

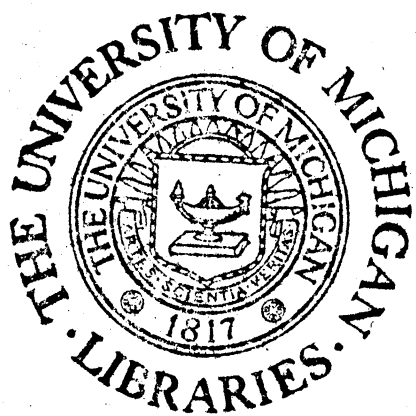
*Harvey n. Cole*

TWENTY CHAPTERS  
OF A  
NATURE-STUDY READER  
FOR THE  
PHILIPPINE ISLANDS

BY  
JOHN G. COULTER, Ph.D.  
TEACHER OF BOTANY, INSULAR NORMAL SCHOOL



MANILA, 1903.



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## PREFACE.

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*Success in the use of these chapters must depend a good deal upon the teacher. Previous training in botany is not at all essential for teaching from these pages, yet the use of the text simply as a reader is not the thing expected. The pupils should also make constant use of a note book and pencil. The plants described have been chosen chiefly on account of their familiarity and availability throughout the Islands, and the pupils should make their sketches directly from nature. The pupils seem to take considerable pride in the preparation of such a "Nature-Study note-book," and it is the best aid to accurate observation. The teacher can easily extend the range of topics studied. The twenty chapters should not be exhausted in less than forty or fifty lessons.*

*Fundamental principles have been presented through the medium of familiar examples, rather than as independent topics, simply because it has been the experience of the writer that the subject "teaches better" that way, at least in such very elementary presentation. Thus, the familiar papaya is made the means of acquaintance with the uses of the various parts of the plant, rather than to take up the topics "root," "leaves," "flowers," etc., in more abstract form. The banana serves to show methods of reproduction. Through pandan, pollination and the light relation of leaves are introduced. This scheme is followed throughout. At some points the text is suggestive rather than explicit, for the Filipino pupil in Nature-Study Classes has shown himself quite capable of seeing the more evident reasons for himself. Numerous questions are asked whose answers, though simple, are to be found outside the covers of the book. It is urged that the teacher shall make the questioning so far as possible of this character.*

*The completed edition of this book will contain additional chapters upon the following topics, mango, the soil, tobacco, lanzonis, guava, coffee, bamboo, piña, cocoanut, and sugar-cane.*

*The cuts of agricultural machinery have been loaned by the Agricultural Bureau, while nearly all the other pictures are the work of four members of the classes at the Insular Normal School, Filemon Cosio, Primo Crisostomo, A. Dimalanta, and Nicholas Francisco.*

*Insular Normal School, November 12, 1903.*



## CONTENTS.

	PAGE
CHAPTER I.—What this Book is About . . . . .	7
CHAPTER II.—About the Papaya . . . . .	9
CHAPTER III.—Story of the Young Papaya . . . . .	13
CHAPTER IV.—About Papaya Flowers . . . . .	16
CHAPTER V.—The Uses of Plants to Man . . . . .	19
CHAPTER VI.—The Useful Plants of the Philippine Islands . . . . .	22
CHAPTER VII.—The Banana . . . . .	25
CHAPTER VIII.—More about the Banana . . . . .	29
CHAPTER IX.—Pandán; a Shore-lover . . . . .	32
CHAPTER X.—Pandán; a Wind-lover . . . . .	36
CHAPTER XI.—Gumamela . . . . .	39
CHAPTER XII.—Macahia; the Shame Plant . . . . .	43
CHAPTER XIII.—About Rice . . . . .	47
CHAPTER XIV.—Rice-Cultivation . . . . .	51
CHAPTER XV.—The Work of Green Leaves . . . . .	56
CHAPTER XVI.—Lantana . . . . .	59
CHAPTER XVII.—Pandacaqui . . . . .	63
CHAPTER XVIII.—Ilang-ilang . . . . .	67
CHAPTER XIX.—Cacao . . . . .	72
CHAPTER XX.—Aurora; a Vine . . . . .	75





## CHAPTER I.

### WHAT THIS BOOK IS ABOUT.

Nature-Study is the study of all things out-of-doors which men have not made. Almost always the first things you see out-of-doors are the plants. Plants form the natural covering of nearly all the land surfaces of the earth. They are living things, just as men and other animals are living things. Without plants, men and other animals would die. This book tells about some of the common plants of the Philippine Islands.

In every country of the world plants are very important in the life of men, but in no country are they more important than in the Philippine Islands. What do you think would happen to the Filipino people if all the plants died tomorrow? How long do you think the people could live?

Many parts of the world can not be used for the growing of plants which produce food and other valuable products because the soil is not fertile. People who live in such parts of the world must get much of their food from other parts. A country whose chief industry is the growing of plants to produce food for other parts of the world is called an agricultural country. The Philippine archipelago will become one of the best agricultural countries in the world when her people have learned how to make the most out of her rich lands. This is one reason why it is important for you to learn about plants and how they live.

All our food and nearly all our money come from plants. We have food which comes from animals, but the animals get their food from plants. So if there were no plants there would be no animals.

It is not so easy to see how nearly all the money of the Filipino people comes from plants, but it is just as true. Many countries are rich because they have mines of gold and silver, or mines of copper and iron and coal. Other countries are rich because they have great factories where clothing and shoes, tools and machinery, and many other necessary things are made. The Filipino people do not have many factories and have very few mines. They have instead a country in which many of the most valuable plants in the world can grow, and nearly all their money comes from selling the products of these plants. Much money is paid for the products of all the mines, and much is paid for the products of the factories, but both together are not worth so much as the products of the plants of the world. Men could live without factories and they could live without mines, but without plants they would very soon die.

If the Filipino people use their rich land to produce in the best way the many valuable plants which grow here, they will become quite as rich and prosperous as people who have many mines and factories. In other countries it is not possible to grow many of the valuable plants which grow here, and the people of these countries are glad to pay a good price for the plant-products of our fertile islands. So it will be a very good thing for the Filipino people when they have learned how to produce enough plant-products for their own use and much besides to export to other countries.

In these beautiful and fertile islands it is possible to produce more than five times as much as is now produced. At this time (1903) the Filipino people buy from other countries just as much as they sell to them. It is easy to see that no people can become very rich until they sell more than they buy. When our Filipino farmers have learned how to get the best crops from their farms this may become true for the Philippines.

In Nature-Study you will gain knowledge which is necessary for a good understanding of the best ways to cultivate plants. The products of plants are made much more valuable when the plants are cultivated. To cultivate a plant means to help it grow. Rice is a cultivated plant because the farmer works hard to help it grow and produce a good crop of rice seeds. In Nature-Study you will learn something of the cultivation of plants. You will learn how plants live and how they produce their young. You will learn what are their friends and what are their enemies. When we cultivate plants we help their friends and try to destroy their enemies. You will learn that animals are necessary helpers in the cultivation of plants. You will learn the work which each of the different parts of the plant has to do, and how this work is done.

Plants which men do not cultivate are called wild plants. Many valuable plants grow wild in the Philippine Islands. Cultivated plants grow in the fields and in the gardens. Wild plants grow in the forests and along the shores and in many other places. It would be very hard to find a place in the Philippine Islands where neither wild nor cultivated plants can grow.

Most of the plants which you will study about in this book are cultivated plants, but the very first one you are to study about is a plant which is very common, but which grows without cultivation. It is the papaya.

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## CHAPTER II.

### ABOUT THE PAPAYA.

The papaya is a plant which grows everywhere in the Philippine Islands and has very few enemies. You have already learned that plants have friends and enemies. Thus, the grasshoppers and dry weather are great enemies of the rice.

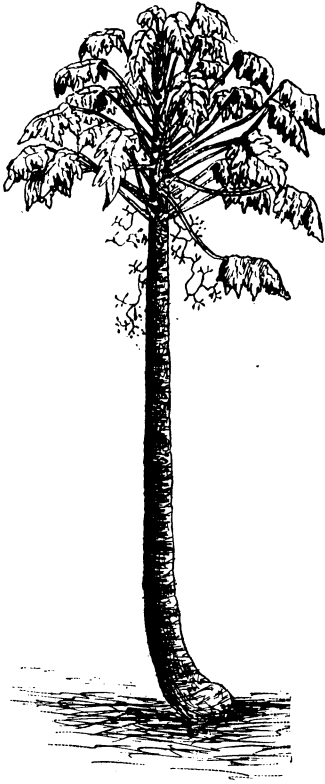
Since the papaya has very few enemies which it is not able to overcome, it is not necessary for men to cultivate it or help it grow. The fruit of the papaya is good food and it seems to be about as good when the papaya grows wild as when it is cultivated, but the fruit will grow larger when some of the young fruits are cut away to give the others more room.

One of the reasons why the papaya has very few enemies is because it can live in ground which other plants cannot use. It is common to see the papaya growing among rocks where the soil is very poor. For this reason other plants do not try to crowd it out, as the macahia tries to crowd out the rice. The papaya is a very strong and healthy plant. If it were not strong and healthy it could not grow so well where the soil is very poor and dry.

The life of papaya is something like the life of the wild people who live in the mountains of the Philippine Islands. These people take the poor parts of the islands for their homes and so the other people leave them alone, for no one cares to crowd them out of the poor places. In the same way the papaya takes the poor parts of the soil for its home and the other plants do not try to crowd it out.

Every Filipino boy or girl knows that there are two kinds of papaya. What do you call the two kinds? In English they may be called the man-papaya, and the woman-papaya. How can you tell these two kinds of papaya apart? Are the leaves different? Are the stems different? Are they the same height? Do they have the same kind of flowers? Do both kinds produce fruit?

The papaya is a very good plant for us to study first because it will show many things about the life of plants which are more difficult to see in other plants. The life of one plant is very much like the life of all the rest, so that what we learn by studying the papaya is true also for thousands of other plants.



THE MAN PAPAYA.

