	49
Seeds and Seedlings, I and II.	" 62.	72-76	51
How a Plant Feeds, I and II.	" 68.	77-80	53
How Plants are Reared, I and II.	} " 74.	81-93	57
How Soils are Formed.	" 80.	94-100	60
Kinds of Soil.	" 83.	101-107	62
More about the Soil.	" 87.	108-111	63
Tillage.	" 89.	112-117	64
Drainage.	" 92.	118-122	65
How We Rob the Soil.	" 95.	123-126	66
How We Help to Feed the Plants.	} " 99.	127-132	67
Climate and Plant Life.	" 101.	133-137	68
Insect Pests.	" 103.	138-147	69
3. <i>Cultivation of Crops.</i>	Bk. 2, Pt. III.	—	72
4. <i>Health.</i>	Bk. 2, Pt. IV.		
Why We Eat.	Page 136.	148-150	72
Heat-giving Foods.	" 140.	151-157	73
Flesh-forming Foods.	" 144.	158-163	74
A Few Common Foods.	" 147.	164-166	74
The Best Kind of Diet.	" 150.	167-169	75
Water, I and II.	" 153.	170-181	76
Other Beverages.	" 160.	182-185	78
What Becomes of Our Food.	" 163.	186-189	79
The Air We Breathe.	" 166.	190-194	79
Why the Wind Blows.	" 169.	195-198	81
Ventilation.	" 171.	199-203	82
The Clothes We Wear.	" 174.	204-207	83
Soil and Climate; or, Where to Live, I and II.	} " 178.	208	83
Insects that Carry Disease.	—	209-224	84
VI. THE SCHOOL GARDEN	—	—	88
VII. APPENDIX			
The Names of Plants.	—	—	95



A WRONG METHOD OF TEACHING EXEMPLIFIED



A WELL-ILLUSTRATED LESSON AND AN INTERESTED CLASS

A COMPANION TO BLACKIE'S TROPICAL READERS

I. INTRODUCTION

HINTS TO TEACHERS

1. Let the children work through the experiments systematically, though some of them may be omitted or postponed if thought desirable. The less-advanced children should be allowed to do portions of experiments.

2. Each child's note-book, with the record of the experiments, should be examined frequently by the teacher, and initialled.

3. A shelf, cupboard, or table should be reserved for apparatus and specimens used in connection with this work. Wooden boxes and cloth bags will be found useful.

4. A stock set of apparatus (e.g. glasses, funnels) should be kept, and lent to the children when required.

5. The first step in work of this sort is invariably the hardest.

6. Whenever there are difficulties in the way, do the *best possible*.

7. Create a spirit of healthy rivalry among the children. Variety, too, will help to make the work a pleasure.

8. In experiments, never tell a child what he can be *led to find out* for himself.

9. Some of the experiments will best be done by the teacher aided by the children.

10. Large diagrams (drawn with coloured crayons on cloth) should be prepared, and may be hung about the schoolroom.

11. Reference should be made throughout the work to the corresponding lessons in the *Tropical Readers*.

12. Teachers should visit one another's schools, and exchange ideas.

HINTS TO PUPILS

1. All work should be recorded in a notebook. The writing should be neat and tidy, and the language clear, brief, and simple. All important facts must be recorded in as few words as possible.

2. Number the pages of the note-book, and leave a wide margin for side notes and headings.

3. Two lines should be left between the end of one experiment and the beginning of another.

4. Record the date on which the work done is written up.

5. In many of the experiments it would be well to divide the record into three paragraphs: (i) Object of Experiment, (ii) What I Did, (iii) What I Saw.

6. Drawings should be made to illustrate the specimens collected, the apparatus used, &c.

7. Such drawings should be very simple, but should show clearly and correctly what they are intended to

illustrate (fig. 1). Do not make small figures cramped in between writing.

8. All practical work should be done *thoroughly*; quality should come before quantity. It is better to do a few things well than to do many carelessly.

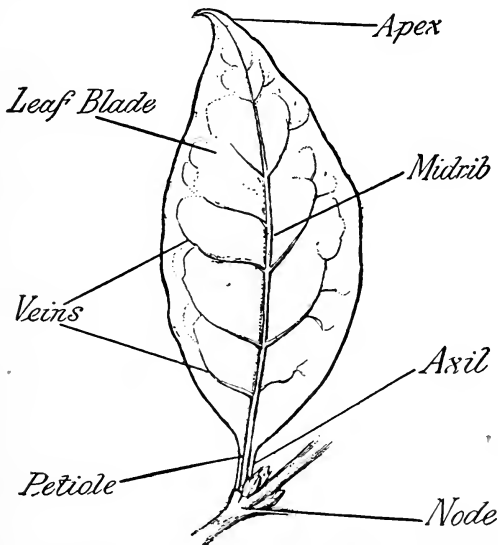


Fig. 1.—Diagram of a Leaf, showing how drawings in pupil's notebook should be made

9. Pleasure should be taken in overcoming any difficulties that may be found in the work suggested.

10. Children often think that it is quite impossible for them to do a certain task, but find on trying that it is really quite easy.

11. If you think you do not know how to do a certain thing, try and find out *by yourself* how to do it before asking the teacher to help you.

12. Take a pride in your notebooks, your collections, your experiments, and your school garden.

THE USE OF APPARATUS

In order that all the practical experiments outlined in this Companion should be satisfactorily carried out, teachers will have to make use of some chemical apparatus and of some reagents. It will often be found that interesting experiments can be successfully performed with simple appliances and with chemical substances in common use, and it is indeed preferable to make use of familiar articles whenever possible.

Any experiment that the teacher proposes to do for the benefit of his class should be tried beforehand. This is important, and will safeguard against annoyance of the teacher and disappointment of the scholars. It has been said of the famous chemist Faraday that in preparing for his lectures he always tried the stoppers of the bottles he intended to use, in order to make sure that they could easily be taken out.

Teachers often extend their work in chemistry beyond the limits of the experiments suggested by the text, matter of the *Tropical Readers*, and the notes given here will, it is hoped, enable them to do such further demonstrations as they may desire.

The necessary manipulation will be found quite easy. The following notes are intended for those teachers who have had no training in practical chemistry:—

Folding Filter Paper.—The paper should be first folded in half and the centre creased; this should then be doubled over again (as shown in fig. 2), and opened out so that a funnel is formed with three folds of paper on one side and one on the other.

Filtration.—Matter in suspension can be readily separated from the liquid in which it is suspended, by

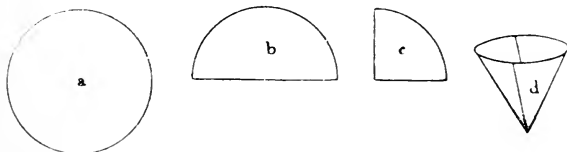
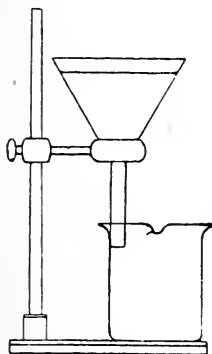


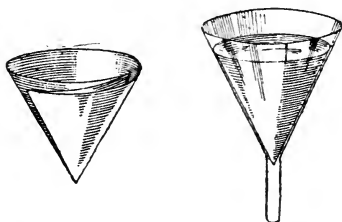
Fig. 2

a, Circular Filter Paper; *b*, do. folded once; *c*, do. folded twice; *d*, opened out into cone

filtration. A funnel is fitted with filter paper, folded as explained above; the mixture is then poured on to the funnel (fig. 3), and the liquid (with any matter in solution) passes through. The use of a glass rod down which the liquid may run will be found a help in pouring out the liquid.



Funnel and Filter
Stand



A, Filter paper folded into proper shape;
B, filter paper placed inside glass funnel

Fig. 3

Decantation.—This is a means of separating fine particles of matter in suspension from heavier substances also insoluble. Thus, if a mixture of soil and

water is stirred rapidly and the water poured off, the clay in suspension is carried away with the water, while the sand settles at the bottom of the vessel (fig. 4).

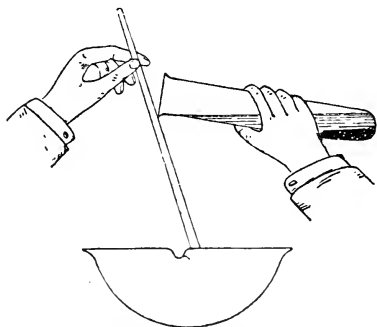


Fig. 4.—Decantation

Evaporation.—A liquid may be driven off in the form of a vapour by exposing it to the influence of the sun's heat. The change may be more rapidly brought about by putting the vessel over a fire.

Heating.—The problem of obtaining a satisfactory source of heat may prove troublesome. A spirit lamp will be convenient, but will not give sufficient heat for all experiments. The writer believes that a small and inexpensive "fireplace", neatly built with a few bricks, in a corner of the schoolground, will prove useful. The cover of a kerosene tin may be put across the top to support whatever is to be heated.

Cutting Glass Tubing.—Draw one edge of a file sharply across the tubing to be cut, at the required length. Take hold of the tubing with both hands, keeping the thumbs near to the mark made by the file; snap sharply across.

Bending Glass Tubing.—Hold the glass tubing in the

flame, turning it round and seeing that it is gradually heated. When the tube shows signs of softening, slowly bend it as desired. Larger sizes of tubing cannot be bent in the flame of a spirit lamp.

Care of Apparatus and Chemicals.—Special precautions have to be taken by teachers who undertake work of this nature. Some of the reagents are highly corrosive, e.g. nitric acid, sulphuric acid; phosphorus takes fire when exposed to the air; sodium is highly dangerous if put into water in too large quantities; and hydrogen and oxygen make an explosive mixture. Further, many chemicals are poisonous, and the greatest care has to be exercised in storing them. Children should never be allowed to handle them by themselves, and they are best kept under lock and key. Glassware should be gently handled to avoid breakage.

Cost.—If full use be made of such substitutes as can be obtained, the cost of this work will amount to very little. Five shillings, it is estimated, will enable the teacher to buy sufficient apparatus to keep the work going, while for ten shillings he can be thoroughly equipped. If there were a regular demand for apparatus some local firm of importers would doubtless be willing to make arrangements to keep a stock of just what teachers might require.

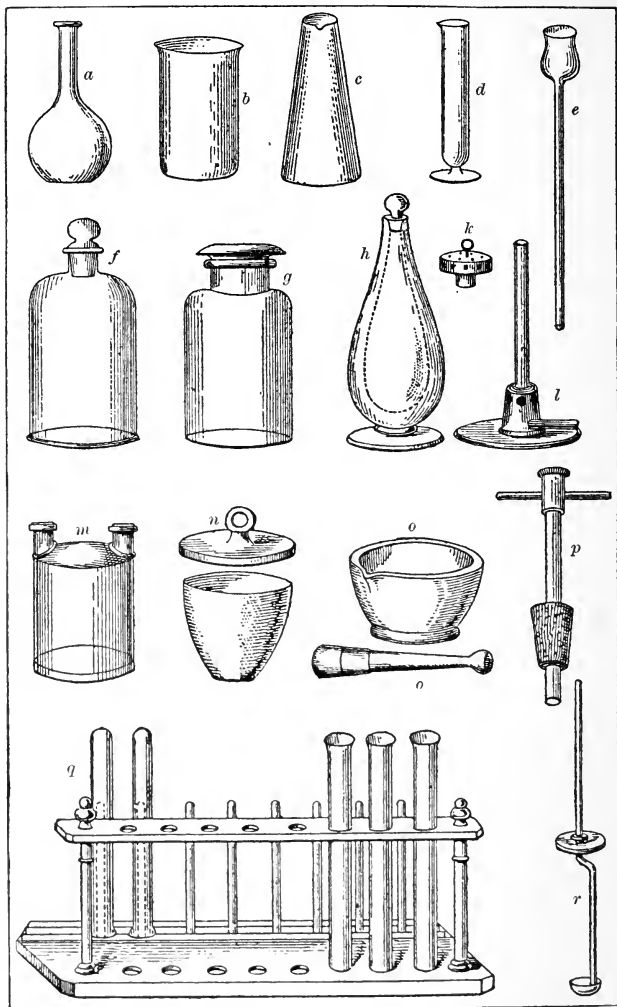


Fig. 5.—Chemical Apparatus

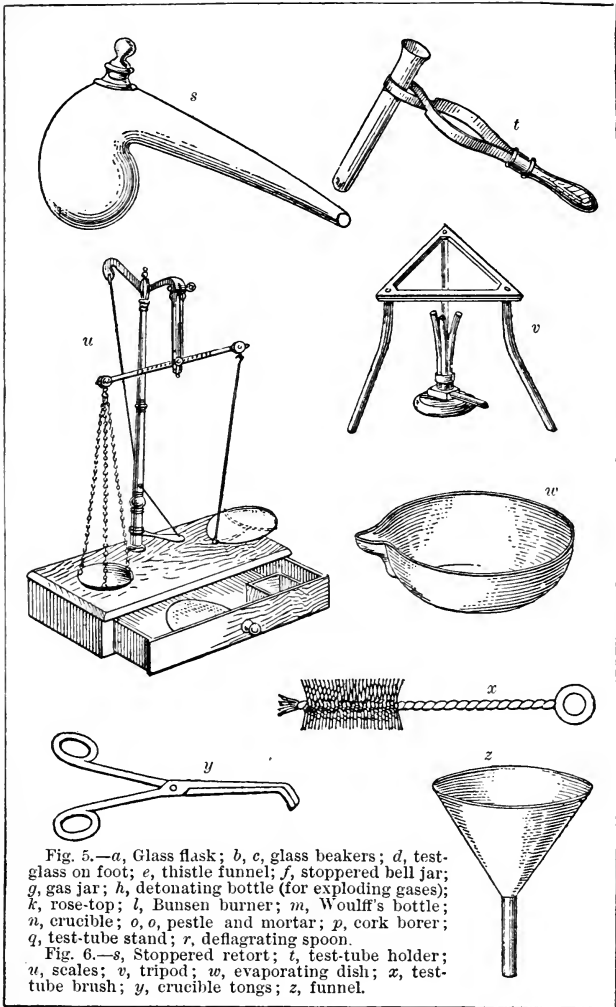


Fig. 5.—*a*, Glass flask; *b*, *c*, glass beakers; *d*, test-glass on foot; *e*, thistle funnel; *f*, stoppered bell jar; *g*, gas jar; *h*, detonating bottle (for exploding gases); *k*, rose-top; *l*, Bunsen burner; *m*, Woulff's bottle; *n*, crucible; *o, o*, pestle and mortar; *p*, cork borer; *q*, test-tube stand; *r*, deflagrating spoon.

Fig. 6.—*s*, Stoppered retort; *t*, test-tube holder; *u*, scales; *v*, tripod; *w*, evaporating dish; *x*, test-tube brush; *y*, crucible tongs; *z*, funnel.

Fig. 6.—Chemical Apparatus

APPARATUS AND SUBSTITUTES

(See Figs. 5 and 6.)

Apparatus.	Proposed Substitute.
Retort stand. ¹ Spirit lamp. Furnace. ¹ Wire gauze. Pipeclay triangle.	Common kitchen lamp, used with alcohol. Brick fireplace. Squares of tin sheeting. Similar triangle made with bits of clay pipes and wire.
Evaporating basins. Funnels (glass). Filter paper. Test tubes. Test-tube stand. Test-tube brush. Thistle funnel. Woulff's bottle. ¹ Cork borer.	Enamelware saucers, tin saucers, yabbas. Tin funnels. Blotting paper cut to size. Block of wood with auger holes. Pointed stick with cloth attached. Clay pipe. Knife with long-pointed blade and a rat-tail file.
Triangular file. Retort. ¹ Flask. Pneumatic trough. Beehive shelf. Glass jars. Glass plates. Deflagrating spoon. Corks. Glass tubing. Bell jar. Pestle and mortar. Tripod stand.	Glasses and enamelware jugs to stand heat. Toilet basin. Two bricks. Jam pots, wide-mouthed bottles. Small squares of window-pane glass. Small tin spoon bent at right angles. Small bamboo joints. Bottle with bottom cut off. Stones. Home-made article of stout wire.