The papaya shows very plainly the different parts of the flower. Since there are two kinds of papaya flowers we find in each kind of flower just one half of the parts which we find in a perfect flower. Plants which have just one kind of flower must have all the flower parts together and we call these flowers perfect flowers. The gumamela, for example, has perfect flowers. But the papaya has half the flower parts in the flower of the man-papaya and the other half in the flower of the woman-papaya. You can easily see in the pictures the difference between these two kinds of flowers. By looking carefully at the flower of the woman and then at the flower of the man papaya can you see why one produces fruit

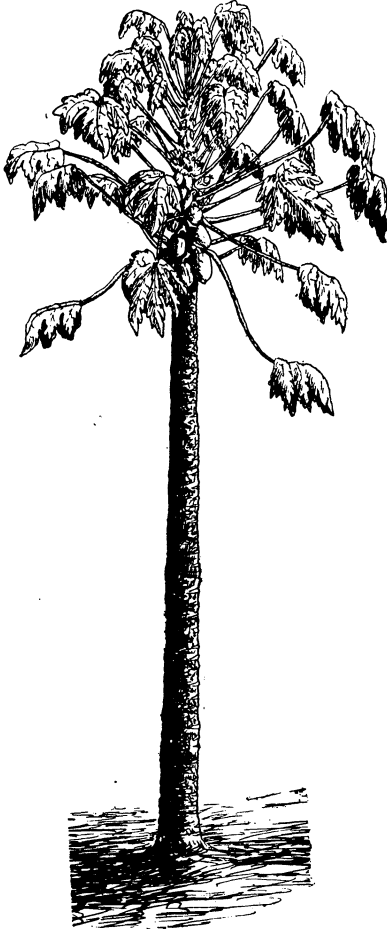
and the other does not?

Have you ever seen a papaya fruit upon a man-papaya tree? Sometimes a small fruit is formed at the very end of the flower-branch of the man papaya. When you see such a tree, you should look carefully to see whether the flower at the end of the flower-branch is different from the others. Are the flowers of the woman-papaya borne on branches or on the main stem?

How soon can you tell whether a young papaya is going to be a man-tree or a woman-tree? How high does the plant grow before

SMALL FRUIT WHICH  
SOMETIMES APPEARS ON  
MAN-PAPAYA.

it begins to produce flowers? Some people say that if you cut off the stem of a young man-papaya tree just after it has produced its first flowers it will become a woman-papaya when it grows up again. Do you know whether this is true?



THE WOMAN-P. PAYA.

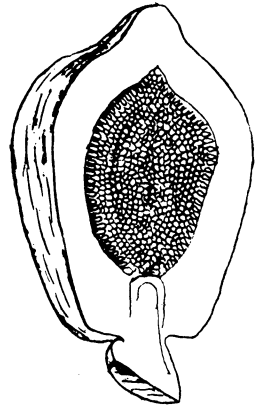
The stems of the papaya are very different from the stems of other plants. When you break off one of the old leaves of the papaya it leaves a mark on the stem. Have you ever noticed these marks? Can you see them best on the old part of the stem or on the young part at the top?

Since the leaves of papaya are very large it is not necessary for the plant to have many of them. They are all borne at the top of the stem. The top part of the stem and the leaves form what is called the crown of the plant. What other common plant has very large leaves and only a few of them in a crown at the top of the stem?

The papaya grows in many other tropical countries besides the Philippine

Islands, and everywhere in the tropics its fruit is good to eat. In temperate countries like the United States the papaya may be grown in the gardens if it is protected from the cold of winter, but in these countries it does not produce good fruit.

The parts of a plant which are underground are called roots. Do the roots of the papaya go very deeply into the ground or are they near the surface? Are the papaya plants blown down easily by storms? Do young papaya plants ever grow up from the bottom of the papaya plants like the young bananas which grow from the bottom of the banana plant? How do you think the young papaya grows? In the next lesson you will read the story of the young papaya.



FRUIT OF PAPAYA CUT OPEN SHOWING THE MANY SEEDS.

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### CHAPTER III.

#### STORY OF THE YOUNG PAPAYA.

The young papaya grows up from a seed. Do you know what a seed is? Inside the ripe fruit of papaya many small, round bodies may be found. These are the seeds. When the seeds are scattered in a good place on the ground they will begin to grow into young papaya plants, unless the chickens or some other enemies find them and eat them up.

Now a plant must have food just like men and animals. When the papaya is a very young plant indeed it gets its food from inside the seed, but soon the young papaya has grown larger and has eaten up all the food which was stored for it inside the seed. It is like a little chick which has just broken out of the egg-shell. Before the little chick is hatched it finds its food inside the egg, but when it has grown so big that it breaks the shell it must begin to scratch for its own food. So the young papaya must begin to find its own food after it has eaten everything inside the seed.

The little chick has three parts which help it get its food. It has eyes to look for food, legs to run and get it, and a beak for picking it up.

The young papaya has nothing like eyes and legs and beak, yet it must have food just like the chick. The three parts of the papaya which help it for this purpose we call the root, the stem, and the leaves. Since the papaya can not run around and find its food, you might think that it gets its food in the ground where it grows and that the food is taken up by the roots. But this is not quite true. If the root took up the food of the papaya what do you think the stem and the big leaves would be for? Why would not the whole plant live under-ground where the food is? No, the food of the papaya does not come from the ground. It comes from the leaves. You wonder how the leaves get the food of the papaya. Do they get it from the air? Do they get it from the water which comes up to the leaves from the ground? No, the leaves do not *get* the food of the papaya plant at all. They *make* it. The leaves of the papaya are like little work-shops and in them the food of the plant is made.

You can see that in this way the young papaya is very different from the young chick. Both must have food, but the chick goes around and finds its own food, while the food of the papaya is made in its leaves. This is a thing which you should remember very well, for it is a thing which makes the lives of plants very different from the lives of animals. Each must have food, and what is food for a plant is also food for an animal, but the great difference is that an animal gets its food already made, but a plant makes its own food.

After we have learned that the leaves of the papaya are for making the food of the plant, we should learn what the roots and the stems are for. Let us think of a young papaya which has used up all the food inside the seed. What is it going to do next? Can the young leaves begin to make food without any help from the roots and the stem?



No, the roots and the stem must help. If we could watch a young papaya as it begins to grow, we would see that the first part of the plant which comes out from the seed is the little root. This is the part of the plant which must begin the work of helping to make food.

If we are going to make a dress or a coat, the first thing we must do is to get the cloth out of which the coat or the dress is to be made. In the same way the young papaya must get the material out of which food is made, and it is the work of the root to get this material. So the young root begins to grow down into the soil and there it finds the things which the leaves know how to make into food. These things are in the water of the soil, and when the root takes up this water it takes into the plant the things which are in the water. You all know that there is salt in the water of the sea. You all know that when you put a lump of sugar into coffee it is soon dissolved in the coffee. In the same way the things which the plant uses in making its food are dissolved in the water of the soil.

While the root of the young papaya has been growing down into the soil, the stem has been growing up into the sunlight. When the stem has grown up a little way the young leaves begin to unfold and spread out in the light. They seem to be trying to get all the light they can. Light is necessary to help the leaves make food.

Perhaps you can think for yourselves now what the stem is for. When the leaves have opened up and the light is shining on them, they are ready to begin the work of making food. Already the root has begun to take up the water of the soil and in this water are the things out of which the leaves can make food. The water passes along the stem until it reaches the young leaves. Then the little workshops begin their work. All day while the light is shining on them they are busy making food for the plant. In the night the food which is made in the leaves

of the young papaya passes into the stem and goes to feed all the hungry parts of the plant.

Now you can see what each of these three parts of the young papaya plant has to do. Every part of a plant has some work to do.

It is the work of the root to hold the plant firmly in the ground and to get the material out of which the leaves can make food.

It is the work of the leaves to make food for the plant. They could not do this work without the sunlight which gives them the power to do it.

The stem has three kinds of work. First, to lift the leaves up into the sunlight. Second, to carry up to the leaves the water which comes from the root. Third, to carry the food which is made in the leaves down to all hungry parts of the plant.

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## CHAPTER IV.

### ABOUT PAPAYA FLOWERS.

After the young papaya has learned how to use its roots and stems and leaves, it grows very rapidly. Do you know how long it takes a papaya to grow up from a seed and bear fruit? There are some trees which take eight or ten years to become as large as a full grown papaya, but if you watch a young papaya you may see that it grows several inches in a few weeks.

The food which is made in the leaves is used in making the new parts of the plant. When the papaya has learned how to find its food and how to grow you might think that it has learned all which there is for a plant to do. It is true that the young papaya could become a large and an old plant by the work of its stems and its roots and its leaves alone, but there is another very important work which the papaya must do before it dies. The work of the roots and the stems and the leaves is not enough. There is the work

of the flowers and the fruit and the seeds yet to be done. The work of roots, stems, and leaves is simply the work of living and is called nutrition. The work of the flowers, fruit, and seeds is the work of producing new papaya plants and is called the work of reproduction. Plants die and plants are born just like animals. Each plant before it dies must produce other young plants or soon there would be none left in the world.

Now you must learn how the papaya produces its young. You have already learned that the young papayas come from seeds, but you have not learned how the seeds are produced. You may learn this by studying the flowers of papaya, for it is the work of the flowers to produce the fruit and the seeds. The papaya is a good plant to show you the work of flowers because it has two kinds of flowers. One kind does part of the work and the other kind does the other part. Each kind of flower is quite simple.

First look at the flowers of the man-papaya. They are much smaller than the flowers of the woman-papaya and there are many more of them. On the outside you find five white parts which are like simple little leaves. These five white little leaves form a part of the flower which is called the corolla. Each of the little leaves is called a petal. In the lower part of the flower the petals are united

FLOWER OF MAN-PAPAYA  
SHOWING THE FIVE  
PETALS AND TOPS OF THE  
TEN STAMENS.

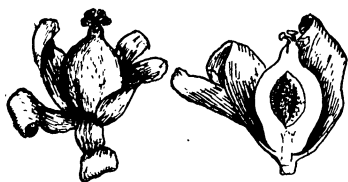
in the form of a tube. Now if you look in the center of a ripe man-flower you will find at the top of this tube several small yellow parts. You can see these yellow parts better if you take a sharp knife and split the tube. Then by looking carefully you will find that there are ten of these small yellow parts. There are five in a ring on the outside and five in a ring on the inside. The outer ones are just twice



FLOWER OF MAN-PA-  
PAYA CUT OPEN TO  
SHOW POSITION OF  
THE STAMENS AT  
THE TOP OF  
THE TUBE.

as long as the inner ones. These small yellow parts of the man-flower are called stamens. You can see the stamens very well in the picture of the man-flower.