¹ Not absolutely necessary.

II. STUDY OF ANIMAL LIFE

There does not appear to be any necessity for dealing separately with the thirty-three lessons on animal life that are to be found in the *Tropical Readers* (Book I, Part I; Book II, Part I). The lines to be adopted in teaching this section will be very similar for each animal. The teacher's object will naturally be to ensure the children's taking a lively interest in the subject, and this can best be done by encouraging them to make and record their own observations.

KINDNESS TO ANIMALS

The modern trend of this branch of education is to insist on the study of animals in their natural haunts rather than to destroy them for the purpose of examining their dead bodies. It is not thought at all desirable that children should be encouraged to collect and kill specimens such as birds, insects, &c., nor should they be allowed to keep live animals in captivity. Much good will be done if no opportunity is lost of impressing on the pupils the necessity of kindness to all animals.

Birds, insects, spiders, and other creatures should not be kept confined in boxes or cages. They should never be handled roughly. Their homes or nests should not be destroyed or interfered with. The children should be made to realize the necessity of taking the greatest care of animals belonging to them, of giving them a liberal and regular supply of food and of water, and of cleaning their cages, nests, stables, &c.

OBSERVATION OF HABITS OF ANIMALS

Children should be led to observe and record such details as the following:—

1. The seasons at which birds, butterflies, ticks, &c. are most plentiful.
2. The flowers that certain birds, butterflies, moths, &c., visit for food.
3. The insects eaten by birds, frogs, lizards, &c.
4. The weeds eaten by domestic and other animals, e.g. Spanish needle by rabbits.
5. The fruits eaten by bats, e.g. duppy cherry, naseberry, guava, &c.
6. Different insects and other pests attacking crops.
7. The adaptation of organs of animals for functions they have to perform, e.g. teeth of a horse, the fringe on the bill of a duck, the tongue of the humming bird, &c.
8. Powers of self-defence and self-preservation, e.g. horns of cow, evil smell of green-bug, sting of scorpion and wasp, colouring of lizards, structure of stick-insects.

PRACTICAL WORK AND EXPERIMENTS

As the teacher reads through the lessons on animal life he will readily see that most of them can be illustrated with objects brought in by the children, e.g.:—

1. *Bees*: Pollen, honey, wax, flowers with nectar.
2. *The Cow*: Milk, leather, bone, candles.

In some cases interesting experiments may be undertaken.

1. *Milk* may be separated into its constituents. Allow to stand, and the *fat* will rise; add limejuice, and *proteids* will coagulate; if the remaining whey is evaporated *sugar* will be left; and *ash* will be produced by burning the residue.

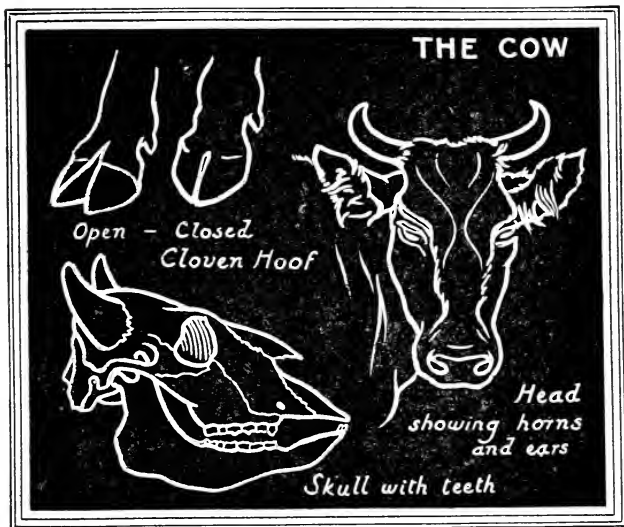
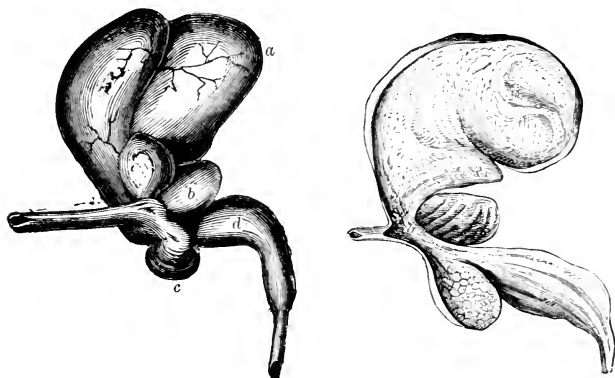


Fig. 7



External View of Stomachs of Cow.
a, Paunch; (*b*) honeycomb bag; *c*, manyplies; *d*, true stomach.

Internal Structure of Stomachs
of Cow

Fig. 8

NOTES FOR A LESSON ON THE COW

(See Figs. 7 and 8.)

Facts to be "drawn out" of children by direct and indirect questions (<i>educere</i> , to draw out).	Methods of teaching; specimens, drawings, experiments, &c.
<p>1. Description of the Cow. <i>Size</i>, large. <i>Hair</i>, short, similar to horse. <i>Skin</i>, tough, thick. <i>Legs</i>, four. <i>Hoofs</i>, two toes. <i>Horns</i>, on front of head. <i>Tail</i>, long, with hair at end. <i>Stomach</i>, four parts. <i>Teeth</i>. <i>Different breeds</i>.</p> <p>2. Habits of the Cow. (Gentle domestic animal.) Eats grass. Chews cud. Lies down. Yields milk.</p> <p>3. Uses of the Living Cow. Cows yield milk. Oxen plough fields, and draw heavy wagons.</p> <p>4. Uses of the various Parts of the Cow when Dead. <i>Beef</i>. <i>Veal</i>, from calf. <i>Tallow candles</i>, from fat. <i>Glue</i>, from horns and hoofs, by boiling. <i>Handles of knives, buttons, &c.</i>, from horns. <i>Leather</i>, from hide, by tanning. <i>Mortar</i>, mixed with hair.</p>	<p>1. Description of the Cow. It is desirable to obtain the use of a cow for demonstration, and to point out the different parts while the children are standing around the animal. Make an incomplete drawing of a cow on the blackboard, and let the children fill in the horns, toes, tail, &c. Draw a diagram on the board, showing the four parts of a cow's stomach.</p> <p>2. Habits of the Cow. Let children observe how the cow eats grass and afterwards chews its cud.</p> <p>4. Arrange beforehand for children to bring in specimens.</p>

NOTES FOR A LESSON ON THE COW.—(Cont.)

Facts to be "drawn out" of children by direct and indirect questions (*educere*, to draw out).

Methods of teaching; specimens, drawings, experiments, &c.

5. Composition of Milk.

Milk is a liquid containing:

1. Fat (in suspension).
2. Albumen (in solution).
3. Sugar "
4. Mineral matter "

5. Composition of Milk.*Articles Required.*

Milk.
Two glasses.
Butter.
Cloth strainer.
Cheese.
Enamel evaporating dish.
Limejuice.

1. *Fat*.—(a) Let children examine. Hold a glass of milk to the light, and observe the fat globules.

(b) Show children a glass of milk that has been standing for some hours, and let them point out that the fat has risen to the surface.

2. *Albumen*.—Pour some limejuice into a glass of milk, and observe that it curdles. The solid matter, consisting of albumen, is known as curd, while the liquid left is whey.

3. *Sugar*.—Separate the curd and the whey by straining through a cloth. The liquid which goes through contains sugar and mineral matter.

4. *Mineral Matter*.—Evaporate the solution in an enamel dish over a fire. It will be noticed that the residue left after the liquid passes off will soon begin to darken in colour. This is the sugar burning. Continue heating until only the mineral matter is left behind in the form of ash.

III. STUDY OF ECONOMIC PLANTS

Space would not permit of notes being given on each plant dealt with in the *Tropical Readers*. The teacher can, however, adapt the general plan to suit each lesson. It is desirable to arouse more interest in the children in the study of the plants seen in the fields and gardens among which they live. Their powers of observation should be trained, while every endeavour should be made to awaken them to a keener appreciation of the value of improved agricultural methods.

DESCRIPTION OF THE PLANT

Part of the time devoted to the study of a plant will naturally be spent describing the structure of its parts. The teacher should insist on leaves, flowers, fruits, &c., being brought in, and should, by direct and indirect questions, obtain information about the specimens from the pupils. These lessons will enable him to note the degree of accuracy shown, and the power of observation possessed, by different members of his class. Discretion will have to be exercised as to how far botanical terms should be used; but it will be well, anyhow, to consider the different details according to some such scheme as the following:—

Roots.—Tap, fibrous, tuberous, aerial, woody, fleshy.

Stem.—

Woody, fleshy, herbaceous,
spiny.

Colour.

Surface.

Method of growth.

Special forms.

Leaf.—

Simple or compound.

Shape.

With or without leaf-stalk.

Veins.

Margin.

Arrangement on stem.

Persistent or falling off.

Flowers.—

Number borne together.

Shape.

Size.

Colour.

Description of calyx.

Description of corolla.

Season of year borne.

Insect visitors.

Fruit.—

Size.

Colour.

Texture of skin.

Kind of pulp.

Seed.—

Number in fruit.

Size.

Nature of seed-coat.

Number of cotyledons.

CULTIVATION

The text matter of the *Tropical Readers* should be practically illustrated by growing such economic plants as convenient in the School Garden.

Correct methods of culture can then be more satisfactorily impressed on the children. Let *each* child *do* as much as can possibly be arranged. Work should cover the following grounds:—

Situation and soil.

Preparation of land.

Selection of seed.
 Propagation.
 Cultivation.
 Tillage, drainage, watering, weeding.
 Control of insect pests.
 Harvesting.
 Preparation for marketing.

USES

Special attention must be drawn to the uses made of various portions of the plants studied; for example:—

COCONUT

FRUIT.—

(a) *Water*.—A drink.

(b) *Meat*.—Oil, confectionery, food for animals.

(c) *Husk*.—Coir mats, coir fibre, mattresses, rope, floor brushes, other brushes.

(d) *Shell*.—Ornamental vases, spoons, drinking vessels.

LEAF.—Baskets, sails, mats, hats, thatch, fencing, booths.

STEM.—Posts for house-building, ornamental wood used for cabinet work, walking-sticks.

PREPARATION FOR MARKET

When the product has to be cured or manufactured for market, the process should be carefully explained to the children. Notes or drawings should be made on the blackboard showing each step, and at the same time specimens should be exhibited illustrating the various stages from the raw to the manufactured article. Special attention should be drawn to faulty methods that affect the value of our exports.

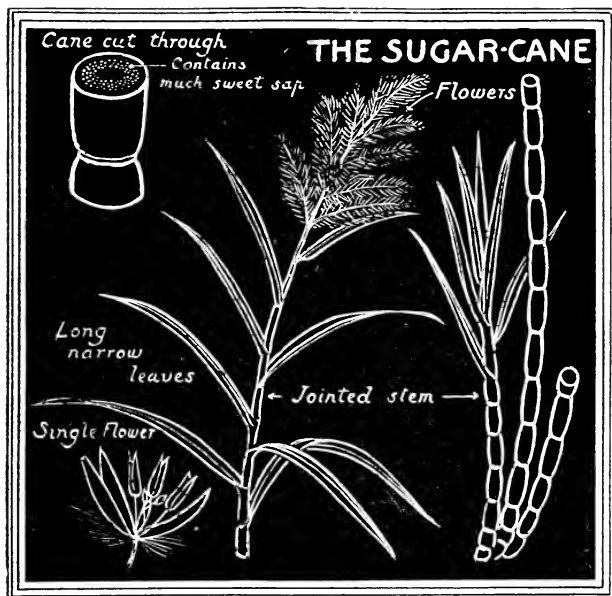


Fig. 9

NOTES FOR A LESSON ON THE SUGAR CANE

(See fig. 9.)

PREPARATION FOR LESSON

Blackboard Drawings

Plant.
 Flower.
 Stem cut through.
 Stages in manufacture of
 sugar.

Specimens

Cane plant.
 Flower-spike.
 Corn.
 Grass-spike.
 Molasses.
 Muscovado sugar.
 Albion sugar.

NOTES FOR A LESSON ON THE SUGAR CANE.—(Cont.)

Pictures

Cane mill.
Sugar estate.

Apparatus and Chemicals

Evaporating dish.
Spirit lamp or fireplace.
Temper lime.

Facts to be "drawn out" of children by direct and indirect questions (*educere*, to draw out).

Methods of teaching; specimens, drawings, experiments, &c.

1. Description of Sugar Cane.

Plant, like a tall grass with stout stems, 8 to 12 ft. high.

Roots, fibrous.

Stem, thick, jointed, sweet.

Leaves, large, narrow, and pointed; veins parallel.

Flowers, large clusters of small flowers, called "cane-flags".

2. Countries.

West Indies, Java, Demerara, India.

3. Parishes in Jamaica.

Clarendon, Westmorland, Trelawney, St. James, Hanover, St. Thomas, St. Catherine.

4. Method of Cultivation.

1. Suitable land selected.
2. Land cleared.
3. Land ploughed and rowed.
4. Cane tops planted.
5. Young canes moulded up from time to time.
6. Canes weeded, mulched, manured.

1. Description of Sugar Cane.

Compare stems and leaves of grass, corn, and cane, all of which are members of the Grass Family.

Exhibit a cane plant with roots to illustrate the description of the plant.

2. Countries.

Point to sugar-growing countries on a map of the world.

3. Parishes in Jamaica.

Fill in sugar districts on blank map of Jamaica.

4. Method of Cultivation.

In the School Garden devote a plot to canes grown in the most approved manner, and there demonstrate how the plant should be cultivated.

NOTES FOR A LESSON ON THE SUGAR CANE.—(Cont.)

Facts to be "drawn out" of children by direct and indirect questions (*educere*, to draw out).

Methods of teaching; specimens, drawings, experiments, &c.

7. Canes "trashed".
8. Ripe canes cut.
9. Next year's plants spring from stools known as ratoons.

5. Manufacture of Sugar.

Order of process.

1. Ripe canes cut.
2. Crushed in mill.
3. Cane juice heated, "limed", and skimmed.
4. Boiled thick until syrup is formed.
5. Syrup allowed to cool, sugar crystallizing out and molasses draining off.
6. Sugar crystals refined in centrifugal.

Manufacture of Rum

1. Molasses (see fifth stage above) mixed with the skimmings and allowed to ferment.
2. Transferred to still.
3. Wash distilled.
4. White wines collected in receiver.
5. White wines coloured with burnt sugar.

5. Manufacture of Sugar.

On the blackboard make rough drawings illustrating in order the stages of manufacture and the type of machinery used.

Prepare a solution of sugar and water, evaporate and obtain the sugar. Prepare sugar from cane juice in an evaporating basin.

Exhibit cane juice, molasses, wet sugar, Muscovado sugar, Albion sugar.

Put some yeast in a solution of sugar and water; observe the change that takes place in a few days, and notice the smell of alcohol.

Put the residue from above in a retort and distil. Collect the liquid that condenses first; test its alcoholic character by smell and by its inflammability.

IV. EXPERIMENTS AND PRACTICAL WORK

I. Animal Life

For general notes on Animal Life see pp. 19-23 of this Companion.

II. Plant Life

PLANTS

(See *Tropical Readers*, Book I, pp. 68-71.)

EXPT. 1. How a Plant Lives and Feeds.—Make a drawing of a growing plant, directing attention to the following facts by side notes:—

(1) The leaves are in the air, and take in carbon dioxide as food.

(2) The roots are in the soil, and absorb their food in the form of solution.

EXPT. 2. Some Roots do not Grow in the Soil.—Collect four plants with roots that do not grow entirely in the soil, or that never reach the soil at all; e.g. wild pine, mangrove, screw pine.

EXPT. 3. Some Plants never have Flowers.—Collect four plants that do not bear flowers, e.g. ferns, mosses.

EXPT. 4. Animals Feed on Plants.—Make a collection of six plants upon which you have observed

animals feeding, e.g. horses upon guinea grass, birds on oranges and guavas, caterpillars on lilies.

EXPT. 5. **Useful Plants.**—Collect four specimens each of plants made use of, as follows:—

Food—e.g. cassava, yam.