In the tops of the stamens, when they are ripe, you can find a little yellow powder, finer than dust. This yellow powder is called pollen. It is the work of the man-flowers to produce this pollen. You will learn what the pollen is for when you study the woman-flower.



FLOWER OF WOMAN-PAPAYA, SHOWING  
PETALS, OVARY, AND STIGMA.

The woman-flower is much larger: It, too, has five petals, but each one is six or seven times as large as a petal of a man-flower, and they are not joined together at the bottom. It is in the center of the woman-flower that we find the most im-

portant part. This part is called the pistil. At the top of the pistil there are five short branches and each of these little branches is branched again. Can you see this part of the pistil in the picture of the woman-flower? It is called the stigma. Below the stigma we find a much larger part which is nearly round. If you cut this part open you will find inside of it the very young seeds. This round part is called the ovary and the very young seeds are called ovules. The ovary becomes the fruit. Can you find an ovary in the man-flowers?

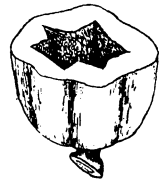
Suppose there were no man-papaya plants. Do you think that the ovary would become a ripe fruit with good seeds inside of it? If the ovary can become a good fruit without the help of the man-flowers, then what are the man-flowers for? But we find that if there were no man-papaya trees there could be no good fruit and seed. The man-papaya is very important in helping make the fruit and seed.

Now you can understand the purpose of the pollen. The pollen of the man-flowers is necessary to help the woman-flowers produce fruit. The pollen must be brought

from the man-flowers to the stigma of the woman-flowers. The stigma is for the purpose of receiving the pollen. After the pollen has reached the stigma, the petals of the woman-flower fall off, and presently the stigma withers up, but the ovary grows larger and larger until at last it becomes the ripe fruit of papaya. In this ripe fruit are many hundred seeds each one of which can produce a new plant if it falls in a good place.

You have learned that the pollen must be brought from the man-flower to the woman-flower. But you have not learned how this is done. Can you think how the pollen may be brought from one flower to another?

You will learn in another lesson how this is done. You will learn that there are little messengers that carry pollen from one flower to another. You will learn that the petals are for the purpose of attracting these messengers. You will learn that these are not messengers for papaya alone, but for many hundreds of other flowers. Nearly all flowering plants must have pollen carried from one flower to another before good fruit and good seeds are produced.



HALF OF YOUNG FRUIT OF  
PAPAYA.

## CHAPTER V.

### THE USES OF PLANTS TO MAN.

The first and most important use of plants to man is for food. Probably no country has more kinds of plants which are used for food than the Philippine Islands. Do you think you could write a list of all the plants which the Filipino people use for food? Almost any Filipino boy or girl can think of more than a hundred kinds of plants which are used for food.

There are many different ways in which the parts of a plant are used for food. Some parts must be cooked before they are eaten; other parts may be eaten without

cooking. In some food-plants we eat only the seeds, in others we eat the entire fruit, and in a few we eat the leaves as well.

Rice and wheat and corn, or mais, are called cereals. The cereals form the most important group of food-plants in the world. We eat only the seeds of cereals and they need to be cooked. In countries of the temperate regions, like the United States, wheat is the most important food-plant. The seeds of wheat are ground into a fine powder called flour, and from this flour bread is made. Flour is sometimes made from corn and rice in the same way. One of the reasons why food which comes from the seeds of plants is especially valuable is that it may be kept for a long time without spoiling, if it is kept dry. Other plant foods must be eaten while they are fresh.

In the markets of the United States the fresh plant foods are called either "fruits" or "vegetables." Sweet plant foods which are eaten without cooking are called "fruit." The banana, the orange, the chico, the mango, and the lanzonis are examples of common Philippine "fruit." But in Nature-Study we use the word fruit to describe that part of the plant which contains the seeds, no matter whether it is sweet and can be eaten raw or not.

Rice, potatoes, and mais are common examples of Philippine vegetables. They need to be cooked before they are eaten. In Nature-Study should we call the potato a fruit? Do cucumbers and tomatoes contain seed?

Plants are even more important to animals as food than they are to man. Since animals, especially horses and cattle, are valuable to man, the plants which supply food for these animals may often be sold for a good price. In the United States one of the most valuable crops which the farmer produces is the crop of hay or dried grass which the horses and cattle eat in the winter. He also grows much oats and barley for the horses. He feeds corn to his hogs, and this is a reason why the hogs of the United States are very much better than the hogs of the Philippine Islands.

Land which is covered with grass which is good food for horses and cattle is called grazing land. Much money is to be made by keeping cattle and horses on good grazing land and driving them to market when they are ready to be sold. In the Philippine Islands there are many square miles of fine grazing land, but very few cattle and horses are kept on it.

Food is the most important product of plants, and the second in importance is timber. Think of the hundred uses of timber! It is used in building houses, ships, wagons, bridges, railroads, and many other very important things. Now we already know that no country in the world can produce better food-plants than the Philippine Islands. If the same thing is true of timber-plants then the Islands are fortunate indeed! And this is true. Many of the finest kinds of timber in the world are to be found here. Millions of acres are covered with fine and valuable trees.

Nearly all of this land is owned by the government and good care is taken that the fine timber is not wasted, but that it is cut down only as fast as it grows up. In many countries where timber is valuable the trees have been cut down so rapidly that now there is very little forest left. It is just as necessary not to be wasteful in harvesting the crop of the forest as it is in harvesting the crop of the fields.

There are many forest crops besides timber which are valuable. Rubber and gutta-percha trees are found in the forests of the Philippines. Gutta-percha is necessary in the manufacture of submarine cables and sells for a high price. Like rubber, it is made from a milky juice which comes out of the trunks of the trees when they are cut. Valuable gums and resins are also found in the trunks of certain kinds of Philippine trees.

There are two plant-products in the Islands which are not used for food or for timber. They are the products for which the Islands are best known. Both of them are

made from the leaves of plants. These plant-products are hemp and tobacco.

Another class of plants which is very useful to man is formed by those plants from whose fibres cloth is made. The most important of this class of plants is cotton. The best cotton is grown in the southern part of the United States. Some cotton is grown in northern Luzon and it could be grown in many other parts of the Islands. Silk and woolen cloths are animal-products. Do you know from what plants jusi and piña are made?

A fourth use of plants to man is their use for medicine. Nearly all medicines are made from plants and the science of plant-study, or botany, was begun by men who were searching for plant-products which would be valuable for medicine.

We may say, then, that the four great uses of plants to man are for food, for shelter, for clothing, and for medicine.

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## CHAPTER VI.

### THE USEFUL PLANTS OF THE PHILIPPINE ISLANDS.

No country in the world can produce more valuable and useful plants than the Philippine Islands. In many other countries, however, the farmers have learned much more about the cultivation of plants than have the Filipino farmers and so have made their crops more valuable.

This should not be so any longer. The farmers of the Philippine Islands should be as good as their land. Since there is no finer farming land than may be found here, there should be no better farmers than the Filipino farmers. This may be so in a few years if the Filipino people learn about the useful plants of their country and cultivate them in the best way.

Which is the most useful and valuable plant in the Philippine Islands? Probably every Filipino boy or girl would answer this question by saying that rice is the most useful plant to the Filipino people. Certainly rice is of



more use to more people than any other plant. Many of the valuable plants of the Islands might die and most of the people would not be the worse for it, but when the rice dies there is much suffering and hunger. The rice-plant should be studied carefully to learn how best to cultivate it and make sure of a good crop.

It has been necessary in recent years for the Filipino people to buy much of their rice from other countries. Many shiploads have come from China. This should not be so. There is plenty of good rice-land and the Filipino people should produce enough rice for themselves and much to ship to other countries beside.

Next to rice, bamboo is perhaps the most useful plant. The first thing a man needs is food. The next thing is a house to give him shelter. Most of the Filipino people live in houses built of bamboo and covered with a roof made of the leaves of the nipa palm. Bamboo is not only useful in the building of houses, but has very many other uses. What are some of the other uses of bamboo?

There are many important food-plants in the Islands beside rice. Corn or mais and potatoes are important, although they grow better in other countries. In some parts of the Islands corn is used by the people even more than rice.

In no country are more kinds of sweet fruits to be found. Philippine mangoes are the best in the world. Everywhere bananas grow and there are more than twenty different kinds. How many do you know? Lanzonis, chico, atis, and mangostin are delicious Philippine fruits. Have you eaten all of these? Which do you like best? None of these can be grown in the United States, but the oranges of California and Florida are much better than those which grow in the Philippine Islands. This is because much care has been taken in the cultivation of oranges in America. The Philippine oranges may be much improved by cultivation.

The plants which you have just read about are those which are most important to the Filipino people for their own use. There are others, however, which are more important than these for the purpose of export. Products which are sent to other countries are called exports. The most important plants whose products are exported from the Philippine Islands are abacá, niog or cocoanut, tobacco, and sugar-cane.

Abacá produces the famous Manila hemp from which the best rope in the world is made. No other country can grow this wonderful plant as well as it grows in the Philippine Islands. There is always a strong demand in the markets of the world for Manila hemp. More of it could be produced without causing the price to decrease. It is one of the crops which the Filipino farmer should cultivate more than he does to-day. The only danger of reducing the good prices now paid for Philippine hemp comes from mixing bad fibres with good ones. That has been done by some dishonest dealers in hemp. To do such a thing is to injure the whole Filipino people, for if it is found that Philippine hemp is not always reliable and good the price for it will become much lower.

The cocoanut is very important both for home or "domestic" use, and for export to foreign countries. Cafia and niog, or bamboo and cocoanut, as we say in English, are the two plants which have a hundred different uses. The cocoanut palm is perhaps better known to the people of temperate regions than any other tropical plant, for dried cocoanut is sold all over the world. What are four different and valuable plant-products which come from the cocoanut?

Much fine tobacco is grown in the islands of the West Indies, especially in Cuba. This is a crop which can also be grown in the United States, but not so well as in the tropics. The islands of Cuba, Sumatra, and Luzon are the best tobacco producing countries in the world. In Cuba and Sumatra more study and care has been given to the culti-

vation of tobacco than in the Philippines, but there is no reason why Luzon should not produce as fine tobacco as any in the world if it is carefully cultivated.

The islands of the Visayan group have fine land for the growing of sugar cane. This is another of the Philippine crops which may be much improved by the use of better methods.

These are but a few of the many plants which make up the wonderful abundance of plant wealth with which the Philippine Islands are blessed. We must remember the rich forest crops which grow wild. We must remember the cacao, the coffee, the cotton, the piña, and the ilang-ilang which will all bring wealth to the farmer who cultivates them carefully.

So it is easy to understand why Filipino boys and girls should learn all they can about the plants of their beautiful Islands. The wealth of the people will always come from the products of the plants, and the value of these products is increased many times when we understand how the plants grow and cultivate them in the best way.

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## CHAPTER VII.

### THE BANANA.

It would be hard to find Filipino boys or girls who could not tell the name of a banana as soon as they saw its big leaves. Bananas grow everywhere in the tropics, and the fruit is sent to all parts of the temperate regions. Although children who live where there is ice and snow in winter may have many bananas to eat, they probably would not know a banana-plant when they saw it unless the ripe fruit was hanging from it. No plants which grow in the temperate regions have such huge leaves as the banana-plant. In the United States bananas are sometimes grown in glass houses where the air is kept warm all the time. These glass houses are called conservatories. They

are built of glass so that there may be plenty of light. Why is it necessary for plants to have plenty of light?

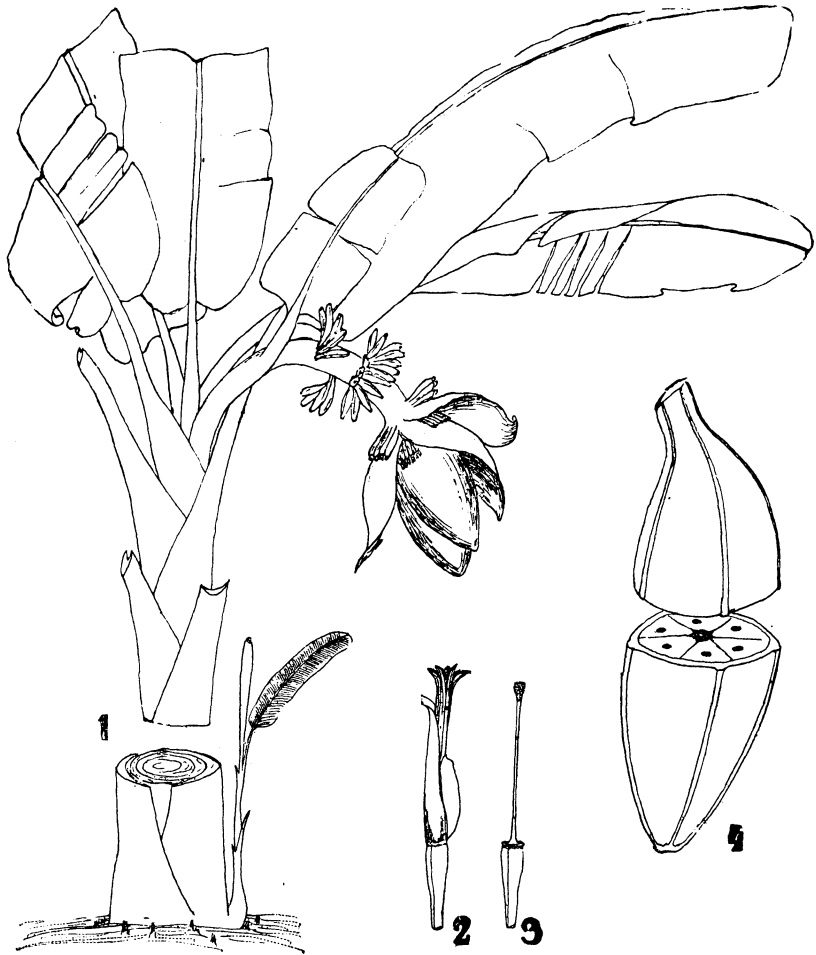
The bananas which are sent from warm countries to be eaten in cold countries are picked while they are still green. If they were picked when they are ripe they would decay long before reaching their destination. The green bananas ripen slowly in America if they are kept in a warm place. You very often see men with little carts going about in the cities of America selling bananas which have come a thousand miles from the south. Some ships come to the United States loaded with nothing but bananas. Thousands of bunches are sent in trains to all parts of the country. Those sent from Central America to the United States are larger than Philippine bananas, but they do not have as pleasant a taste as when they are allowed to become nearly ripe on the trees.

There are more different kinds of bananas in the Philippines than are ever seen in America. Can you tell your teacher the names of ten different kinds? Which kind do you think is best to eat? Here is a picture of the butuhan. The butuhan is not good for eating but is the most common kind. Why is it not good for eating? Many people are very fond of the lacatan. Is lacatan cultivated or wild? Does the butuhan grow wild? We may call the butuhan the most successful kind because it is the most common.

How many different parts are there in a banana-plant? In the picture you can see the stem and the big leaves and the flower-part and some of the fruit. What is the part which you can not see in the picture?

The leaf is so very large that you can easily see its different parts. In the center is a strong, stiff part called the midrib. It is like a strong bone in the body of the leaf and holds it up so that it can do its work. From the midrib, other ribs run out to the edge of the leaf. These smaller ribs are called the veins of the leaf. In the leaf of banana

the veins all have the same direction. They run straight from the center to the edge of the leaf. Did you notice the veins of the leaf of papaya? Are they all in the same direction?



BUTUHAN.—(1) The plant, showing that the stem is formed by overlapping leaves. The parallel veins are seen on the leaf of the sucker.—(2) and (3) The flower, showing its irregular corolla. Notice that the corolla rises above the ovary.—(4) Fruit, cut open.

Since the veins of a banana leaf all run the same way it is easy to tear the leaf that way, but very difficult to tear it

the other way, across the veins. Nearly all the old leaves of banana are torn into strips by the wind. It does not kill the banana leaves to be torn in this way. They seem to do their work just as well as before, but if you cut a banana leaf across the veins, it will soon die. This is because the veins, beside giving strength to the leaf, are for the purpose of carrying to its different parts the materials necessary for its work. What other part of the plant receives the materials which are necessary for the work of the leaf? The veins also carry back into the stem of the plant the food which is manufactured in the leaves.

The banana, like the papaya, grows up very rapidly. It does not grow up from seeds, but has an underground part of the stem which sends up side-shoots or suckers. These suckers may be cut away and planted in other places. When the big leaves of the sucker begin to unfold they grow very fast. Sometimes a leaf grows several inches in one day. First there is a long, green roll, formed of two leaves. When these unroll other leaves appear, and thus the beautiful, spreading crown is formed. The stem is formed of the leaf-stalks or petioles which are rolled one over the other

Do you know how long it takes a banana-plant to grow up from the sucker and produce fruit? Most of the bananas which are eaten in America come from the West Indies. There the first crop of fruit is ready in less than a year from the time of planting. Do the bananas grow so quickly as that in the Philippines?

The fruits and not the leaves of the banana are valuable, yet we know that if we cut off the leaves or let horses eat them there will be no fruit. The Filipino horses seem to be very fond of young banana leaves. There is another plant which is much like the banana whose fruit is not valuable but whose leaves are. Have you seen this plant? It is the abacá. The abacá belongs to the same family of plants as the banana. It may be called the cousin of the banana.

Since the banana and the abacá have such large, spreading leaves they are useful not only for their own sake, but also to shelter other useful plants which need a good deal of shade when they are young. It is common to use bananas to shade young cacao plants, and abacá may well be used for the same purpose.

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## CHAPTER VIII.

### MORE ABOUT THE BANANA.

Have you ever watched a young banana-plant grow up from the bottom of an old one? It is hard to find an old banana-plant without young ones growing up around it, unless the baby banana-plants have been cut down or eaten by the goats or horses. These young banana-plants or suckers soon become too crowded together if they are all allowed to grow. It is best to cut away all but three or four. The suckers which are cut away may be planted in other places. Since the large leaves need plenty of room, the suckers should be planted about twelve or fourteen feet apart.

The banana is one of the easiest plants to cultivate and one of the most productive. The best bananas are grown where the soil is deep and has plenty of the decayed parts of plants in it. The decayed parts of plants supply rich food-material for the roots of living plants. Do you know about how long one banana-plant can live? Do you know how many bunches of bananas one plant can produce?

You know that papaya-plants grow up from seeds and that banana-plants grow up from suckers. Do you know whether banana-plants ever produce good seeds? Can you see the seeds in the fruit of lacatan? You can see them easily in the fruit of butuhan, but do you think that these seeds are able to produce new plants? It is easy to understand that if the seeds of banana were good for producing new plants the fruit would not be so good to eat.

The seeds of lacatan are so small and weak that we eat them without noticing them.

Is it better for a plant to produce its young by means of seeds or by means of suckers? This is a rather difficult question to answer, but we can certainly see that the seed method is better in some ways than the sucker-method. Seeds are often carried by the birds or by the wind far away from the parent-plant and grow up where there is plenty of room. Unless men transplant them, the suckers must grow up very near the old plants, and many of them die from being crowded too closely together. When plants are crowded too closely together there is not enough food-material for all the roots and not enough light for all the leaves.

Now let us look at the flower-part of the banana. The flowers of bananas are all a good deal alike, but perhaps you will find those of butuhan the easiest to get. In the center of the plant we find a large red part which has something of the shape of a heart. Is this part a single flower or is it composed of many flowers? We shall have to open it to be sure. On the outside we find dark-red leaves. Beneath each of these stiff leaves a row of yellow or white flowers is to be found. So we may be sure that the large, red part is not a single flower, but is composed of many flowers separated by the red leaves. Such a group of flowers is called an inflorescence, and the red leaves are called bracts. The pink flowers of *cadena d'amor* and the man-flowers of papaya are also arranged in inflorescences, though not so close together as the flowers of banana. The flowers of the palm trees are also arranged in inflorescences. Have you ever eaten a young inflorescence of banana? It is good to eat when cooked.