Drink—e.g. coconut, cocoa.

House-building—e.g. cedar, broadleaf.

Dyes—e.g. logwood, fustic.

Medicines—e.g. Jack-in-the-bush, leaf-of-life.

ROOTS—I

(See *Tropical Readers*, Book I, pp. 72-74.)

EXPT. 6. **Tap-roots.**—Collect ten plants with *tap-roots* (e.g. coffee, cocoa, orange, carrot, turnip, cassava, broom-weed) and put those that are *fleshy* together.

EXPT. 7. **Fibrous Roots.**—Collect six plants with *fibrous roots* (e.g. guinea grass, cane, corn, red lily).

EXPT. 8. **Root-cap** (fig. 10).—Examine roots of the water hyacinth and mangrove, and observe that the *root-caps* at the tip are so much developed as to be visible to the naked eye.

EXPT. 9. **Growing Portion of a Root is near Tip.**—To show that only the lower portion of a root grows longer, put a seedling, the root of which has been marked with Indian ink or tied with bands of thread at intervals of about $\frac{1}{8}$ in. in a funnel (see fig. 11), and keep moist by surrounding with damp cotton wool or blotting paper. A copy should first be made on

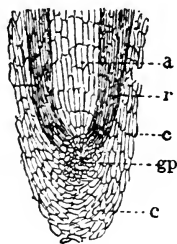


Fig. 10. — Longitudinal Section through the Apex of a Root

a, Axis; *r*, cortex; *gp*, growing-point; *cc*, root-cap.

paper to show the exact position of the marks put on the root. In three or four days compare the root with the copy, and observe that the marks are farthest apart towards the end of the root. In recording this experiment make drawings.



Fig. 11.—Experiment to determine the Growing Point of a Root

EXPT. 10. Development of Roots from Radicle of Bean Seed.—Grow a number of bean seedlings, germinating the seeds on damp blotting paper, in moist sawdust, and in the soil itself. Make six drawings from observations, showing the radicle from the time it was dormant until it had developed into a root system two months old.

EXPT. 11. Development of Roots from Radicle of Corn Seed.—Repeat Experiment 10, examining the growth of roots in corn seedlings instead. Observe that the radicle dies back after a time, and numerous fibrous roots take its place.

ROOTS—II

(See *Tropical Readers*, Book I, pp. 75-78.)

EXPT. 12. Storage of Food in Roots.—Keep carrots and turnips growing until they produce flowers and seeds; observe that the fleshy roots get much smaller.

EXPT. 13. Aerial or Adventitious Roots.—Make drawings of the aerial or adventitious roots, which

grow partly or entirely above ground, on six plants, e.g. screw pine, mangrove, orchid, sugar cane.

EXPT. 14. **Necessity for Roots.**—Cut the roots off a weed; plant it in the soil; support it by a stake. Note whether it grows or not.

EXPT. 15. **Root-hairs.**—Grow some radish seedlings on a piece of flannel and observe the tiny root-hairs.

EXPT. 16. **Tuberous Roots and Tubers.**—Examine the tuberous root of the cassava and compare it with the tuber of a yam; put both aside in a moist place, and observe that the latter readily develops shoots from its “eyes”.

STEMS AND SHOOTS—I

(See *Tropical Readers*, Book I, pp. 78–82.)

EXPT. 17. **Food Solution travels up Stem from Roots.**—Cut through the stem of a plant growing vigorously, about 6 in. from the ground, and note the “bleeding” due to the escape of food in solution going up the stem from the roots. Do not confuse with gummy matter given off by plants in order to heal wounds.

EXPT. 18. **Food Solution travels up through Woody Portion of Stem.**—Put a branch (e.g. of a rose tree) with leaves to stand in water coloured with red ink. Expose in the sunlight for three or four hours. Observe that the red ink has travelled up into the leaves, and, by cutting across the stem and also peeling down a piece of the bark, note that it has passed through the woody portion of the stem only; the pith, cambium layer, and bark will not have been reddened.

EXPT. 19. **Underground Stems.**—Collect and make drawings of *rhizomes* of the ginger and iris; *tubers* of

the white yam, coco (tania), and Irish potato; and of *bulbs* of the onion, garlic, and red lily. Observe that all these underground stems possess "eyes" or buds from which shoots may grow.



Fig. 12.—The Potato Plant, showing tubers

EXPT. 20. Edible Portion of Cassava.—Observe that the tuberous or fleshy root of the cassava has no buds, and is therefore a root.

EXPT. 21. Edible Portion of Sweet Potato.—Determine by examination and experiment whether the edible portion of a sweet potato plant is a tuber or a fleshy root.

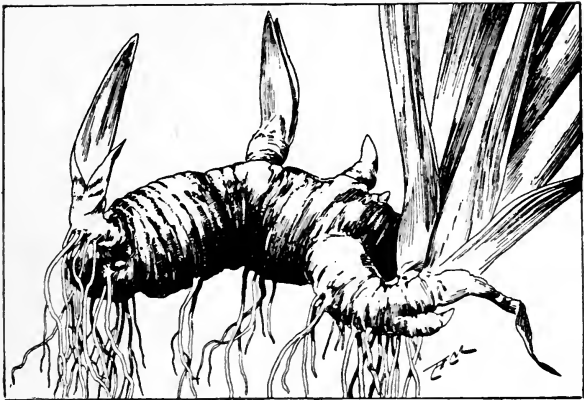


Fig. 13.—Rootstock, or Rhizome, of Iris

EXPT. 22. Cuttings in Water.—Put two or three cuttings of crotons in water and observe that roots develop at the base.

EXPT. 23. Food does not travel down a Stem if the Cambium Layer is Injured.—Get three cuttings as in the experiment above, but remove a ring of bark about 2 in. wide and about 1 in. from the base. Scrape the exposed portion roughly and place in water. Observe that in the case of these cuttings the roots arise above the ring, showing that the ring prevented the carriage of food to the lower portion of the cutting.

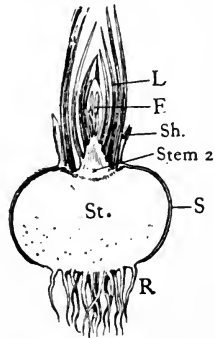


Fig. 14.—Longitudinal Section of Corm of Crocus

L, Leaves; F, flower; sh, sheathing leaves; st, stem; s, brown scale leaves; R, roots. (Stem 2 will become next year's corm.)

EXPT. 24. **Corms and Bulbs.**—Compare the underground stem of the crocus or snowdrop (a corm) with

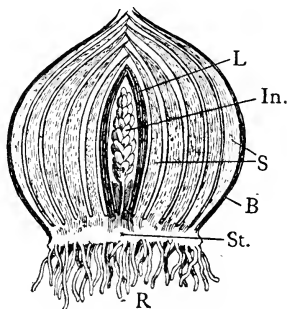


Fig. 15.—Section of Bulb

L, Foliage leaves; In, inflorescence; s, fleshy scale leaves; B, brown scale leaves; St, stem; R, roots.

that of the onion (a bulb), cutting both across and making drawings of the sections.

STEMS AND SHOOTS—II

(See *Tropical Readers*, Book I, pp. 82–86.)

EXPT. 25. **Tendrils.**—Collect shoots of the grape vine, sweet cup, cerasse, chocho, and four other plants that possess tendrils with which they climb.

EXPT. 26. **Coiled Tendrils.**—Closely examine the tendril of a chocho or grape vine, and observe that it has a straight portion in the middle of the coiled part; this prevents its kinking when drawn tight, and reduces the chance of its being broken by strong winds.

EXPT. 27. **Twining Plants** (fig. 16).—Observe how the yam vine twines round its support. Wind a piece of string spirally round a stick to represent the direction

taken by the yam. Note whether the yampie is also a twiner or not, and, if it is, in what direction it grows.

EXPT. 28. Shapes and Coverings of Stems.—Collect:

(a) Six round (*cylindrical*) stems, e.g. soursop, genip.

(b) Four *three-sided (triangular)* stems, e.g. bine-pear, Jerusalem candlestick.

(c) Four *four-sided (quadrangular)* stems, e.g. granadilla.

(d) Six stems with *smooth surfaces*, e.g. mango, sweet potato.

(e) Four stems with *hairs*, e.g. cowitch.

(f) Four stems with *hollow joints*, e.g. bamboo, wild cane.



Fig. 16.—Twining Stem

EXPT. 29. Protective Hairs and Prickles.—What purpose does it seem likely that the hairs on the cowitch (which should not be handled) and the prickles of the prickly pear serve? Make drawings of hairs and prickles.

EXPT. 30. Layers of Bark, Wood, and Pith.—Examine young plants of broomweed, and note that the pith gets smaller while the woody part enlarges.

EXPT. 31. Heartwood and Sapwood.—Examine logs of wood cut from branches of large trees, and observe that there are two layers of wood—the hard and darker-coloured heartwood in the centre and the outer layer of sapwood.

EXPT. 32. Stems of Monocotyledons and Dicotyledons.—Get portions of the stem of the corn, mango, cane, and sunflower plants; saw across, and make drawings

with coloured crayons of the sections; state which are similar in structure to one another.

LEAVES—I AND II

(See *Tropical Readers*, Book I, pp. 86-93.)

EXPT. 33. Simple and Compound Leaves.—Collect and make drawings of—

(a) Ten *simple undivided* leaves, e.g. orange, mango, sweet-sop.

(b) Six *simple* leaves that are *divided* or *lobed*, e.g. bread-fruit, castor oil.

(c) Twelve *compound pinnate* leaves, e.g. logwood, tamarind, Barbados pride, poinciana.

(d) Six *compound digitate* leaves, e.g. silk-cotton (Ceiba), choya (Cleome).

EXPT. 34. Leaf Stalks.—Examine the stalks of leaves, and collect four belonging to each of the under-mentioned classes:—

(a) *Petiolate leaves*, e.g. mango, custard apple.

(b) *Sessile* (without stalks), e.g. wandering Jew, tobacco, French cotton, monkey fiddle.

(c) *Stipulate*, e.g. rose, gungo, rattle-bush.

(d) *Sheathing*, e.g. sugar cane, Indian shot, guinea grass.

EXPT. 35. Shapes of Leaves (fig. 17).—Collect simple leaves or leaflets that are the following shapes:—

(a) *Linear*, e.g. guinea grass, crocus.

(b) *Oval*, e.g. guava, pimento.

(c) *Egg-shaped (ovate)*, e.g. dumb cane, four o'clock, arrowroot, clammy cherry (scarlet).

(d) *Egg-shaped upside down (obovate)*, e.g. cashew, lignum-vitæ (leaflet).

(e) *Elliptical*, e.g. grape fruit, star apple, aralia (leaflet).

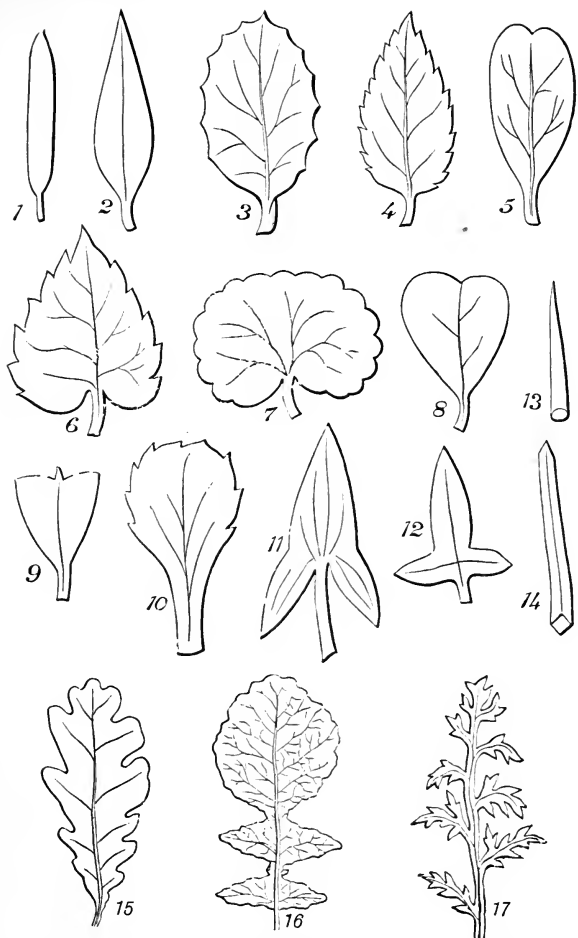


Fig. 17.—Simple Leaves illustrating variety in Shapes and Edges

1, Line-like; 2, lance-shaped; 3, elliptic; 4, egg-shaped; 5, egg-shape reversed; 6, heart-shaped; 7, kidney-shaped; 8, heart-shape reversed; 9, wedge-shaped; 10, with "winged" stalk; 11, arrow-shaped; 12, halbert-shaped; 13, awl-shaped; 14, needle-shaped; 15, 16, 17, leaves with deeply divided edges.

(f) *Heart-shaped (cordate)*, e.g. mahoe, corallila (white), eddoe, bleeding heart (caladium), anatta.

(g) *Spoon-shaped (spathulate)*, e.g. forget-me-not.

(h) *Lance-shaped (lanceolate)*, e.g. mango, bamboo, dagger plant, roseapple.

(i) Draw one example each of the eight different classes mentioned above, and at the side of each draw the object after which it has been named. For example, draw the *heart-shaped* leaf of the anatta, and next to it draw a heart.



Parallel-veined Leaf



Net-veined Leaf

Fig. 18

EXPT. 36. **Veins** (fig. 18).—Collect six kinds of leaves that are—

(a) *Parallel-veined*, e.g. corn, lily, ginger, banana.

(b) *Net-veined*, e.g. pumpkin, yam, golden apple.

(c) Prepare “skeleton” leaves of both types by soaking in water until the blade softens and the fleshy part can be torn away, leaving the veins intact.

EXPT. 37. **Margins of Leaves**.—Collect four leaves in each of the following classes, distinguished by their margins:—

(a) *Even* or *entire*, e.g. mango, sour-sop, golden apple, pimento.

(b) *Serrate* (*sawlike*), e.g. rose, acalypha.

(c) *Spiny*, e.g. pineapple, penguin.

(d) *Dentate* (*like teeth*), e.g. Jack-in-the-bush, water lily (*Nelumbium*).

(e) *Crenate*, e.g. leaf-of-life, geranium.

(f) *Ciliate* (with hairs), e.g. rex begonias.

EXPT. 38. **Surfaces of Leaves.**—Collect four leaves in each of the following classes, distinguished by their surfaces—

(a) *Smooth*, e.g. pimento, mangrove, allamanda.

(b) *Rough*, e.g. petrea, chocho.

(c) *Hairy*, e.g. nettle, turnip, tobacco, velvet leaf.

(d) *Prickly*, e.g. wild thistle.

(e) *Waxy*, e.g. wild plantain, wax plant, French cotton.

Put a waxy leaf in cold water; note film of air; take out and observe that leaf is not wet; rub off wax with soft cloth and warm water; put back into cold water and observe that leaf now gets wet.

EXPT. 39. **Deciduous and Persistent Leaves.**

(a) Whenever you observe a plant bare of leaves (e.g. red plum, cedar, genip, silk-cotton) record its name, together with a note of the time of the year at which it regularly sheds its leaves.

(b) Make a list of twelve trees that do not shed all their leaves at regular seasons, e.g. *lignum-vitæ*, mango, lime, bread-fruit, sweet-sop.

EXPT. 40. **General Collection.**—Make a large and general collection of leaves, and sort them into the following classes:—

(a) Simple and compound leaves.

(b) Undivided simple and lobed simple leaves.

(c) Parallel- and net-veined leaves.

EXPT. 41. **Full Description of Leaves.**—Draw any three leaves, describing the nature of the various parts (shape, petiole, veins, margin, &c.).

FLOWERS—I, II, AND III

(See *Tropical Readers*, Book I, pp. 93-101.)

EXPT. 42. **Description of Flower.**—Collect and describe the different parts of three flowers, e.g. orange, guava.

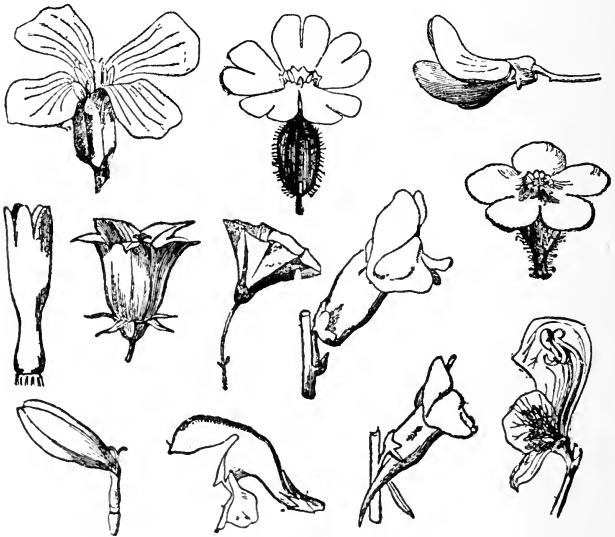


Fig. 19. —Forms of Corolla

EXPT. 43. **Drawings.**—Make careful drawings of any three flowers, naming the various parts.

EXPT. 44. **United Petals.**—Collect twelve flowers in which the petals are more or less united, giving the

flower the shape of a bell, funnel, &c. (fig. 19), e.g. guava, orange.

EXPT. 45. **Sepals.**—Collect twelve flowers with green sepals and four with coloured sepals, e.g. poinciana, orchids.

EXPT. 46. **Number of Petals.**—Observe and record the number of petals usually found in—

(a) Monocotyledonous plants, e.g. red lily, ginger lily.

(b) Dicotyledonous plants, e.g. hibiscus, orange.

EXPT. 47. **Insect - pollinated Flowers.**—Examine flowers that are visited by bees (e.g. logwood, genip, lignum-vitæ); look for the sweet liquid (nectar) and taste it.

EXPT. 48. **Pollen found on Stamens of Flowers.**—Examine four fully opened flowers, and see if you can get pollen from the stamens to adhere to your finger.

FRUITS

(See *Tropical Readers*, Book I, pp. 101–105.)

EXPT. 49. **Development of Fruit from Flower.**

(a) Trace the development of a fruit from the flower bud to the mature fruit, and observe which parts of the flower fall off and which enlarge.

(b) Select a tree on which all stages may be found at the same time, e.g. pomegranate, lime; collect a series and arrange in gradation, putting first the bud, next the flower, &c.

(c) Select a particular flower on a tree and record, with drawings, the changes that take place until the fruit is ripe.

EXPT. 50. **Berries.**—Examine the following berries, and observe that they all possess an outer skin that en-

closes a juicy pulp, in which are seeds: Grape, orange, cucumber. Collect four other berries.

EXPT. 51. Drupe or Stone Fruits.

(a) *The Mango is a Drupe.*—Cut a mango across with a sharp stroke of a cutlass or hatchet, and observe that the real seed is surrounded by (1) an outer skin, (2) a fibrous juicy pulp, and (3) a hard woody covering.

(b) *The Mango Seed.*—Cut open the “stone” of a mango and note the real seed inside with its own coverings. The part of a mango thrown away, and spoken of as the “seed” or “stone”, is, in reality, the seed covered with the third or hard layer of the fruit itself.

(c) *The Coconut is a Fibrous Drupe.*—Make a drawing of a cross section of a coconut, colouring the different parts and explaining, by comparing it with a mango, why it is correct to call it a *fibrous drupe*.

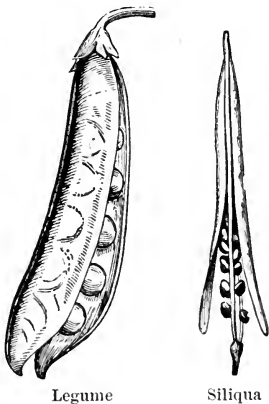


Fig. 20

EXPT. 52. Legumes or Pods.

—Observe that pods (e.g. red pea, Barbados pride, rattlebush, butterfly plant) are made of one cell only, and that they possess two seams by which they open and scatter their seeds. Collect pods, closed and open, from

ten different kinds of plants.

EXPT. 53. **Capsules** (fig. 21).—Collect and examine fruits of the sand-box, anatta, and okra, and of three other plants with capsules; particularly observe any that are split open and have shed their seeds. Record the number of divisions in each fruit.

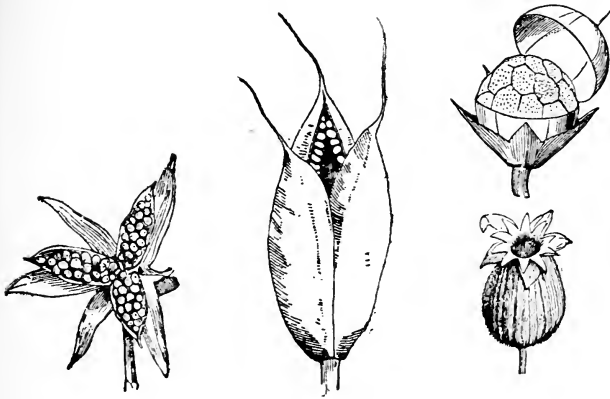


Fig. 21.—Capsules

EXPT. 54. Scattering of Seeds.

(a) Record the greatest distance from the parent plant that you have known of seeds being scattered by natural means.

(b) Pick several pods or capsules that are nearly ready to split open; put near a fire or in bright sunshine and observe the result.

EXPT. 55. Compound Fruits.

(a) Observe by watching from time to time that a number of *separate* flowers go to form the fruits of the pine-apple, bread-fruit, and jack-fruit.

(b) Compare the flowers of the pine-apple and penguin, and also their fruits. Make drawings, showing the number of flowers that go to an individual fruit in each case.

SEEDS

(See *Tropical Readers*, Book I, pp. 105-108.)

EXPT. 56. Examination of Parts of a Bean Seed.—Soak some bean seeds for two or three hours in a saucer containing water, or keep them on damp flannel until they start to grow; observe how the seeds absorb water and swell, and how the seed coat crinkles and splits. The two seed leaves (cotyledons) should now be gently pulled apart and the baby plant, which may be separated with a needle, can be examined. Make drawings.

EXPT. 57. Examination of Parts of a Corn Seed.—Examine corn seeds in a similar manner, noting that they have but one seed-leaf, and that the reserve of food is not in the seed-leaf but around it. Make drawings.

EXPT. 58. How the Store of Food for the Embryo is Used.—Plant some corn and bean seeds, and, when they are seedlings about a week old, examine and observe that the food supply has in both cases largely decreased.

EXPT. 59. Number of Seed Leaves (Cotyledons).—Plant seeds of six different kinds of plants (e.g. Indian shot, iris lily, mango, coffee, cocoa, castor oil, corn), and observe whether they possess one or two seed-leaves.

THE BAMBOO, CORN, ETC.

For general notes on the Study of Economic Plants, see pp. 24-29 of this Companion.

V. EXPERIMENTS AND PRACTICAL WORK

I. Animal Life

General notes on Animal Life will be found on pp. 19-23 of this Companion.

II. Plant Life and Soils

THE PARTS OF A FLOWER

(See *Tropical Readers*, Book II, pp. 53-56.)

EXPT. 60. Description of Flowers.—Collect blossoms of the orange, guava, or any other simple flower; examine carefully and describe the various parts on the following plan:—

The flower as a whole: Mention general shape, size and diameter, colour and perfume; state whether borne singly or in clusters.

Calyx: Mention the number of sepals or lobes, shape, and colour.

Corolla: Mention number of petals or lobes of corolla, their shape and colour.

Stamens: If a few, give exact number, if many, say indefinite; mention colour and length of filament and colour of pollen dust.

Pistil: Mention number of carpels, length of style, and state whether stigma is divided or not.

EXPT. 61. **Drawings of Flowers**.—Make careful drawings, preferably in coloured crayons, of any three flowers; name the parts, and put notes opposite stating the function of each of the parts, viz. calyx, corolla, stamens, pistil.

EXPT. 62. **Ovaries and Seed Eggs** (fig. 22).—Pull off the outer whorls of a pea flower, of an orange flower,

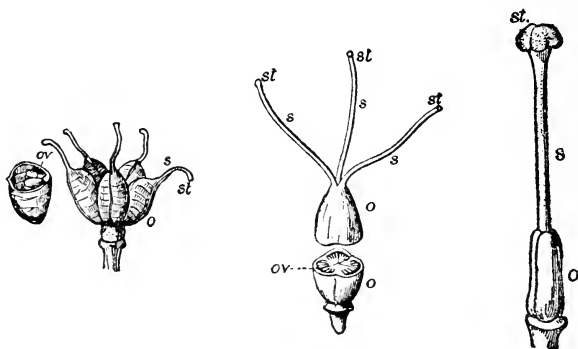


Fig. 22.—Pistils, showing ovaries

o, Ovary; s, style; st, stigma; ov, ovules.

and of two other flowers, leaving the pistils intact; in each case cut across the ovary with a needle or sharp knife, and observe if it is divided into a number of cells or not; record the number of cells in each flower, and observe the small “seed eggs”, or ovules, that, after fertilization, develop into seeds.

EXPT. 63. **Irregular Flowers**.—Examine and make drawings of the following flowers which, in some respect or other, are irregular in form:—

(a) *Lilies*: There are no regular sepals.

(b) *Coco or caladium*: There are a number of male and female flowers without sepals or petals.

(c) *Corn*: Staminate or pollen-bearing flowers are borne on the tassel near the top of the plant, while the pistillate flowers which change into the ear are separate and are situated lower down.

(d) *Sunflower and other Compositæ*: In reality a number of small flowers are borne together on a "head".

(e) *Poinsettia*: or "six months red and six months green": A large, conspicuous, and brightly coloured floral bract surrounds the true flowers.

(f) *Swan flower or Dutchman's pipe*: Constructed so as to attract flies and to keep them in captivity until fertilization has taken place.

(g) *Orchids*: Varied forms, having one of the three petals more conspicuous than the other two.

FLOWERS AND SEEDS (FERTILIZATION)— I AND II

(See *Tropical Readers*, Book II, pp. 56-62.)

EXPT. 64. Fertilization is due to Ripe Pollen coming in contact with Mature Stigma.

(a) *Pollinated Pistils develop Fruit*.—Examine the pistils of a number of flowers that have been open for a day or two, and record whether the stigmas are tipped with pollen or not; observe which develop into fruits.

(b) *Flowers not Pollinated do not produce Fruit*.—Cover over the female flowers on a pumpkin or cucumber vine with a paper bag or with one of fine muslin before they open; observe that fruit will not develop from those flowers, as pollen cannot get at them.

(c) *Effect of removing Stamens*.—Carefully pull apart the whorls of any bud bearing both stamens and pistils

just before it opens; remove the stamens; put a paper cover over the plant, and observe that seeds will not be produced.

EXPT. 65. How Plants prevent Self-fertilization.

(a) *Stamens and Pistils on Different Flowers.*—Examine and make a list of six plants that have been found, on examination, to possess stamens and pistils on different flowers, e.g. begonia, pumpkin, corn, melon.

(b) *Different Sexes on Separate Plants.*—Make a list of four plants, the staminate flowers of which are on different trees from the pistillate flowers, e.g. nutmeg, genip.

EXPT. 66. Flowers with Honey.—Make a collection of ten flowers in which honey or nectar may be found, e.g. logwood, genip, silk-cotton, mangrove, ebony, mango.

EXPT. 67. Nectaries or Special Receptacles for Honey.—Make drawings of three flowers that have specially developed nectaries, e.g. nasturtium.

EXPT. 68. Pollen carried by Insects.—Examine a number of bees visiting flowers and observe how pollen adheres to them.

EXPT. 69. Flowers visited by Birds and Insects.—Make a list of flowers that you have observed being visited by—

(a) *Humming birds:* e.g. poinciana, monkey fiddle, hibiscus;

(b) *Bees:* e.g. genip, logwood, ebony, “six months green and six months red”;

(c) *Butterflies:* e.g. Barbados pride, vervain, sage;

(d) *Moths at night:* e.g. ragged lily, tiger lily, wild ginger, evening glory.

EXPT. 70. How Flowers attract Insects.

(a) Collect six flowers with *brightly coloured petals*, e.g. Bauhinia, ebony, lignum-vitæ.

(b) Collect four flowers with *brightly coloured sepals*, e.g. orchids, poinciana.

(c) Collect four flowers with *brightly coloured "honey guides"* (i.e. distinct bright lines down the petals), e.g. morning glory, celandra.

(d) Collect four flowers that have a *strong scent*, e.g. stephanotis, Cape jessamine, frangipanni, trumpet flower.

EXPT. 71. **The Characteristics of Wind-pollinated Flowers.**—

(a) *Inconspicuous Colouring.*—Examine four wind-pollinated flowers and observe their inconspicuous colouring, e.g. sugar cane, corn.

(b) *Exposed Stigmas.*—Examine the tassel of a young ear of corn and observe that the thread-like styles are sticky, and that they extend beyond the sheath, thus permitting of their being pollinated by wind-borne pollen.

(c) *Extended Anthers.*—Collect some wind-pollinated flower (e.g. grass) and observe that its anthers hang out from the flower, so that the wind may easily blow the pollen to another plant.

SEEDS AND SEEDLINGS—I AND II

(See *Tropical Readers*, Book II, pp. 62-67.)

EXPT. 72. **Seed Coats.**—Soak seeds of corn, broad-bean, and castor-oil plants, together with three other kinds of seeds in water. After they have become swollen, remove the coverings and examine the parts.

EXPT. 73. **Parts of Corn and Bean Seeds.**—After soaking corn and bean seeds in water, examine and make drawings of their parts, showing the nature of the seed coats, the number of the cotyledons, the position of the embryo, and the food reserve.

EXPT. 74. Food Stored in Seeds.

(a) *Starch in Cotyledons*.—Test the cotyledons of the mango, red pea, and genip for starch, by pouring on a few drops of iodine solution and observing the dark-purple colour produced. Compare with result obtained by adding solution to pure starch.

(b) *Starch in Endosperm*.—Cut a grain of corn or a castor-oil seed in two, and test with iodine for starch.

(c) *Manufacture of Starch*.—Prepare starch from mango or corn seeds by grating or crushing and washing with water.

(d) *Oil in Seeds*.—Prepare oil from coconut, castor-oil, and two other kinds of seeds by grating or crushing, boiling with water, and then skimming off the oil that rises.

EXPT. 75. Conditions necessary for Germination.

(a) *Water for Germination*.—Show that moisture is necessary for the germination of seeds by putting six red pea seeds in a dry bottle and six in a bottle with damp blotting paper at the bottom. Observe and record which grow.

(b) *Air for Germination*.—Show that air is necessary by putting corn seeds in two bottles of water. In one case use ordinary water; in the other use water that has been boiled and to which has been added a layer of sweet oil to prevent the access of fresh air. Record if there is any difference in the germination of the seeds.

(c) *Warmth for Germination*.—Too great heat and too great cold prevent germination. Put six bean seeds in a tin, and heat strongly over a fire (without scorching) for half an hour. Try to germinate. Put another lot in a pot and keep packed in ice (if obtainable) and covered with paper.

EXPT. 76. **Development of Seedlings** (figs. 23, 24).

(a) *Changes that take place as Embryo grows.*—

Plant about twelve bean or corn seeds, and by taking them up at intervals of two days observe the changes that take place. Make drawings of about six different stages, showing how the radicle and plumule develop.

(b) *Position of Seed-coats.*—Grow seedlings of any six kinds of plants (e.g. cocoa, coffee, corn, red pea), and record in which cases the seed-coats remain below ground and in which they are brought above it.

(c) *Modified Cotyledons.*—Examine seedlings of the red pea and observe that the lowest pair of leaves (in reality the cotyledons) differ from the real leaves higher up.