Under the first red bract we find flowers which are about two inches long. The flowers under the next bracts are a little shorter, and if you pull off the bracts one at a time you can at last find flowers which are less than one



inch long. You can see very plainly how the lower part of the flower slowly changes into the fruit. You learned from papaya that this part of the flower is called the ovary. You should make six or seven pencil-pictures of banana-flowers, beginning with the youngest and finishing with the fruit itself.

You will notice many differences between the flowers of banana and those of papaya. In the first place, the banana has only one kind of flower while the papaya has two. For this reason all the flower-parts of banana must be in the same flower. The corolla of papaya has a regular shape, like a wheel. The corolla of banana is irregular. Then in the woman-flower of papaya the petals are fastened below the ovary. In banana the petals are fastened above the ovary. The petals of banana are not separate like those of woman-papaya. They are united in a long tube, which spreads open when the flower is ripe. At the top of the corolla you may see five large stamens. Inside of these stamens you find a swollen part, like the knob on the end of a cane. This is the stigma. You remember that the stigma of papaya is divided into branches and is closely fastened to the top of the ovary. Since the ovary of banana is below the petals there is a long, slender part to connect the stigma with the ovary. You can see this part when you cut the flower open. It is called the style. Nearly all flowers have styles, so that we say that the pistil is composed of ovary, style, and stigma.

Now that the flower is cut open you can see the stamens very plainly. How many are there? Are they fastened to the corolla or to the bottom of the flower? Can you find any pollen?

There is still another very important difference between the flowers of banana and the flowers of papaya. You learned that the pollen of papaya is carried from the stamens of one flower to the stigma of another. You learned that this transfer of pollen occurs in most flowers even though stamens

and stigma are to be found in the same flower. You learned that this is necessary in order to make good seed. Now in banana the pollen is not transferred from one flower to another. This is one of the reasons why the banana does not have good seed and must produce its young by means of suckers. When you open the banana-flower you can see that the stigma is covered with pollen from the stamens of the same flower. The pollen-bearing parts of the stamens, which are called "anthers," grow very close to the end of the pistil, so that the pollen is sure to reach it.

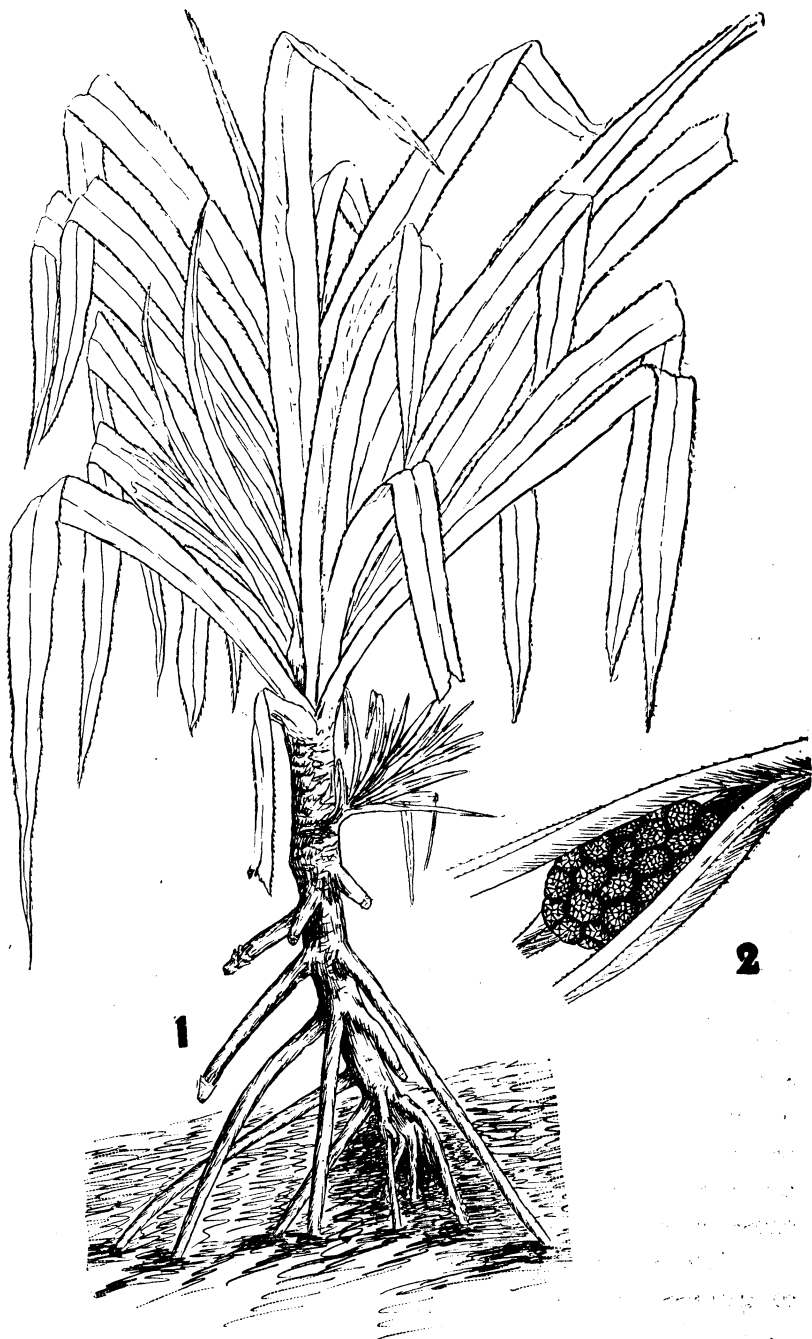
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## CHAPTER IX.

### PANDAN; A SHORE-LOVER.

The pandan is a peculiar plant, common along the shores of all tropical countries. You can find it in nearly all parts of the Philippine Islands. The only important use of pandan to the Filipino people is the use of the leaves for making mats. Can you explain how this is done?

You may know pandan by its strange roots. These roots are as much in the air as they are in the ground. Because they seem to prop the plant up, they are called prop-roots. You can often find roots of pandan which have begun to grow down from the stem, but which have not yet reached the ground. At the end of these roots the "root-cap" is always to be found. If you pull off this cap the tender, growing end is found beneath. The root-cap is always found at the end of growing roots, but in very few plants is it so easy to examine as in pandan. Usually it is deep under the ground and comes off when we pull the plant up. The root-cap is very necessary when the root is growing in the soil, pushing its way deeper and deeper. Without it, the tender tip would soon be bruised and injured. Of course the cap is not so useful while the end of the root is in the air, yet its presence proves that the part



PANDAN.—(1) The plant. The root-caps may be seen at the ends of the short roots.—  
(2) The compound fruit which is formed from an inflorescence of female flowers.

we are examining is not a branch of the stem. It is a true root, trying to reach the soil. Protecting caps are not so necessary for the growing ends of stems and branches. Of course it is much easier to grow in the air than in the ground. Besides, the tender tips of stems and branches are protected by the young leaves which curve over the end. Roots never have leaves.

The leaves of pandan are also peculiar. They are hard and tough and have stiff points along the edges. It is hard to pull them without scratching the hands. They are long and narrow, and, when young, they point straight upwards. When they are older they bend in the middle and the outer end droops toward the ground.

Now we know that every part of a plant is for some purpose. Do you think we can tell the purpose of the prop-roots and the hard, stiff leaves of pandan with their peculiar shape and position? Why are they so different from the roots and leaves of nearly all other plants?

If we are to understand the purposes of the parts of a plant we must always think of the place where it lives. We can understand the peculiar parts of pandan better if we remember that it lives most commonly along the shores. It may be called a "shore-lover."

Now you know that along the shores of the Philippine Islands many plants are killed every year by the salt water which is blown in from the ocean by the typhoons. Along the Luneta, which borders the shore of Manila Bay at Manila, no plants can be grown except those which have hard, tough leaves which will not be killed by the driven spray. Salt water is much worse for plants than the fresh water which strikes them as rain, however hard the rain may be driven by the wind. The salt kills tender leaves. So if a plant is a shore-lover it must have hard, tough leaves like those of pandan.

The shape and position of the leaves, as well as their toughness, help pandan in its life on the shores. They are

long and narrow and may be whipped in the wind without being torn. Their veins run in the same direction. Their sharp points or spines keep them from being eaten by animals.

Along the shore there is very little shade. Shore-lovers have the heat and light of the sun on them all day long. You know that green plants must have light, yet they may get too much, both of light and heat, unless their leaves are somewhat like the leaves of pandan. The leaves of pandan point either toward the sun or toward the ground. So, in mid-day, when the sun is brightest and the heat is greatest, they do not get so much light and heat as if their broad sides were towards the sun. The rays of the sun at mid-day do not shine straight upon them, but at an angle. This is another thing which helps pandan to live where other plants would quickly die.

Now can we explain the strange roots of pandan? Does it have roots which are half in the ground and half in the air because it is a shore-lover? This is not an easy question to answer. We think that the prop-roots of pandan may be due to the tides, yet of course pandan often lives and has prop-roots where the tides never reach them. Do you know what tides are? Do you know what tide-marks are?

For boys and girls who live along the shores these are very easy questions. They know that the water goes out at some times and comes back at other times. These changes of water are called the tides. When the water comes up high on the land it is called high-tide. When it goes out it is called low-tide. There is a low-tide mark and a high-tide mark. As you walk along the shore it is very easy to see the high-tide mark. It is shown by the mud which is left by the water when the tide goes out. Now it is very common for the pandan to grow between the tide-marks. When it is low-tide the prop roots are exposed to the air, but when it is high-tide they are covered with

water and can do the natural work of roots. So this arrangement of the roots seems to help the pandan live between the tide-marks.

There is one other very important reason why the pandan is a shore-lover. It is because its peculiar fruits are scattered by the waters of the sea. They float in the salt water and may be carried great distances without being injured. At last they are washed high up on the shore by the waves in some storm, and there they soon form young pandan plants. As you walk along the shores it is very common to find pieces of pandan fruit washed up by the waves, perhaps half buried in the sand. It is a compound fruit. That is, the fruit is not formed from a single flower, but is formed from the whole inflorescence of female flowers. Each of the small parts of the fruit of pandan contains a seed. It does not injure them to be buried in the sand. It is a sort of natural planting.