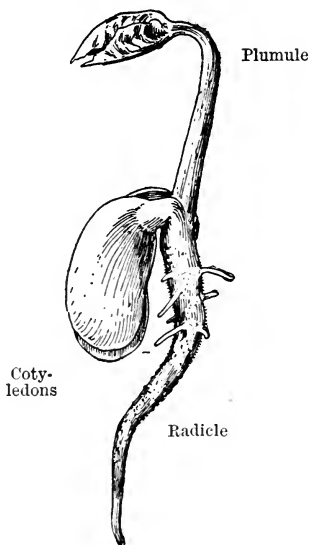


Fig. 23.—Germinating Bean

HOW A PLANT FEEDS—I AND II

(See *Tropical Readers*, Book II, pp. 68-74.)

EXPT. 77. **Roots absorb Mineral Matter in Solution from the Soil.**

(a) *Soluble Matter in the Soil.*—Shake up a handful of soil repeatedly in a bottle with about twice its own volume of water; filter and evaporate the filtrate. The



1, A Dry Seed, showing the ridge corresponding to the radicle within. 2, A Moistened Seed surrounded by its swollen, mucilaginous seed-coat. 3, A Seedling, showing the radicle, root-hairs, and the seed-leaves, not yet freed from the seed-coat (testa = T). 4, A Seedling where the lobes of the seed-leaves are quite expanded. 5, A Seedling, showing the plumule (P), and with the seed-leaves (C) expanded and ready to work. R = radicle.

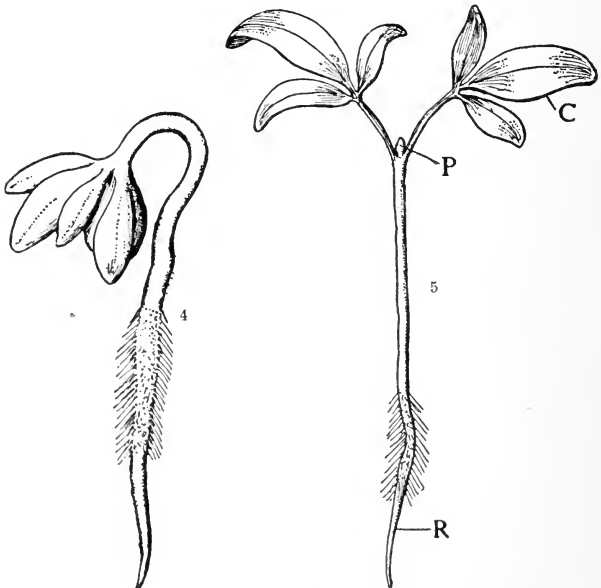


Fig. 24

deposit shows that the soil contains mineral matter that may be dissolved.

(b) *Roots absorb Matter in Solution.*—Take up a small plant carefully and put its roots into a vessel of water coloured with red ink; after four hours' exposure to sunlight, examine and note that the red ink has travelled into the veins of the leaves; pull a portion of the bark down and cut the stem across, observing that the ink has travelled up the woody portion only.

(c) *Roots cannot absorb Particles in Suspension.*—Repeat the foregoing experiment, colouring the solution with carmine instead of red ink. In this case no colouring matter will be absorbed, as the red of the carmine is due to the small particles that are in suspension and not in solution.

EXPT. 78. **Plants get rid of the Surplus of Water by Evaporation through their Leaves.**

(a) *Collection of Water evaporated from a Guango Tree.*—On the morning of a sunny day insert a bunch of leaves of a guango tree in a wide-mouthed bottle; tie the bottle to the branch and tightly plug the bottle with a piece of cloth or cotton wool. Examine in the afternoon and pour out the water collected.

(b) *Collection of Water evaporated from a Cashew Tree.*—Try the same experiment on a cashew tree, the small leaflets of which are specially adapted to growth in a dry district, and note that less water will be collected.

(c) *Plants unable to secure a Sufficient Supply of Water will wilt.*—Examine the soil in which a growing plant is wilting; note if it is dry or wet.

(d) *Leaves possess Small Openings (Stomata).*—Put a leaf from any tree (e.g. sour-sop, orange) into hot water that has only just ceased boiling, and note the air bubbles due to the heated air escaping through the stomata. The bubbles are chiefly on the under sides.

EXPT. 79. Plants take in Carbon Dioxide, split it up, retain the Carbon, and give off the Oxygen.

(a) *Carbon Dioxide is present in the Air.*—Expose some freshly prepared lime-water in a saucer and observe the thin white film formed on the surface owing to the action of carbon dioxide.

(b) *Carbon Dioxide gets into the Air by the Breathing of Animals.*—Breathe into lime-water and the same precipitate as found above will be formed, though in larger quantities.

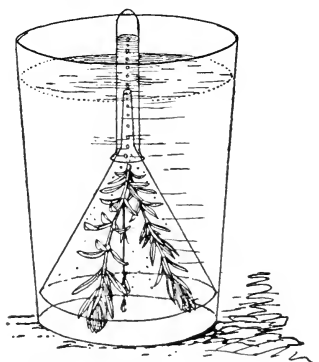


Fig. 25.—Plant giving off Oxygen

(c) *Plants take in Carbon Dioxide, forming Starch.*

1. *Assimilation.*—Pick a green leaf in the afternoon of a day that has been sunny, and test with iodine.¹ Starch will be found.

2. *Assimilation will not take place in the Dark.*—Put a pot plant in a dark cupboard for twenty-four hours. Test with iodine; no starch will be found.

3. *If Stomata are closed, no Assimilation will take place.*—In the morning vaseline both sides of a leaf; pick it in the afternoon; test with iodine, and observe that no starch will be found.

(d) *Plants give off Oxygen from the Carbon Dioxide taken in.*—Put some watercress or duckweed in a vessel of

¹*Iodine Test for Starch in Leaves.*—After the leaf has been picked, it should be put in boiling water for two or three minutes. It should then be bleached by soaking in alcohol. Put the leaf, when more or less colourless, in a solution of iodine, prepared by dissolving a few crystals of iodine in alcohol or in a solution of potassium iodide. If starch is present the leaf will be coloured dark purplish.

water; place it in the sunshine, and notice the rise of bubbles of oxygen. This gas may be collected by putting a funnel over the leaves and inserting a test tube with water (see fig. 25). Test for oxygen by carefully removing the test tube and inserting a glowing taper.

EXPT. 80. Plants take in Oxygen and give out Carbon Dioxide.—Put some growing shoots in a bottle containing a little water; cork tightly and put in the dark. In about twenty-four hours test with lime-water and observe the precipitate due to the carbon dioxide given out by the young shoots.

HOW PLANTS ARE REARED—I AND II

(See *Tropical Readers*, Book II, pp. 74-79.)

EXPT. 81. Necessity for Selection of Seed.—Select seeds from the best fruit of four trees that have been noticed to bear well. Plant in a suitable position and well-prepared soil about your home.

EXPT. 82. Sowing of Large Seeds.—Plant mango, pear, cocoa, and orange seeds in a nursery bed in the School Garden.

EXPT. 83. Sowing of Small Seeds.—Plant tobacco, lettuce, and cabbage seeds in boxes protected from ants; plant some of each thickly, and others thinly, and in regular furrows; note that those sown thinly and regularly produce much stronger seedlings and are more easily transplanted.

EXPT. 84. Careful Watering of Seedlings.—Regularly water the seedlings without damaging them.

EXPT. 85. Transplanting Seedlings.—When they are sufficiently grown, move the seedlings, with as much earth as possible around the roots; plant out in beds.

EXPT. 86. Propagation by Tubers.

(a) Obtain some tubers (e.g. white yam and Irish potato), cut them into pieces and plant; note the development of eyes and the growth of new plants.

(b) Get a glass jam-pot and put a sweet-potato tuber into it with the uppermost end protruding, fill the vessel with water, and note the bud that develops.

EXPT. 87. Propagation by Bulbs.

(a) Cut the bulb of a red lily or onion in two and look for the bud from which a new plant may be produced.

(b) Plant a bulb in a pot of soil or in the ground, and record what growth takes place.

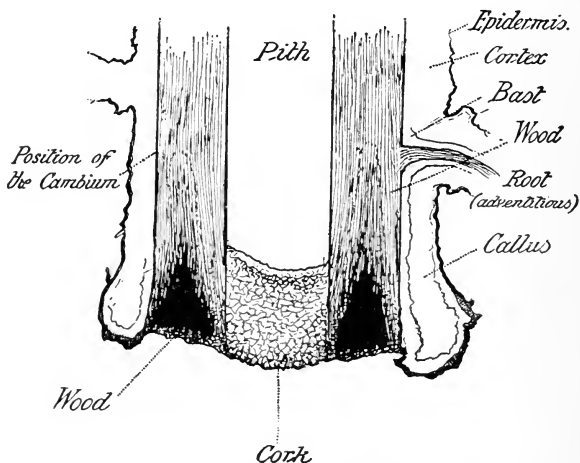


Fig. 26.—Section of the Base of a Woody Cutting

EXPT. 88. Cuttings in Soil.—Plant six cuttings each of hibiscus, sweet potato, and rose. At intervals take up some of the growing cuttings and observe the formation of callus and the development of roots (fig. 26).

EXPT. 89. **Cuttings in Water.**—Put some croton or oleander cuttings in water and note the formation of roots; plant in the soil.

EXPT. 90. **Layering the Rose.**—Layer a branch of a rose plant by bending it to the ground as shown in fig. 27. If carefully done this will be a sure means of propagating roses.

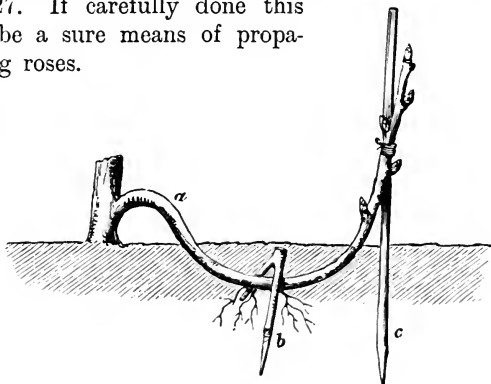


Fig. 27.—Layering

a, Branch to be layered; *b*, hooked peg; *c*, stick to keep shoot upright.

EXPT. 91. **Plants that will not grow from Cuttings.**—Discover by experiment three plants that cannot be grown by cuttings (e.g. orange).

EXPT. 92. **Budding.**—Practise budding on the following plants:—

1. Orange.
2. Mango.
3. Rose.
4. Hibiscus.
5. Susumber (use buds of an egg-plant).

EXPT. 93. **Grafting by Approach.**—Raise two grafted mangoes from a specially good tree by this method of grafting.

HOW SOILS ARE FORMED

(See *Tropical Readers*, Book II, pp. 80-83.)

EXPT. 94. How Water aids in the Formation of Soils.—By a riverside or gully observe that—

(a) The water has worn a course for itself over the land.

(b) Many of the rocks have become broken off and are still rough.

(c) Rocks that have been rubbed against one another are smooth.

(d) Sand has been formed as a result of the breaking up of rocks.

(e) Boulders have been brought down by the river or gully when in flood.

EXPT. 95. Collection of Rough and Smooth Stones.—Collect eight stones showing various stages in the breaking up of rough rocks and the making of the smooth river stone.

EXPT. 96. How Alluvial Soils are formed.—



Fig. 28.—Sediment in River water

(a) Observe that in rainy weather the river is discoloured, owing to clay and vegetable matter in suspension, and that this is deposited in the form of silt and mud where the water flows slowly.

(b) Collect a vessel of discoloured water from a river (small children should not be told to do this) or drainage trench along the roadside, and allow it to stand for twenty-four hours (fig. 28). Pour off the water and examine the residue.

EXPT. 97. Action of Water containing Carbon Dioxide.—Observe that if pure water is poured on limestone no change takes place, but that if muriatic acid, vinegar, or limejuice is poured on it it is gradually dissolved. In a similar manner water, after it has travelled through the soil, takes up carbon dioxide, and is then able to dissolve carbonates slowly.

EXPT. 98. Animals play an Important Part in making and improving Soils.—

(a) Observe that *remains of animals* gradually decompose and form part of the humus in the soil.

(b) *Excreta of Animals.*—Put some cow or other manure on a worn-out plot of land, and observe what beneficial effect it has on the soil.

(c) *Value of Bones.*—Break up some old bones into as small pieces as possible, and use as manure.

(d) *Work of Earthworms.*—Collect some earthworm casts, crush, and observe the good texture of the material continually being brought to the surface of the soil.

EXPT. 99. How Vegetation forms and enriches Soil.—

(a) *Humus.*—Observe that in undisturbed positions a rich vegetable mould is found under trees from the decay of leaves and branches that have fallen from above.

(b) *Roots occasionally split Rocks.*—Record any instance that you have seen of the roots of a plant splitting open a rock.

EXPT. 100. How Air aids in the Formation of Soil.—Examine the surface of rocks exposed to the action of the air, and observe by scratching that the surface is softer than the inside.

KINDS OF SOIL

(See *Tropical Readers*, Book II, pp. 83-86.)

EXPT. 101. Sand, Clay, and Vegetable Matter in Soils.—Put a handful of soil in water, stir with a stick, and notice that—

- (a) The *sand* it contains settles at the bottom.
- (b) The *clay* remains in suspension.
- (c) The *vegetable matter* rises and floats.

EXPT. 102. Lime in Soils.—Add muriatic acid to samples of different soils, and those containing lime will effervesce.

EXPT. 103. Proportion of Organic Matter in Soils.—Weigh 1 lb. of soil; place it on a tin sheet; heat it over a strong fire for two hours, and when cool weigh it again. The loss of weight is due to the organic matter burnt, and to the water driven off in the form of vapour.

EXPT. 104. Leaves become Decomposed and form Humus.—Collect fresh leaves and leaves in various states of decay, showing stages in the formation of leaf mould and humus.

EXPT. 105. Humus becomes Darker in Colour when Wet.—Dry some leaf mould in the sun; wet it, and observe that it becomes darker in colour.

EXPT. 106. Pure Sand contains no Plant Food.—Prepare sufficient pure sand to fill a medium-sized pot by repeatedly washing ordinary sand with water until no discoloration of the water used is noticed; spread the clean sand out on an old shovel and heat it on a fire for half an hour. When cool, plant some bean seeds in the sand; observe that they grow readily at first, having sufficient nourishment in the seed, but soon die, owing to lack of food in the sand.

EXPT. 107. Different Kinds of Soil.—By mixing the

constituents together in the proper proportions, make different types of soil. Label and put away—

- (a) A sandy soil.
- (b) A loam.
- (c) A clayey soil.
- (d) A marl.

MORE ABOUT THE SOIL

(See *Tropical Readers*, Book II, pp. 87 and 88.)

EXPT. 108. Available Plant Food.—Repeat Experiment 77, showing that the soil has plant food in solution.

EXPT. 109. The Finer the Tube the Higher the Liquid rises.—Put two glass tubes of different bore in a vessel of water coloured with red ink. Note that the water rises higher in the smaller tube.

EXPT. 110. Rise of Water through Porous Substances.—Put the end of a piece of chalk into some ink, and note the rise of the ink; show similar action with three other substances, e.g. blotting paper.

EXPT. 111. Rise of Water through Soil.—

(a) Put some soil into a glass tube or into a lamp chimney; tie a piece of cloth over the bottom and put it to stand in a vessel containing about 1 in. of water. Examine after some hours, and notice that the water has worked its way up through the soil, which has become moist some distance above the level of the water.

(b) Make a drawing representing a section of soil, and showing surface soil, impervious strata, and water level; draw a kerosene lamp, lighted, and make notes showing the similarity of evaporation of water from the surface of the soil to loss of oil from a burning wick.

TILLAGE

(See *Tropical Readers*, Book II, pp. 89-92.)

EXPT. 112. **Value of Tillage.**—Prepare a bed in the School Garden, with one half well tilled and the other hard and untilled. Grow an equal number of similar plants (say fifty corn plants) in each half, and observe the better growth and larger yield from the plants in the tilled soil.

EXPT. 113. **Roots develop more extensively in a Well-tilled Soil.**—Carefully uproot young plants from the tilled and untilled portions of the bed mentioned above and observe the larger development of roots on those in the former. Make drawings of the root systems, showing the comparative extent of growth in each instance.