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## CHAPTER X.

### PANDAN; A WIND-LOVER.

The fruit of pandan is not to be found at all times of the year, like the fruit of papaya or banana. You may have some trouble in finding it, but, when you do, you will see that it looks a good deal like the fruit of piña. The leaves of pandan and piña also look much alike. In America the fruit of piña is called pine-apple, but in England and the English colonies it is usually called pine. For this reason the pandan has been called by the English "screw-pine," although pandan and piña are not closely related like banana and abacá. There is another great group of plants, very different from both the pandan and piña, which are also called pines. These pines are tall trees which are common in temperate regions, but rare in the tropics, except in the mountains. In the Philippine Islands they are to be found in the mountains of Benguet and Zambales provinces.

The leaves of pine trees are hard and are shaped like needles. They remain on the tree all winter long, no matter how much snow and ice there may be. Pine-trees furnish one of the most useful kinds of timber in the world.

Although the pandan or screw-pine and the true pines are very different plants in nearly every way, in one important thing they are alike. They both use the wind for the transfer of the pollen from one flower to another. For this reason they are both called wind-lovers. Like papaya, pandan has two kinds of flowers. The male flowers produce pollen; the female flowers produce fruit. Yet the flowers of pandan do not look at all like those of papaya. They do not have bright colored petals or pleasant odors. Indeed, you might think at first that they are not flowers at all, but since they produce either pollen or fruit we know that they must be flowers, however strange their appearance may be. They are arranged in close inflorescences, like the flowers of banana. The male flowers are composed of nothing but the many small, white stamens. The female flowers are composed of nothing but the pistils. They may be called naked flowers.

Now it is time for you to understand why most flowers are not naked, but are clothed with bright corollas and have pleasant odors. You can understand the purpose of these parts best by comparing them with flowers like those of pandan which do not have these parts.

You learned from papaya that the pollen must be transferred from the stamens of one flower to the stigma of another, or else good seeds and fruit will not be produced. You learned that the pollen of banana is not transferred from one flower to another, and bananas do not produce good seed. Now if you watch bright colored flowers on sunny days you will see that they are often visited by bees and butterflies and other insects. These insects fly from flower to flower seeking the sweet honey or nectar which is

to be found in the corollas. You might think that the insects are enemies of the flowers, since they rob them of their sweet nectar, but the truth is that they are among the best friends which the flower has. The flowers are very glad of their visits. The bright colors and pleasant odors are for the very purpose of attracting these insects so that they will come to the flowers. The sweet nectar is a food of which they are very fond. The flowers are glad to give it to them in payment for their visits.

Why? Because these insects are the special messengers which carry the pollen from one flower to another. Because, while the insects are getting the nectar, some of the pollen is sure to stick to their bodies, and when they go to the next flower it is rubbed off on the rough or sticky surface of the stigma. Now you can understand why many flowers are clothed with bright corollas and have pleasant odors. Such flowers may be called insect-lovers. Now, too, you can understand why the flowers of wind-lovers, like pandan, are naked. Bright colors and pleasant odors would not attract the wind. The wind goes to all parts of the plant alike. Many kinds of trees in the Philippine forests, whose flowers are borne high up where the wind is sure to strike them, are wind-lovers.

Is it better for a plant to be a wind-lover or an insect-lover? We may see that each way has some advantages over the other. If a plant is a wind-lover it does not have to make bright-colored petals to attract the insects, or sweet nectar for them to eat. When a plant has these things it means that the stems and roots and leaves have had a great deal of work to do in making them. A plant which is a wind-lover saves all this work. You must remember that flowers and fruit are produced by the work of the roots and leaves, and those plants are most successful which produce good fruit and many seeds with the least amount of work. So you may think it is better for a plant to be a wind-lover than an insect-lover, since much work



is saved by this method. Yet we must remember that the wind is not so safe a messenger as the insects. It will not blow the pollen straight from the anthers to the stigmas. For every grain of pollen which safely reaches the stigma perhaps thousands of others are blown to other places. For this reason wind-lovers must produce very much more pollen than insect-lovers. For this reason you find in the inflorescences of the male flowers of pandan very great quantities of pollen. The inflorescences are composed of thousands of stamens crowded close together. When they are ripe you may shake showers of pollen from them. It is almost as hard a task for the plant to make so much pollen as it is to make bright corollas and sweet nectar and only a little pollen. So you see that each way has some advantage over the other and both are good.

## CHAPTER XI.

### THE GUMAMELA.

The gumamela is a shrub. All plants may be divided into trees, shrubs, and herbs. The herbs are the low, weak plants which do not grow much higher than your waist. Shrubs or bushes are plants with woody stems which branch a good deal, but do not grow as high as trees. The gumamela is a perfect example of a shrub.

Gumamela is perhaps the commonest garden flower in the Philippine Islands. It is not cultivated for its use, but for its beauty. Its large, red flowers can be seen for half a mile. Do you know any other flowers which can be seen from so far away?

The gumamela can be grown in temperate countries, but its flowers are never so large and beautiful as they are in the tropics. In the United States this flower is called hibiscus. Does the gumamela bear flowers all year long? Does it produce good fruit and seed?

If you gather a gumamela flower and look at it carefully you can very easily see all the different parts. Since the flower is clothed with bright and beautiful petals you may be sure that it is visited by insects. What insects have you ever seen visiting the gumamela? The first thing which we notice in the flower is the corolla. It is composed of five, very large, red petals. Are these petals united like the petals of a banana or are they separate? The banana flower may be called a closed flower, because its petals are closely united into a tube which hides the stamens and the



GUMAMELA.

pistil. But the gumamela has an open flower, and we can see the central parts even more plainly than we did in the papaya. Outside and under the red corolla may be found the small, green part called the calyx. The calyx is composed of five united sepals. Outside the calyx are several small, pointed, green leaves which are not a proper part of the flower. They are called bracts.

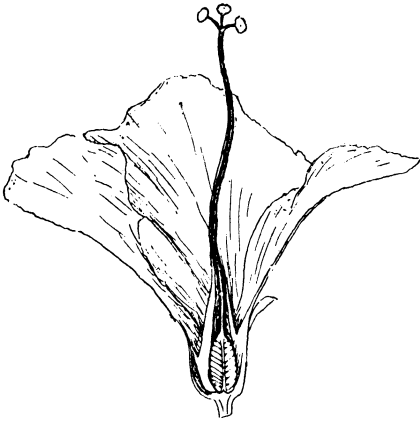
Now if we look at the center of the flower, one, long, slender, red part is seen. At the top it is divided into five

branches, each with a dark-red, little knob at the end. These little knobs are the stigmas of gumamela. You know already that the stigma is for the purpose of receiving pollen. Below the five short branches which carry the stigmas many stamens are seen. Each of these stamens has a very slender, little stem which branches out from the main stalk. About how many stamens do you find in one flower?

When the flower is ripe the top part of each little, red stamen opens and you may see the bright yellow pollen grains. Since the pollen grains of gumamela are much larger than those of other plants, you can see each one with the naked eye if you look very closely. Each stamen produces about fifty or sixty grains of pollen.

Now you have found the stamens and the top part of the pistil, but where is that very important part of the flower which bears the young seeds, and after a while forms the fruit? You know that the right place to look for this part is at the bottom of the pistil. You found it there in the female-flower of the papaya and in the banana flower. You know that the name of this part is the ovary. But you cannot see the ovary of the gumamela until you cut the flower open. If you first pull off the petals, and then carefully cut open the bottom of the flower, you can find the ovary. It is covered by the bottom of the long, slender, red part which bears the stamens and the stigma branches. This part is called the "column."

If you split open the column you will find a long white thread inside of it. This thread connects the stigmas with the ovary. It is called the style. You learned about the style in studying the flowers of butuhan, but the style of gumamela is very different from that of butuhan because it is covered by the column. This column is really composed of the lower parts of the stamens which are closely united together. You can understand these things much better by looking very carefully at the picture of the gumamela flower cut open.



FLOWER OF GUMAMELA CUT IN HALF.

Of course there are very many flowers which do not have a "column" formed by the union of stamens and pistil. In most flowers these parts are separate. Yet there is a great family of plants called "column-bearers" because they have the stamens and pistil united. These plants are common in the Philippines. Malvas and calut-calutan are common examples. The gumamela d'arania is another member of this family which is common in Philippine gardens. In English this flower would be called the "drooping hibiscus." Its flowers do not seem to have the strength to hold themselves erect like the flowers of the large gumamela. The long, very slender column hangs straight down. The petals are much divided, so that they seem to form a sort of fringe. Are the leaves of the gumamela d'arania different from those of the large-flowered gumamela? You will have to look very carefully to make sure of this, for on the gumamela it is common to find two kinds of leaves. The leaves at the bottom of the plant are often very different in shape from those at the top.

Neither kind of gumamela produces good fruit and seed. If you want to plant gumamela in the garden how do you do it? If the gumamela does not produce good seed you may wonder what the flowers are for. You have already learned that all parts of a plant have some purpose and that it is the purpose of flowers to produce fruit and seed. Now in the gumamela we have a plant which produces fine flowers, but does not finish the work by ripening

the seeds. You can find in the ovary the very young seeds, but they never become mature.

The reason for this is that the gumamela has been cultivated by men for the sake of its flowers and not for the sake of its seeds. Rice is cultivated for its seeds and so it always produces good seeds. But the life of gumamela is made easy for it by keeping away all its enemies, and it is reproduced by cuttings which men make from the old plants. This is not a natural way of reproduction, but it is an easier way for the plant than the seed-method, so the gumamela has gradually lost the power of producing good seed. They are no longer necessary, as they were very many years ago when gumamela was a wild plant. But gumamela still has the habit of making very handsome flowers.

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## CHAPTER XII.

### MACAHIA; THE SHAME PLANT.

This plant has a very good name. Every boy and girl in the Philippine Islands knows that when the macahia is touched with the hand or with a stick it bends down and closes up its leaves as though ashamed of itself and trying to hide. Although the macahia hangs its head as though in shame when you notice it, it must be a very happy plant if plants are happy when their lives are successful. Few plants in the Philippine Islands are more successful than macahia. It grows everywhere and spreads modestly, but rapidly, crowding out other plants. It produces fresh flowers and fresh fruit every day. Its seeds are very healthy and soon grow into young plants. In tropical countries the macahia is considered a troublesome weed. Plants which are troublesome to the farmer and crowd out the cultivated plants are called weeds. Macahia is one of the enemies of rice, and the rice-paddies must be kept carefully cleared of it, for macahia spreads rapidly when the water stands low on the paddy and crowds out the rice.

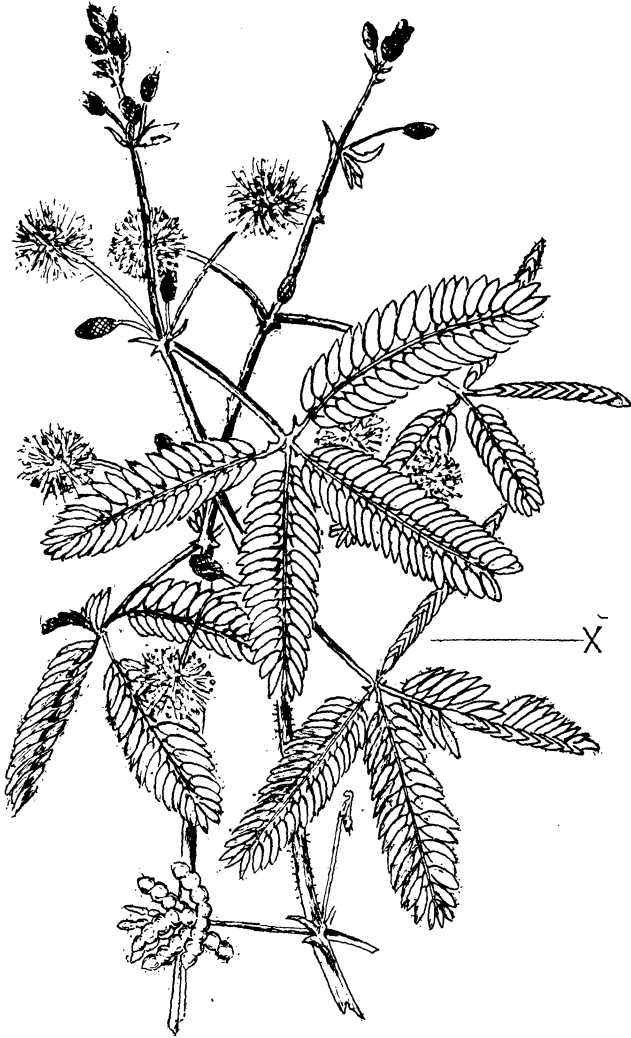
Although macahia is a wild plant in the tropics it is a very carefully cultivated plant in the temperate regions, where it is considered a great curiosity. There it is called the "sensitive plant," because it is so sensitive to the touch. In America the macahia can be grown only in the conservatories because it can not live in cold weather. The glass-roofed conservatories are carefully heated in winter and kept at just the same temperature all the time, so that many tropical plants can be grown in them quite as well as though they were at home.

There are many public conservatories in the United States, and when people come to visit them they stop before the sensitive plant just as they might stop before a cage of monkeys in a museum of animals. Macahia is the only plant in the world which seems to be able to move of itself when you touch it, and people who have never seen it before are very much interested in seeing the way it behaves.

Macahia may be called a creeping herb. Its leaves are compound leaves. A compound leaf is one which is divided into many small leaves, which are called leaflets. You can plainly see that the leaf of macahia is composed of many pairs of small leaflets. How many pairs of leaflets do you usually find in one leaf? The acacia tree is another common Philippine plant which has compound leaves. The acacia and macahia belong to the same family of plants, though one is a large tree and the other a small and modest herb. They seem to be very different, yet if you compare the flowers and the fruits and the leaves of these two plants you will see that in many ways they are much alike. At least they are near enough alike to be called cousins.

The fruit of the macahia and the fruit of the acacia are both pod fruits. A pod is a long, narrow fruit which has seeds in one or two rows and opens by splitting down the middle. The dap-dap and the Spanish flag are two other common plants which have pod-fruits. All plants which

have pod-fruits belong to the same great family. This family is a very successful one in the Philippines. The



MACAHIA, THE SENSITIVE PLANT.—The leaf marked "X" has been touched, so that now the leaflets are closely folded, one over the other.

most valuable timber-trees in the Islands belong to this family. It is called Leguminosae. Legume means pod.

The flowers of macahia are fresh and pretty every morning, but when afternoon comes they have faded in the hot sun. If you want to examine them you must be sure to go out in the morning. Macahia seems to have a round, pink flower, but when you pick it and look closely you will see that this round, pink part is composed of very many small flowers. If you gather macahia flowers before ten o'clock you will find a small white body at the end of each of the slender pink rays which come out from the flowers. These slender pink rays are the stamens and the white bodies at the ends are the anthers which contain the pollen. Now if you want to find the tiny corollas of macahia you will have to pull one of the clusters of flowers apart and look very closely. You learned from banana that a cluster of flowers growing close together as in macahia is called an inflorescence. The flowers of acacia also form an inflorescence.

If you carefully separate the small flowers which form the inflorescence of macahia you will find that the corolla of each tiny flower is not more than an eighth of an inch long. The petals are united. Four stamens and a long, slender pistil seem to come from each flower. The tiny flowers of macahia are crowded so closely together in the inflorescences that there is not room for a pod to be developed from the ovary of each one of them. Perhaps there are fifty flowers in one inflorescence, yet you rarely find more than eight or ten pods in a single cluster. If you watch a macahia inflorescence from the time it is very young until the ripe fruits are formed, you can see how some of the pods seem to get a start on the others and soon crowd them out. You can do this by very gently tying a piece of thread just behind a young macahia inflorescence so that you will be able to recognize it the next day. How many days do you suppose it takes for the pods to be formed from the inflorescences? You would be surprised to find how quickly this is done. Of course it is the



flowers whose stigmas are the first ones to be pollinated which are the ones to get the start in developing the pods. So all the little flowers of macahia are trying to get the pollen on their stigmas as soon as possible. The stigmas are very small, but since all the flowers are very close together some pollen is almost sure to be carried from one flower to another. What insects have you ever seen visiting the flowers of macahia? Do you think it is an insect-lover or a wind-lover?

The pods of macahia have many slender spines upon them. Can you think of any way in which these spines help to scatter the seeds?

## CHAPTER XIII.

### ABOUT RICE.

Wheat is the most important food-plant of the United States. Millions of dollars worth of wheat is grown in the United States each year and much of it is sold to people of other countries. Yet wheat is not so important to the people of the United States as rice to the Filipino people. There are many other common plants which are used for food in the United States, so that if the wheat crop should fail there would be many other things to eat. But when the rice crop fails in the Philippine Islands there is much suffering and hunger. There are many other plants which are good for food, but the farmers do not grow enough of them to supply food for all the people. Much corn or mais is grown in some parts of the Islands and used by the people for food instead of rice, but the corn crop is only large enough to supply the people who live where it grows.

Not many years ago when the rice crop failed many Filipinos starved to death. Many people had to live on the seeds of a kind of common grass which you call amor-seco. The seeds of amor-seco are very small and hard and not good for food, but they kept many people from starvation.

It is pleasant to think that such a thing could not happen in the Philippine Islands in these days. When the rice crop fails the government is ready to buy rice in other countries and sell it to the people for what it costs. The government did this in 1902, when there was a very small rice crop on account of the death of nearly all the carabao. The government also keeps large quantities of rice stored up so that it can be quickly distributed if there is danger of a famine. When there is not enough for people to eat, it is said that there is a famine.

There should never be a famine in the Philippine Islands, for no country in the world is better for the growing of food-plants. The Filipino people should not only grow enough rice for their own use, but they should grow enough besides to sell great quantities to the people of neighboring countries, just as the farmers of America sell much of their wheat to Europe and receive a great deal of money for it.

There is a far better way of preventing a rice-famine than by buying rice and storing it up, or by sending to other countries for it. This way is to learn carefully about the best methods of rice-cultivation and then to use them upon the rice-farms of the Philippines. When the Filipino farmers grow their rice in the best way, and have American machinery to help them in the cultivation, there will be very little danger of a famine unless all the carabao die.

There are many kinds of rice in the Philippine Islands. In the picture you may see two kinds which are common. Some of the kinds are much better for food than others, and it is important to be sure that the seed which is sown is the seed of one of the best kinds.

Rice belongs to the same family of plants as the common grass, and yet, as every Filipino boy knows, the grass is one of the worst enemies of rice. Whenever the water gets low on the rice paddies the grass begins to grow and crowd out the rice. If there is plenty of water on the



RICE IN FLOWER.—Two kinds which are common in the Philippine Islands.

paddy the grass cannot grow as well as the rice, for the rice is a water-lover, but much water kills the grass. Another enemy of rice is the common field mouse which eats it at the bottom whenever the field is too dry. So it is easy to see that the most important thing in growing rice is to have plenty of water.

Since it is important to have plenty of water standing on the rice while it grows, the best rice land is very flat. The more the land slopes, the quicker the water runs off, and it is necessary to have the pilapil very close together to hold the water. What you call pilapil in the Philippine Islands are called dykes or levees in America. In Louisiana and Texas much rice is grown on very flat land, so the dykes can be built far apart. When the dykes are far apart it is much easier to use machinery in cultivating and harvesting the crop. This is another reason why flat land is much better than sloping land for the growing of rice.

The flowers of the rice-plant are very small and grow close together. They form an inflorescence, as in macahia. But the flowers of rice are quite different from those of macahia. They do not have any bright colored petals. They do not attract the insects. But if you look carefully at the inflorescence of rice when the flowers are ripe you can find the stamens and the stigmas. The stamens produce a great deal of pollen. The stigmas are very large for such a small flower. From these things we may know that the pollen of rice is transferred by the wind, like the pollen of pandan. The rice is a wind-lover.