EXPT. 114. **Water is more readily absorbed in a Well-tilled Soil.**—Pour a bucket of water on to a hardened roadway, and observe how much of it runs off; pour another bucket of water on to a well-tilled bed, and observe that it is readily absorbed.

EXPT. 115. **A Loose Surface (or Earth Mulch) aids in retaining Water in the Soil.**—

(a) Notice that on a sunny afternoon the surface of a well-prepared bed always looks dry. This is due to the fact that there is little escape of moisture from underground.

(b) To show that there is water below the dry-looking surface, step firmly on the middle of the bed. Return in two hours, and observe that where the soil was compressed the conditions were made suitable for the rise of water (by capillary action), and the soil has become damp.

EXPT. 116. Methods of Tillage.—

(a) *Preparation of Bed.*—In the School Garden prepare a thoroughly loosened and well-forked bed.

(b) *Cultivation.*—Loosen the soil around a growing plant without injury to the roots.

(c) *Earth Mulch.*—Keep the surface of the beds in the School Garden with a layer of well-tilled soil at the surface—especially if drought is feared.

EXPT. 117. Tools.—Make drawings of ten tools, briefly writing opposite to each its most important use.

DRAINAGE

(See *Tropical Readers*, Book II, pp. 92-95.)

EXPT. 118. Drainage a Necessity.—Dig up a growing weed carefully and plant it in a pan that has no drainage holes; keep the soil moist, and the plant will soon die owing to excess of water.

EXPT. 119. Water is found Below the Surface of the Soil.—

(a) Dig deep holes in three different kinds of soils and note the depth at which the soil shows signs of being moist.

(b) Make a list of any wells that there are in the district and the depth at which water is obtained.

EXPT. 120. To detect whether Drainage is Necessary.—Select a portion of soil and—

(a) Examine surface soil and subsoil, noting if it is clayey and wet.

(b) Push a stick into the soil and observe if water is found in the hole when the stick is taken out.

(c) Note if soil sticks to tools.

(d) Try an experiment on a portion of land in the School Garden to discover whether drainage trenches improve the return.

EXPT. 121. Removal of Water by Artificial Drainage.—

(a) Observe how the shallow gutters at the side of the road carry off the excess of water that falls during a heavy rain.

(b) Examine deep drainage trenches in cultivated land, especially near the sea. Water may often be noticed running continually in them, even in dry weather.

EXPT. 122. Lime as an Aid to Free Drainage.—

(a) Bore some holes in a pan and nearly fill it with powdered clay; pour water in, and notice how slowly it drains through.

(b) At the same time get another pan and put in it a mixture of powdered clay and "white lime". It will be observed that in this case the water drains through much more freely.

HOW WE ROB THE SOIL

(See *Tropical Readers*, Book II, pp. 95-98.)

EXPT. 123. Under Natural Conditions Plants return Matter taken from the Soil.—Collect and examine some of the surface soil in an uncultivated woodland, and observe that it is dark in colour and composed of decayed leaves and vegetable matter. On the ground will be found leaves from the trees above in various stages of decomposition.

EXPT. 124. Soils become Exhausted when Continually Cropped.—In the School Garden grow plants repeatedly on one plot without adding manure; observe that after a time the plants grown there become weakly and yield poor crops.

EXPT. 125. One Reason for practising Rotation of Crops.—Examine the root system of a turnip and of

a corn plant; observe that the roots gather food at different depths.

EXPT. 126. Nature teaches that New Plants should start at a Distance from the Parent.—

(a) Examine a clump of bananas and observe that the suckers grow outwards and away from the parent.

(b) Collect six kinds of seeds scattered by *wind*, e.g. French cotton, logwood, wild allamanda.

(c) Collect four kinds of seeds distributed by *animals*: burr-grass, devil's horsewhip, wild plumbago.

(d) Collect four kinds of seeds that are *water-borne*, e.g. coconut, antidote cocoon.

HOW WE HELP TO FEED THE PLANTS

(See *Tropical Readers*, Book II, pp. 99-101.)

EXPT. 127. General and Special Manures.—Make a collection of general manures (e.g. stable manure) and of special manures (e.g. lime and bones).

EXPT. 128. Value of Different Kinds of Manure.—Try experiments in the School Garden in order to show the value of—

(a) Stable manure.

(d) Lime.

(b) Cow-peas vine.

(e) Wood ashes.

(c) General weeds.

EXPT. 129. Plants that gather Nitrogen from the Air.—Very carefully root up plants of cow-peas, red peas, shame-lady, rattle-bush, or any other legume, and observe the wart-like nodules on their roots. The presence of the nodules is a sign that valuable plant food (viz. nitrogen) is being taken in from the air.

EXPT. 130. The Guango gathers Nitrogen from the Air and enriches the Soil.—Observe how much greener the grass generally is under a guango tree.

EXPT. 131. Vegetable Manures improve the Texture of a Clayey Soil.—Get some clay and powder it, divide it into two parts, mix one-half with some stable manure, and put the lots into two tins with holes bored at the bottom. Put these over two glasses and pour into each an equal quantity of water. Observe that the water passes more readily through the clay that is mixed with manure.

EXPT. 132. Vegetable Matter makes Sand Less Porous.—Try an experiment similar to the one above, using sand instead of clay, and observe that the mixture of sand and stable manure is less porous than the pure sand.

CLIMATE AND PLANT LIFE

(See *Tropical Readers*, Book II, pp. 101-103.)

EXPT. 133. Crops of the World.—Make a blank map of the world, putting in the more important crops grown in the different countries.

EXPT. 134. Crops of Jamaica.—Make a map of Jamaica, showing the districts in which coffee, sugar cane, ginger, and bananas are principally grown.

EXPT. 135. Study of Plants in District around School.—Draw a map of the country surrounding the school for about 4 miles. Fill in different types of plants that may be seen.

EXPT. 136. Plants on the Hills and on the Plains.—Record any differences that you have noticed between the plants growing on the hills and those on the plains known to you.

EXPT. 137. Plant Societies.—Collect specimens of plants characteristic of—

(a) The seashore.

(c) The roadsides.

(b) Inland swamps and marshes.

(d) Pastures.

INSECT PESTS

(See *Tropical Readers*, Book II, pp. 103-106.)

EXPT. 138. Collection of Damaged Specimens.—

(a) Collect *roots* of two different kinds of plants attacked by insect pests, e.g. root of rose by macacca worm, root of cocoa by fiddler beetle.

(b) Collect damaged *leaves* of three different kinds of plants attacked by caterpillars, e.g. cabbage, tobacco, sweet potato.

(c) Collect injured *stems* of two kinds of plants attacked by insect borers, e.g. sugar cane, wild cassada.

(d) Collect a sample of *seeds* attacked by small beetles, e.g. corn, peas, tamarind.

EXPT. 139. Drawing of Insect Pests.—Make drawings of three destructive insects, recording what they damage; colour with crayon.

EXPT. 140. Scale Insects.—Collect four different kinds of *scale insects*, examining such plants as



Fig. 29.—Breeding Cage for Caterpillars

oleanders, oranges, hibiscuses.

EXPT. 141. How the Caterpillar changes its Form.—In a breeding cage (fig. 29), made as shown in the

figure, put a caterpillar, with some leaves of the plant on which it was found feeding. Give it as much food as it will eat from day to day, and watch. Record the date on which it turns into a chrysalis, and also when the adult insect (butterfly or moth) emerges (fig. 30).

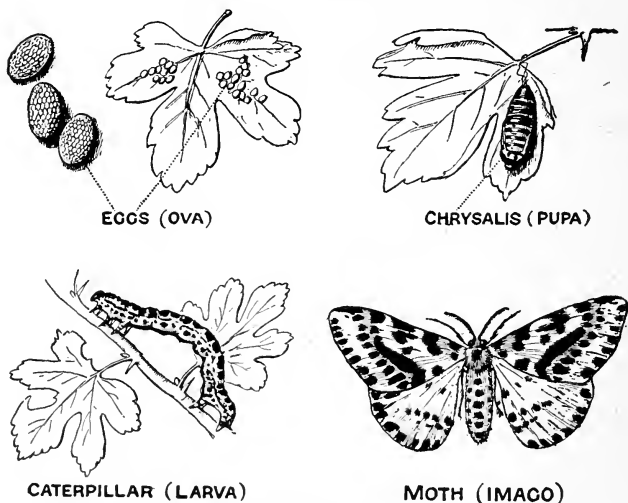


Fig. 30.—Development of a Moth (the eggs on the left of the leaf are highly magnified)

EXPT. 142. Damage done to Corn by Grub inside.—Open some grains of corn attacked by the corn weevil, and observe the white grub inside that does the damage.

EXPT. 143. List of Insect Pests in District.—Compile a tabulated list of plants that are attacked by insects. Record—

- (a) Name of plant.
- (b) Name of pest.
- (c) Nature of damage.
- (d) Remedy found effectual.

The list should be added to from time to time, and it is suggested that the teacher should compile the list, and should encourage the children to report pests noticed by them.

EXPT. 144. **Remedies.**—

(a) *Handpicking.*—Each child should take part in hand-picking caterpillars, beetles, &c., which attack plants in the School Garden or at home.

(b) *Spraying with Paris Green for Biting Insects.*—The teacher may himself show the elder children how Paris green should be used if a suitable occasion offers. As this remedy for caterpillars and other foliage-eaters is a deadly poison, it should only be used where the utmost precautions are possible and will be taken.

(c) *Kerosene Emulsion¹ for Sucking Insects.*—Wash the portions of a plant badly covered with scale insects, or with thrips, with kerosene emulsion. Repeat treatment in twelve days.

EXPT. 145. **Natural Enemies of Insects.**—Make a list of any birds, reptiles, or any other animals that you have seen catching insects.

EXPT. 146. **Parasites upon Animals.**—Make a list of any small parasites that you have observed living on domestic animals.

EXPT. 147. **Ticks.**

(a) Collect as many different kinds of ticks as you can, and make drawings of them.

(b) Put a *large* engorged silver tick in a well-corked bottle, and leave until she has laid her eggs. Keep until the eggs hatch into grass-lice. Kill all with boiling water.

¹ For preparation of insecticides, see *Suggestions for School Gardens*, p. 144.

III. Cultivation of Crops

For general notes on the study of Economic Plants see pp. 24-29 of this Companion.

IV. Health

WHY WE EAT

(See *Tropical Readers*, Book II, pp. 136-140.)

EXPT. 148. **Functions of Foods.**—In a tabular form set out the functions of foods. In the first column put the names of the different types, in the second, examples of each class, and in the third column their functions.

EXPT. 149. **Kinds of Foods.**—Collect two samples each of the different kinds of foods:

- (a) Carbonaceous, e.g. starch, sugar.
- (b) Nitrogenous, e.g. lean meat, white of egg.
- (c) Mineral, e.g. salt.

EXPT. 150. **Carbon and Nitrogen in Foods.**—To illustrate the presence of these important elements in foods—

(a) *Carbon*: Heat meat and bread, and the carbon will be noticed as they char.

(b) *Nitrogen*: Powder cheese, and mix it with lime; apply heat, and test for ammonia with a piece of moistened litmus or turmeric paper. (Red litmus will be turned blue, and yellow turmeric will be reddened, if ammonia is present.)

HEAT-GIVING FOODS

(See *Tropical Readers*, Book II, pp. 140-144.)

EXPT. 151. **Heat-giving Foods.**—Collect small samples of five heat-giving foods, e.g. arrowroot, rice, corn, yam.

EXPT. 152. **Many Foods contain Starch.**—

(a) Prepare starch from yam, corn, potato, and rice, by grating or pounding, putting on a piece of muslin, washing and squeezing through the cloth into a vessel; allow the fine grains of starch which pass through to settle.

(b) Pour iodine on to a slice of Irish potato, and observe the dark-blue coloration, due to the presence of starch.

EXPT. 153. **Sugar found in Plants.**

(a) Prepare sugar from cane juice by adding lime (about one tablespoonful to a quart), skimming, and evaporating a small quantity.

(b) Squeeze some juice from an orange or pineapple, put it in a vessel, and evaporate it; observe the sugar.

EXPT. 154. **Oils obtained from Plants.**

(a) *Coconut Oil.*—Find out how coconut oil is prepared, and write an account of the method.

(b) *Oil in Citrus Fruits.*—Squeeze the fresh rind of a tangerine or shaddock into a candle flame, and observe how the oil takes fire.

EXPT. 155. **Effect of Heat on Starch.**—Soak some rice grains in hot water, and note how quickly they swell.

EXPT. 156. **Fat is a better Heat-producer than Meat.**—Put a lighted match to a bit of lean meat and to a piece of fat, and observe which burns more readily.

EXPT. 157. **Tapioca.**—Obtain some tapioca, and write an account of how it is made.

FLESH-FORMING FOODS

(See *Tropical Readers*, Book II, pp. 144-147.)

EXPT. 158. **Flesh-formers.**—Collect three foods of animal origin containing albuminoids, e.g. white of egg; lean meat.

EXPT. 159. **Casein from Milk.**—Add vinegar (acetic acid) or lime-juice (citric acid) to milk, and stir; when the curd, consisting largely of casein, is formed, pour on to a filter paper.

EXPT. 160. **Gluten from Corn and Wheat.**—Prove that gluten may be got from both corn and wheat by pounding them to fine white powder in separate cloth bags; rub under water between the fingers. The starch will pass through into the water, and the gluten will be left behind as a sticky mass.

EXPT. 161. **Gluten cannot be got from Rice.**—Repeat the above experiment, using rice instead of corn, and it will be found that no gluten will be obtained.

EXPT. 162. **Fibrin from Blood.**—Stir some fresh blood with a bit of stick, and observe that the fibrin in it soon forms a semi-solid substance; wash clean with water.

EXPT. 163. **Albumen in White of Eggs.**—Pour some white of egg in a bottle; pour on some water, and cork; thoroughly shake up for about four minutes; filter, and heat the filtrate; observe that the albumen coagulates.

A FEW COMMON FOODS

(See *Tropical Readers*, Book II, pp. 147-150.)

EXPT. 164. **Composition of some Common Foods.**—

(a) *Yam.*—Determine the amount of *starch* found in 1 lb. of yam by grating it finely, mixing with water,

straining through a coarse cloth into a clean vessel, and allowing to settle; weigh the dried starch.

Weigh 1 oz. of yam, cut it into small pieces, and put it into a tin partly immersed in boiling water. Weigh the yam after four hours, and calculate the amount of *water* that has been lost.

Burn 2 oz. of yam, and observe the *mineral matter*, or ash, that is left.

(b) *Sweet Potato*.—Treat an equal quantity of the sweet-potato tuber in the same way.

(c) *Corn*.—Prepare starch, oil, and gluten from a sample of native corn. Collect samples of various preparations made from corn.

(d) *Rice*.—Powder 1 oz. of rice, wash in a muslin bag, allowing the starch to pass into a tin in which it can settle; pour off the water; dry and weigh the starch.

(e) *Beans*.—Dry some beans in the sun; powder and mix with lime; heat and test for ammonia with moistened litmus paper (see Experiment 150*b*).

EXPT. 165. **Ripe and Unripe Bananas**.—Taste ripe and unripe bananas, and record which are sweeter; find out if cooking a green banana makes it taste any sweeter.

EXPT. 166. **Animal Foods**.—Collect small portions of eight different kinds of animal food, e.g. milk, pork, beef. Observe the extent to which *fat* is present in the samples collected.

THE BEST KIND OF DIET

(See *Tropical Readers*, Book II, pp. 150-153.)

EXPT. 167. **Too many Heat-giving Foods**.—Collect samples of foods commonly eaten that do not contain a sufficient quantity of albuminoids, e.g. yam, sweet potato, bread-fruit.

EXPT. 168. **Necessity for a Mixed Diet.**—Collect small samples of different foods, some of which consist principally of carbonaceous matter, and others of which are rich in nitrogen. Put them together so as to form a satisfactory mixture of heat-giving and flesh-forming foods, e.g. rice and peas, salt fish and akee.

EXPT. 169. **Milk a Mixed Food.**—

(a) *Albumen.*—Pour some lime-juice on milk, and observe that the albumen coagulates in the form of curd.

(b) *Fat.*—This may be observed by allowing a glass of milk to stand for some time.

(c) *Sugar* is contained in the whey. Evaporate the whey on an enamel dish over the fire; it will soon char.

(d) *Ash.*—Continue burning, and the residue will be mineral matter.

WATER—I AND II

(See *Tropical Readers*, Book II, pp. 153–160.)

EXPT. 170. **Properties of Water.**—Examine some water and observe that—

(a) It is a clear, tasteless, inodorous liquid.

(b) It is colourless in small quantities, but in large quantities it has a bluish tint.

EXPT. 171. **Three States of Water.**—Get a lump of *ice*; allow it to melt; boil the *water* so formed until it has all passed off as *steam*.

EXPT. 172. **Water dissolves Solids.**—Put some common salt or some magnesium sulphate in water, stir until dissolved; taste the liquid to prove the presence of the substances in solution.

EXPT. 173. **Difference in Rain-, River-, and Sea-water.**—Evaporate equal quantities of rain-water, river-

water, and sea-water. Record the relative quantity of residue in each case, and taste that from sea-water.

EXPT. 174. **Softness of Rainwater.**—Show that soapsuds are easily formed in rain-water; rain-water is therefore called *soft*.

EXPT. 175. **How to make Rain-water Hard.**—Get a quart of rain-water; through a glass tube or bit of small bamboo breathe into it so as to supply it with carbon dioxide; add $\frac{1}{2}$ lb. of marl or powdered chalk; allow it to soak for twenty-four hours, stirring and breathing into it occasionally. Test with soap, and note that soapsuds are not so easily formed as in the case of the rain-water.

EXPT. 176. **Water also contains Gases.**—Shake up a vessel of water, put over a fire, and observe that bubbles of air pass off long before the water boils.

EXPT. 177. **Weight of Water.**—Discover by experiment the weight of 1 gallon of water.

EXPT. 178. **Formation of Water by Combination of Oxygen and Hydrogen.**—Invert a tumbler over a burning candle, and observe drops of water formed by the combination of the oxygen of the air and the hydrogen of the candle.

EXPT. 179. **Presence of Sewage Matter.**—Shake a mixture of water and a little stable manure in a bottle; observe the dark appearance. Pour into a dilute solution of permanganate of potash, and observe that the sewage destroys the colour of the permanganate.

EXPT. 180. **Contamination of Ponds.**—Make a drawing of a pond, showing how the water in it may get contaminated.

EXPT. 181. **The Best Means of purifying Water for Drinking Purposes.**—Boil some water, and note that water should never be drunk unless it has been boiled.

OTHER BEVERAGES

(See *Tropical Readers*, Book II, pp. 160-162.)

EXPT. 182. **Cocoa is a Nutritious Food containing the following:—**

(a) *Fat*.—(i) Prepare “cocoa butter” from some cured pods.

(ii) Draw a cup of chocolate from native cocoa, and observe the fat globules.

(b) *Starch*.—(i) Grate some cured cocoa beans, and wash in a muslin bag over a vessel.

(ii) Test with iodine, and observe the dark-blue coloration due to starch.

(c) *Gluten*.—Grate some nuts, tie in a small muslin bag, and wash under water. The sticky substance left is partly gluten.

EXPT. 183. **A Good Cup of Coffee.**—Divide a pint of coffee into three portions. Parch one portion too much, another too little, and the rest properly. Draw a cup of coffee with each, and observe that only that which has been correctly parched is palatable.

EXPT. 184. **Preparation of a Cup of Tea.**—

(a) Prepare a cup of tea by pouring boiling water on to the leaves and letting it stand for two minutes. Pour off, and observe clear colour and palatable taste.

(b) Compare tea as drawn above with tea that has been put in warm water and boiled for ten minutes. Observe bitter taste and dark colour due to tannin.

EXPT. 185. **Beverages.**—Make rough drawings of eight fruits from which beverages are obtained, e.g. coffee, lime, coconut.

WHAT BECOMES OF OUR FOOD

(See *Tropical Readers*, Book II, pp. 163-166.)

EXPT. 186. **Flow of Saliva.**—Observe that as a bit of bread or any food is chewed, saliva accumulates in the mouth.

EXPT. 187. **Saliva changes Starch into Sugar.**—Keep some starch in the mouth for a little time, and observe that it becomes sweetish to the taste. The change is more easily noticed by putting a second lot of starch in the mouth and observing the contrast.

EXPT. 188. **Sweetbread.**—Obtain a “sweetbread” from a butcher and make a drawing of it.

EXPT. 189. **Diagram of Digestive Organs and Juices.**—Copy the diagram of the digestive organs on page 164, and show the position of the mouth, the gullet, the stomach, and the intestines. In the diagram made by you, show where the saliva, the gastric juice, the bile, and the pancreatic juice meet the food in its course through the body.

THE AIR WE BREATHE

(See *Tropical Readers*, Book II, pp. 166-169.)

EXPT. 190. **Composition of the Atmosphere.**—Show the presence of the following in the air:—

(a) *Oxygen.*—Fan some smouldering coals, and note that the fresh supply of oxygen thus brought to the coals causes them to burn more brightly.

(b) *Nitrogen.*—Burn a small bit of phosphorus (less than half the size of a red pea) under a bell jar standing in water (fig. 31). Observe that the gas forms four-fifths of the air, and by testing it with a lighted taper

show that it will neither support combustion nor take fire.

(c) *Carbon Dioxide*.—Expose a saucer (preferably a blue one) containing some freshly made lime-water to the air for a number of hours. Observe the milky precipitate found on the surface.



Fig. 31.—Preparation of Nitrogen

(d) *Water Vapour*.—Put a glass of cold water in a warm room. Observe the drops of water condensing on the outer side of the vessel.

(e) *Impurities*.—Note the particles seen floating in the path of a sunbeam. Shake a dusty coat or cushion near by and see how the number increases.

EXPT. 191. Plants and Animals depend on one another for the Gases they breathe.

(a) *Animals require Oxygen*.—If an insect be put in a jar containing no oxygen it will soon die.

(b) *Plants give out Oxygen*.—Put some shoots of water-cress or other water plant in a vessel of water; observe the bubbles of oxygen rising. Collect as shown in fig. 25, and test for oxygen by carefully removing the test tube and inserting a glowing match.

(c) *Plants require Carbon Dioxide*.—Char a bit of wood, proving the presence of carbon in plants.

(d) *Animals give off Carbon Dioxide*.—Breathe through a tube into lime-water, and observe the heavy precipitate, proving the presence of carbon dioxide in the gases breathed out.

EXPT. 192. Oxygen necessary for Combustion.—Put a lighted candle in a wide-mouthed bottle or jar, cover

over, and notice that the candle goes out as the oxygen is used up.

EXPT. 193. **Burning Substances add Carbon Dioxide to the Air.**—After observing that the candle goes out in the experiment above, add lime-water and shake. A milky precipitate will be noticed.

EXPT. 194. **Where the Water Vapour in the Air comes from.**

(a) *Plants.*—Tie a wide-mouthed bottle on to a branch of a guango tree, and observe that water condenses inside. The mouth of the bottle should be closed.

(b) *Animals.*—Breathe against a piece of glass, and observe the moisture deposited.

(c) *Water Surfaces.*—Observe how water exposed in a saucer evaporates into the air. In a similar way water in the sea, rivers, ponds, &c., is always passing off into the air in the form of vapour.

WHY THE WIND BLOWS

(See *Tropical Readers*, Book II, pp. 169-171.)

EXPT. 195. **Air expands when Heated.**—Fit up a flask as shown in fig. 32; heat gently, and observe that the hot air expands as shown by the rising of the drop of water.

EXPT. 196. **Warm Air rises.**—Put light bits of paper or small feathers above a fire, in a chimney for example, and observe how they rise with the warm air.

EXPT. 197. **How a Balloon may be made.**—Make a balloon about 2 ft. in

(c 282)



Fig. 32.—Expansion of Air when heated

diameter by pasting paper over a *very light* framework; put two fine wires crossing one another at the opening at the bottom; tie a sponge where the wires meet, and saturate it with alcohol; set fire to the sponge and the balloon will rise. This experiment should only be done by the teacher.

EXPT. 198. **Soil both absorbs and gives out Heat more quickly than Water.**—Heat at the same time over the same fire a tin filled with soil and another of equal size filled with water, for five to ten minutes; observe which gets hotter. Allow both to cool, and observe which cools first, remembering that the soil was the hotter.

VENTILATION

(See *Tropical Readers*, Book II, pp. 171–174.)

EXPT. 199. **A well-ventilated Building.**—Write a description of any building that you consider well ventilated.

EXPT. 200. **A badly-ventilated Building.**—Write a description of any building that you consider to be badly ventilated.

EXPT. 201. **Small Quantity of Carbon Dioxide in Air taken into Lungs.**—Leave a vessel of lime water exposed to the air. Observe that it turns milky, but very slowly, as there is only 0·04 per cent of carbon dioxide present in the air which is taken into the lungs.

EXPT. 202. **Larger Quantity of Carbon Dioxide (about 4·7 per cent) found in Air breathed out.**—Breathe through a glass tube or small bamboo into a vessel of lime water. A heavy milky precipitate will be formed.

EXPT. 203. **Carbon Dioxide on Floor of Sleeping-room.**—Put a saucer with lime-water on the floor of

a badly ventilated room in which a number of persons sleep. Observe the precipitate on the surface of the lime-water.

THE CLOTHES WE WEAR

(See *Tropical Readers*, Book II, pp. 174-178.)

EXPT. 204. **Sources of Materials used for Clothing.**
—Make drawings of the plants or animals from which the materials used for clothing may be obtained.

EXPT. 205. **Collection of Materials used for Clothing.**
—Make a collection of the different classes of materials used for clothing, and to each attach a label, with its name and a note about its special uses.

EXPT. 206. **Effect of Heat on Different Colours.**—Expose bits of white and black cloth of the same size and material in the sun on a hot day. Observe which gets hotter first.

EXPT. 207. **Flannel is very absorbent of Moisture.**—Observe that a flannel shirt absorbs more perspiration than a linen or cotton one.

SOIL AND CLIMATE, OR WHERE TO LIVE—

I AND II

(See *Tropical Readers*, Book II, pp. 178-183.)

EXPT. 208. **Healthy and Unhealthy Sites for Houses.**
(a) Notice the nature of the country around the school, and decide on a position that you think would be a *healthy site* for a house. Record the reasons for your selection.

(b) Notice the nature of the country around the school, and decide on a position that you think would be an *unhealthy site* for a house. Record the reasons for your selection.

(c) Make a drawing showing a *desirable situation* for a house; indicate the elevation, prevailing winds, character of soil and subsoil, &c.

(d) Make a rough drawing showing an *undesirable situation* for a house; indicate elevation, nature of soil and subsoil, neighbouring swamps, &c.

INSECTS THAT CARRY DISEASE

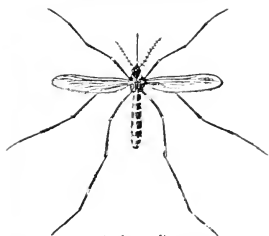
Investigations, made since the preparation of the *Tropical Readers* have shown conclusively the important part played by insects in conveying diseases from one person to another, and attention is therefore here drawn to the subject. The value of health is generally recognized, and the benefit to the community generally will be great if each teacher makes his school a medium for spreading information as to how the dangers of infection through the agency of insects may be lessened. Mosquitoes, flies, fleas, and bugs are amongst our worst foes, and the illustration shows the diseases for which they are responsible.

MOSQUITOES

EXPT. 209. Connection between Breeding Places of Mosquitoes and Malarial Fever.—Make a list of districts where people suffer commonly from malaria. In each case state if there are swamps near by, and if mosquitoes are plentiful.

EXPT. 210. Search should always be made for likely Breeding Places of Mosquitoes.—Look for any likely

MOSQUITO



(enlarged)

Carrier of
Malaria, yellow fever, filaria.

Breeds in
Stagnant water.

Prevention:
Remove breeding places.

HOUSE FLY



(a little larger than natural size)

Carrier of
Typhoid and skin diseases.

Breeds in
Stable manure, garbage, etc.

Prevention:
Bury manure, burn rubbish,
use disinfectants.

Remedies:
Traps, fly papers.

FLEA



(much enlarged)

Carrier of
Bubonic plague.

Breeds on
Rats and other animals.

Prevention:
Cleanliness.

Remedies:
Trap and poison rats; clean
floors with Jeyes' and Cyllin.

BED-BUG



(line shows natural size)

Carrier of
Yaws and other skin diseases.

Breeds in
Crevices of beds, etc.

Prevention:
Cleanliness.

Remedies:
Boiling water, Keating's,
kerosene oil.

breeding places (pools, empty tins, broken bottles, &c.) to be found at home or near the school.

EXPT. 211. Stagnant Pools of Water should be filled up.—Fill up any stagnant pools of water found near your home, and likely to form suitable places in which mosquitoes may lay their eggs.

EXPT. 212. Empty Cans and Half-broken Bottles likely to collect Water should be removed.—From time to time collect empty tins and half-broken bottles left lying about, and bury them so as to prevent their becoming breeding places for mosquitoes.

EXPT. 213. Mosquitoes often breed in Places used for storing Water.—Constantly examine barrels and other vessels in which water is stored for use.

EXPT. 214. Kerosene Oil kills Wrigglers if poured on to the Water in which they are found.—Pour some water containing wrigglers into a glass; observe that the wrigglers come to the surface to breathe. Pour some oil on the surface of the water, and note that the wrigglers soon die, because the oil prevents their getting air.

EXPT. 215. Common Wrigglers found in Water change into Mosquitoes.—Put some wrigglers into a bottle not quite filled with water, and covered over with a cloth bag. Notice the wrigglers from day to day, and observe the changes that take place until the adult mosquitoes are produced.

EXPT. 216. How to detect Wrigglers of the Malaria Mosquitoes.—Observe that these rest in a horizontal position when they are breathing at the surface of the water.

EXPT. 217. How to detect the Malarial Mosquitoes.—Carefully watch mosquitoes as they bite, and observe that in malarial districts some stand with their bodies

almost upright; these are the kind that cause malarial fever.

FLIES

EXPT. 218. Dirty Habits of Flies.—Observe that flies crawl over animal excreta, and over decomposed vegetable matter; observe, also, that they often fly direct on to food for human consumption.

EXPT. 219. How to trap Flies.—Three-quarters fill a tin or glass with strong soap water; take a piece of bread or thick paper, make a small hole in the centre, and put a circle of jam or molasses around the hole on one side of the bread. Now place the bread over the mouth of the glass, having its hole over the centre of the glass, and the circle of jam on the *under side* next to the soapsuds. Expose where flies are common.

EXPT. 220. To prevent Flies breeding.—Burn all rubbish, and have stable manure buried or removed. Keep closets constantly disinfected with earth, lime, and ashes.

FLEAS AND BUGS

EXPT. 221. Fleas on different Animals.—Catch fleas from as many animals as you can.

EXPT. 222. Fleas breed in Dirty Rooms.—Observe that fleas are most common in rooms that have been left unclean for a long time.

EXPT. 223. How to destroy Fleas.—If opportunity arises, try the following methods of destroying fleas:—

(a) Clean floors with Cyllin, Jeyes, tobacco decoction, or dumb-cane.

(b) Wash pet animals (e.g. dogs) with tobacco decoction and soap; hand-pick and kill fleas while they are still stupefied after the washing.

EXPT. 224. **How to destroy Bed Bugs.**—If *one* is seen, immediately search diligently in all likely crevices for eggs and young ones, destroying with boiling water or kerosene oil on a feather. Never let one pass, as they breed rapidly, and are dangerous to health.

VI. THE SCHOOL GARDEN

ESTABLISHMENT OF A SCHOOL GARDEN

The establishment and care of a School Garden should be regarded as one of the most important duties of a teacher in any part of the country. Full information on such important points as the following may be obtained from the book, *Suggestions for School Gardens*, by the Hon. J. R. Williams, M.A., our present Superintending Inspector of Schools:—

Selection of plot.

Tools.

Clearing the ground.

Fencing.

Plan of the garden.

Laying out the garden: Paths, beds, trenches.

Soil, tillage, drainage, manure.

Seed beds and seed boxes.

Seedlings, potting.

Care of plants: Weeding, pruning.

Propagation of plants.

Rotation of crops and catch crops.

Friends and enemies of the garden: Insect pests.

Cultivation of vegetables.

Cultivation of economic crops—The following have been dealt with: Cocoa, coffee, ginger, pine-

apple, tobacco, banana, cotton, orange, guinea corn, sarsaparilla, pindars, vanilla, grapes.

Some insecticides.

Work in a School Garden offers great possibilities, although it presents many difficulties. Teachers will find that forethought and preparation for the various branches of the work are absolutely necessary to prevent many of the children, if not the majority, wasting their time.

Putting monitors in charge of small groups, and telling them very definitely beforehand what is expected of them, will be found a useful practice. Pupils should be given certain tasks for various periods of time. It might be one child's duty for a month to keep the garden free of bits of paper, dead leaves, &c.; another might for a week have to water certain plants, and a third have charge of the walks.

OBJECTS OF WORK

What the main object of work in a School Garden should be is still disputed by educationalists and others interested in the subject. Some would insist that the training of a child's powers of observation is the only object to be attained, and that it would be both out of place and useless, owing to the age at which children leave the public elementary schools, to endeavour to inculcate practices and to teach facts that would be of direct use in after life.

School Garden work may be considered to serve three distinct purposes, and although complete realization of these cannot be hoped for, much of value may be accomplished in each class.

The main objects are—

(1) Practical illustration of the agricultural principles taught in the schoolroom.

(2) Development—and creation, if need be—of the child's interest in gardening and nature study.

(3) The teaching of facts and training in practices likely to be of direct agricultural value to the child later.

I. PRACTICAL ILLUSTRATION OF PRINCIPLES OF AGRICULTURE

Attention is drawn throughout the chapters of the *Tropical Reader* to many of the principles on which successful cultivation is based. The School Garden will be the means of giving the children an opportunity of putting these into practice, with the result that the lessons taught will be better understood, and will be more likely to be of permanent value. Whenever it is possible the experiments should be carried out in the School Garden, and in many cases this can be done. A list of those experiments specially suitable is given below. Each has been described fully in an earlier part of this Companion.

Experiments and Practical Work

Roots, I.—

10. Development of roots from radicle of bean seed.
11. Development of roots from radicle of corn seed.

Roots, II.—

12. Storage of food in roots.
14. Necessity for roots.
16. Tuberos roots and tubers.

Stems and Shoots, I.—

17. Food solution travels up stem from roots.
18. Food solution travels up through woody portion of stem.

22. Cuttings in water.

23. Food does not travel down the stem if the cambium layer is injured.

24. Corms and bulbs.

Fruits.—

49. Development of fruit from flowers.

Seeds.—

58. How the store of food for the embryo is used.

59. Number of seed leaves.

Flowers and Seeds.—

64 *b*. Flowers not pollinated do not produce fruit.

64 *c*. Effect of removing stamens.

Seeds and Seedlings.—

76 *b*. Position of seed coats.

76 *c*. Modified cotyledons.

How Plants are reared.—

82. Sowing of large seeds.

83. Sowing of small seeds.

86. Propagation by tubers.

87. Propagation by bulbs.

88. Cuttings in soil.

89. Cuttings in water.

90. Layering a rose.

91. Plants that will not grow from cuttings.

92. Budding.

93. Approach grafting.

How Soils are formed.—

98. Animals play an important part in making and improving soil.

Kinds of Soil.—

101. Sand, clay, and vegetable matter in soils.

102. Lime in soils.

- 103. Proportion of organic matter in soils.
- 104. Leaves become decomposed and form humus.
- 105. Humus becomes darker in colour when wet.
- 106. Pure sand contains no plant food.
- 107. Different kinds of soil.

Tillage.—

- 112. Value of tillage.
- 113. Roots develop more extensively in a well-tilled soil.
- 114. Water is more readily absorbed in a well-tilled soil.
- 115. A loose surface aids in retaining water in the soil.
- 116. Methods of tillage.

Drainage.—

- 118. Drainage a necessity.
- 119. Water is found below the surface of the soil.
- 120. To detect whether drainage is necessary.
- 122. Lime as an aid to free drainage.

How we rob the Soil.—

- 124. Soils become exhausted when continually cropped.
- 125. One reason for practising rotation of crops.

Insect Pests.—

- 144 *a.* Hand-picking.
- 144 *b.* Spraying for biting insects with Paris green.
- 144 *c.* Kerosene emulsion for sucking insects.

II. DEVELOPMENT OF INTEREST IN GARDENING

This is an important side of the subject, and one affecting the future prosperity of the island.

Teachers will have to exercise tact, and though the children must do a reasonable amount of work, they

must be made to regard such labour with pleasure and to look forward to it.

Give the children a difficult task and make them feel a sense of responsibility; arouse their interest by exciting rivalry; let them understand the reason for what they have to do; let them participate, even to a small extent, in any profit there may be.

Interest created in their work as pupils will doubtless react to their benefit when they leave school, and may lead to their cultivating the soil for benefit and profit.

III. TEACHING OF FACTS OF AGRICULTURAL VALUE

The third function of a School Garden has special reference to the elder children, who should be taught to perform carefully the tasks mentioned below. The teacher might give the boys certificates of competency when they prove themselves efficient at such work, but care should be taken to insist on a high standard of reliability and workmanship.

It is beyond the scope of this Supplement to give details as to how the work should be done, and reference must be made to *Suggestions for School Gardens*, already referred to, and to other manuals. Teachers who have attended the annual course of practical training in agriculture will be best qualified to undertake this work.

The following are suggested tasks that the children should be able to do before leaving school:—

1. **Lining Out a Bed.**—To line out a bed of uniform width, making use of a cord, pegs, and measurements.

2. **Preparation of Soil.**—To prepare the soil thoroughly and make a neat bed.

3. **Holes for Plants.**—To make a deep and wide hole for the reception of a plant.

4. **Filling and Draining of Pots.**—To fill a pot or box for plants, making provision for free drainage.

5. **Pathways and Borders.**—To make a neat edge to a pathway and keep the path free of weeds and dead leaves.

6. **Propagation by Seeds.**—To sow small seeds in regular furrows and cover them to a correct depth.

7. **Protection of Seeds from Ants.**—To protect a box in which seeds are to be sown so that ants cannot get at them.

8. **Careful Watering.**—To water seeds sown, seedlings, and delicate plants without damaging them.

9. **Propagation by Cuttings.**—To make, set, and care for cuttings.

10. **Transplanting.**—To transplant seedlings, as well as established plants, with an intact ball of soil.

11. **Removal of Weeds.**—To remove weeds from a garden bed or pathway *before* they seed.

12. **Insect Pests.**—To search plants regularly for pests likely to attack them.

13. **Soil Cultivation.**—To loosen the soil around the roots of a growing plant without injuring them.

14. **Application of Manure.**—To fork in well-rotted stable manure round the roots of a plant.

15. **Care of Tools.**—To keep tools in good working order, sharp, and with well-fitting handles, and to put them away in one place after use.

16. **General Tidiness.**—To keep a garden tidy, removing bits of paper, dead branches, withered flowers, &c.

APPENDIX

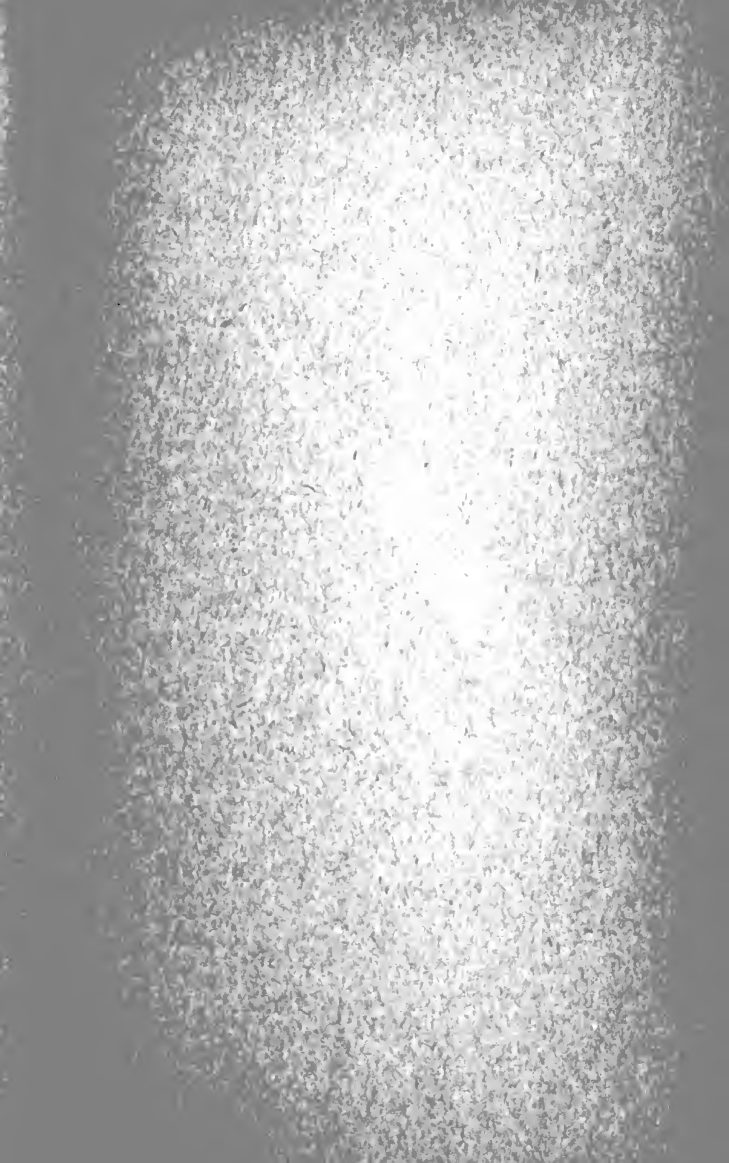
THE NAMES OF PLANTS

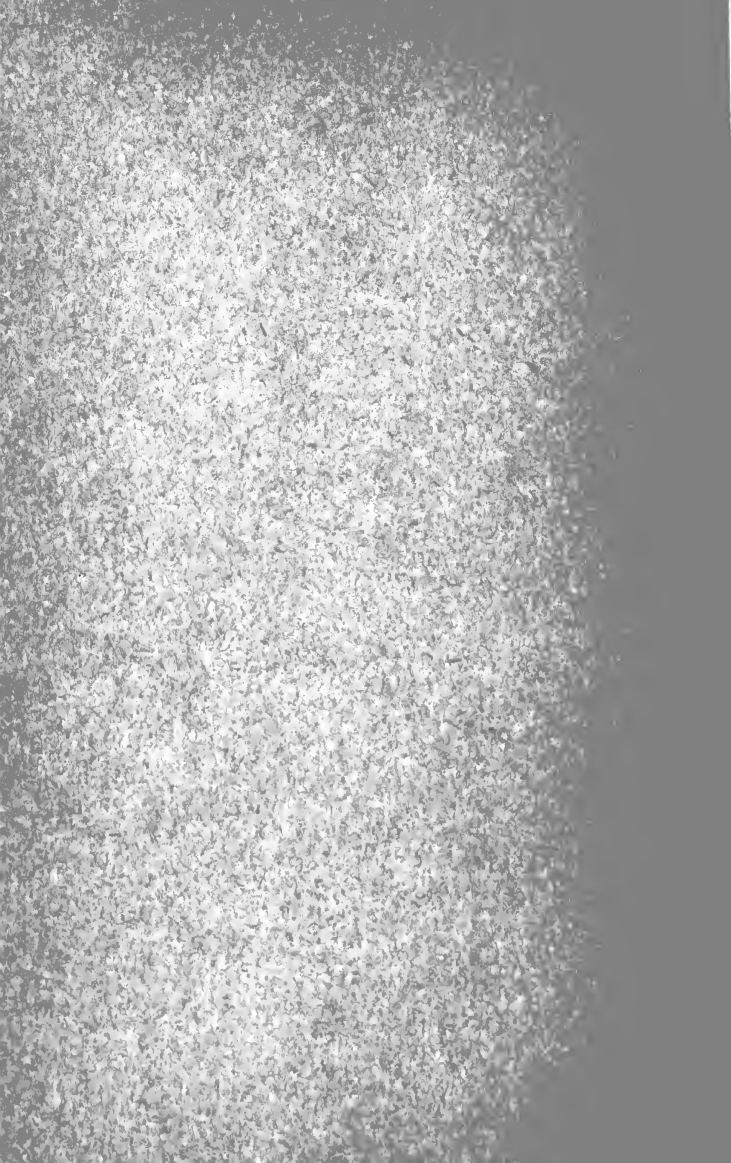
As many of the common weeds and other plants referred to in this Companion have different names in different parts of the island, the botanical names of such plants are given below. Should doubt arise in any case as to identification, the matter should be referred to a botanist.

The fruit and important shade trees are so well known throughout the West Indies that it is not considered necessary to include their scientific names.

Common Name.	Botanical Name.
Acalypha.	<i>Acalypha marginata.</i>
Allamanda, wild.	<i>Tecoma stans.</i>
Aralia.	<i>Aralia Guilfoylei.</i>
Barbados pride.	<i>Cæsalpinia pulcherrima.</i>
Bine-pear.	<i>Hylocereus triangularis.</i>
Broom-weed.	<i>Sida carpinifolia.</i>
Burr-grass.	<i>Cenchrus</i> (two species).
Butterfly plant.	<i>Bauhinia variegata.</i>
Cerasee.	<i>Momordica balsamina.</i>
Choya (Cleome).	<i>Cleome pungens.</i>
Clammy cherry.	<i>Cordia Collococca.</i>
Coralilla.	<i>Porana paniculata.</i>
Cowitch.	<i>Mucuna pruriens.</i>
Crocus (snowdrop).	<i>Zephyranthes</i> (several species).
Dagger plant.	<i>Yucca aloifolia.</i>

Common Name.	Botanical Name.
Devil's-horsewhip.	<i>Achyranthes aspera.</i>
Duck-weed.	<i>Lemna minor.</i>
Dumb-cane.	<i>Dieffenbachia Seguine.</i>
Duppy-cherry.	<i>Ehretia tinifolia.</i>
Dutchman's pipe.	<i>Aristolochia (several species).</i>
Eddoe.	<i>Zanthosoma esculenta.</i>
Four o'clock.	<i>Mirabilis Jalapa.</i>
French cotton.	<i>Calatropis procera.</i>
Jack-in-the-bush.	<i>Cordia cylindrostachya.</i>
Jerusalem candlestick.	<i>Euphorbia lactea.</i>
Leaf-of-life.	<i>Bryophyllum calycinum.</i>
Monkey fiddle.	<i>Pedilanthus (two species).</i>
Nettle.	<i>Tragia volubilis.</i>
Penguin.	<i>Bromelia Pinguin.</i>
Plumbago, wild.	<i>Plumbago scandens.</i>
Prickly-pear.	<i>Opuntia Tuna.</i>
Rattle-bush.	<i>Crotalaria (several species).</i>
Sand-box tree.	<i>Hura crepitans.</i>
Silk-cotton (<i>Ceiba</i>).	<i>Eriodendron anfractuosum.</i>
Tania.	<i>Zanthosoma esculenta.</i>
Velvet leaf.	<i>Cissampalos Pareira.</i>
Wandering Jew.	<i>Zebrina pendula.</i>
Water-cress.	<i>Nasturtium fontanum.</i>
Water-hyacinth.	<i>Eichhornia speciosa.</i>
Water-lily.	<i>Nelumbium jamaicensis.</i>
Wax plant.	<i>Hoya carnososa.</i>
Wild cassada.	<i>Turpinia occidentalis.</i>
Wild ginger.	<i>Hedychium coronarium.</i>
Wild thistle.	<i>Argemone mexicana.</i>





New York Botanical Garden Library

QH55 .W67
Wortley, E. J./A companion to Blackie's ^{juv}



3 5185 00043 5592