The leaves of rice are very different from the leaves of any other plant you have studied. They are long and narrow, like leaves of grass. If you hold a leaf of rice or a leaf of grass up to the light you may see many fine lines in the leaf which are not so green as the rest of the leaf. These are the veins. In the leaves of banana, rice, grass, pandan and many other common plants the veins of the

leaves are all in the same direction or nearly so. They are called parallel-veined leaves. Many plants have leaves whose veins run in many directions, like the strings in the nets of the fishermen. Such leaves are said to be netted-veined. Do you find more leaves which are parallel-veined or more which are netted-veined?

The leaves of rice and grass point nearly straight to the sky. They do not seem to be getting all the sunlight which they might get if their leaves had the position of the leaves of papaya. The sun shines directly upon the leaves of papaya. It shines obliquely upon the leaves of rice. So you see that rice, like pandan, seems to be afraid of getting too much heat and light.

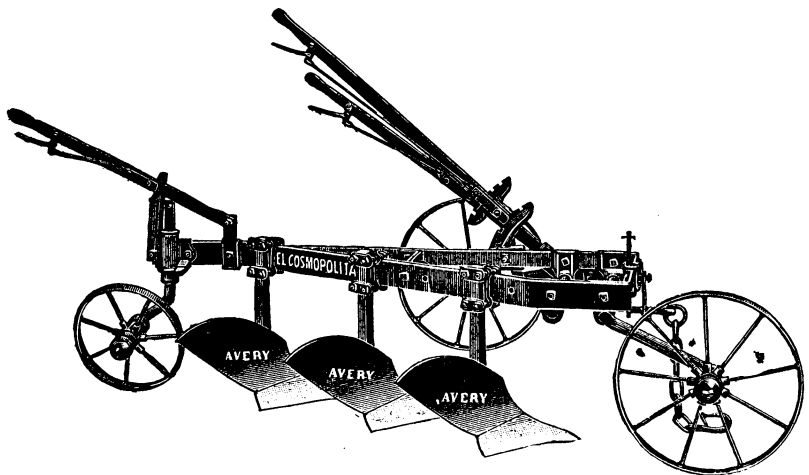
## CHAPTER XIV.

### RICE-CULTIVATION.

The cultivation of rice in the Philippines is very different from what it is in America. Texas and Louisiana are the two great rice producing states of the United States. In these states a man who works in the rice fields is paid about two hundred dollars in American money each year, besides his board. The Filipino workman does not get nearly so much money each year. Neither does he produce nearly so much rice as the American workman. This is chiefly because the American workman uses machinery which the Filipino does not have. One American workman with the aid of his machinery can take care of about eighty acres of land each year, and get from it about one hundred and sixty thousand pounds of unthreshed rice. The Filipino workman can take care of only about three acres of land from which he gets about fifteen hundred pounds of unthreshed rice. So you see that the owner of the land can well afford to pay his workmen nearly ten times as much as the Filipino workmen get, for, with the

help of machinery, they produce nearly a hundred times as much rice.

In the Islands we have lowland and upland rice. What native names do you give to these two kinds of rice? Probably every Filipino boy or girl knows that the best time to begin to cultivate lowland rice, which is the common kind, is in June or July. Before the rice is planted, the land must be very well plowed and harrowed. In America the plowing is done by gang-plows. These are plows which make three or four furrows at a time, and so do the work more rapidly than single plows. Mules pull these plows instead of carabao, and they go much faster. Six or eight mules are fastened to one gang-plow. In the Philippine Islands it is common to put the seed-rice into a part of the land called the punlaan late in the month of July. In August the young plants are carefully pulled up, their tops cut off, and they are placed in the fields where they are to grow and bear seed. This is called transplanting.

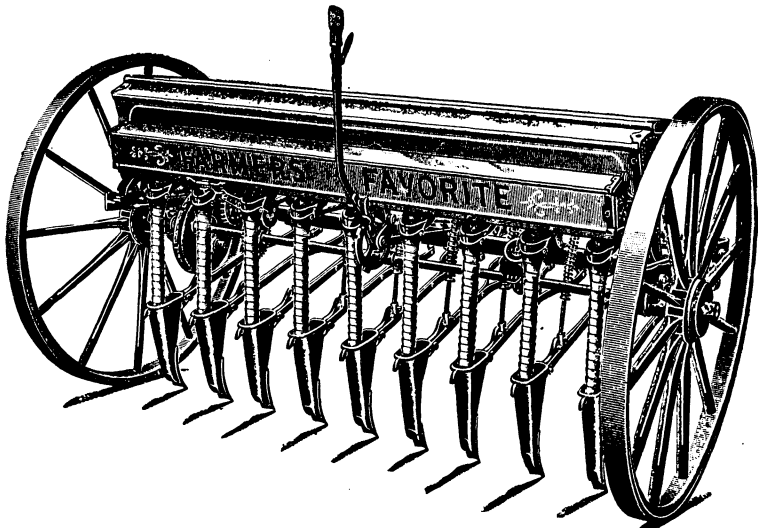


GANG-PLOW.

Now in America the rice is not transplanted. It is sowed from a machine called the seed-drill. The seed-drill plants the rice seeds in just the right amount and just

the right distance from each other, and does the work much more quickly than it could be done by hand.

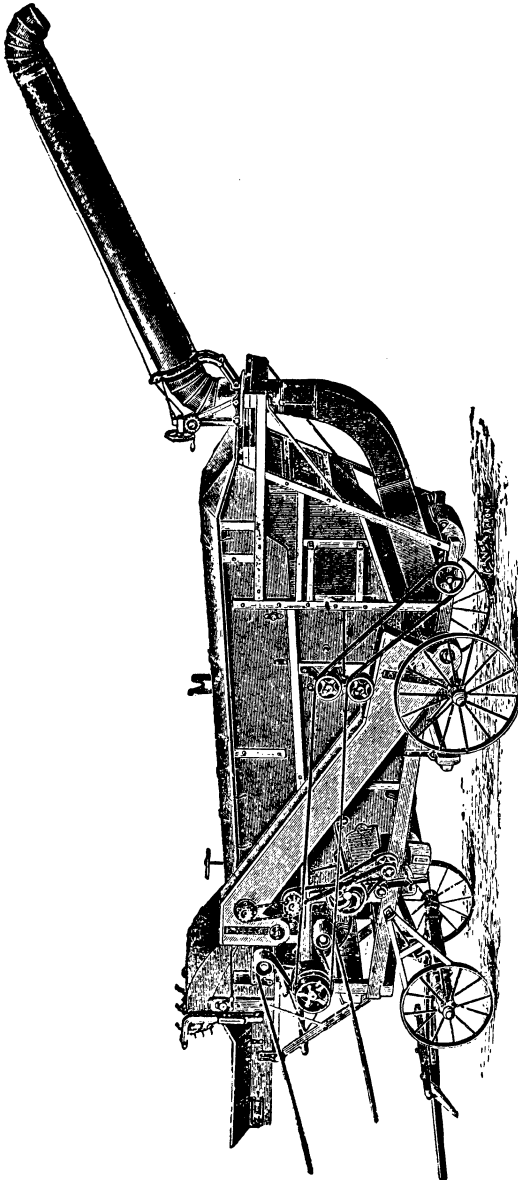
The largest and finest machines which are used in America in the cultivation of rice are the machines for harvesting and threshing. With the use of a machine which reaps and binds the rice at the same time, one man with the help of six mules can harvest from eight to twelve acres of rice in a day. It is very easy for you to see, however, that such a machine would not be a good thing to use upon rice land where the pilapil or dykes are close together. The use of such a machine is practicable only in very flat land where the pilapil are far apart. Since the pilapil are only about sixty feet apart in most of the rice-fields of the Philippines it would not be worth while to use such a harvesting-machine.



SEED-DRILL.

The threshing-machine can be used no matter how close together the pilapil are, for the unthreshed rice is all brought to the machine. A large machine can thresh fifty thousand pounds of rice in a day, so you see that one machine could do all the work for many farmers. In

America the owner of a threshing-machine takes it around from one farm to another and the farmer pays him for



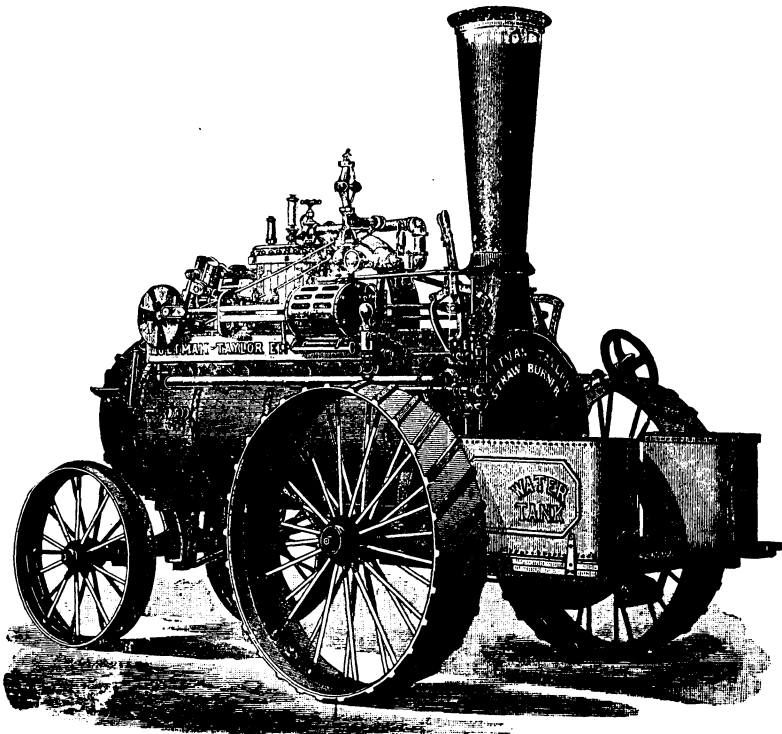
RICE THRESHING-MACHINE.

threshing his rice. Sometimes threshing-machines earn sixty or seventy dollars in American money in one day. Such a machine, and the engine which runs it, costs about twelve hundred dollars when it is new. They would be very useful in the Philippine Islands.

The engine which you see in the picture is not used only to run the threshing-machine. It is also used to pull the threshing-machine over the country roads from farm to farm, for the machine is very large and heavy. In the picture of the threshing-



machine you see on the right a long funnel. From the end of this funnel the rice straw escapes and is piled up in a stack. This straw can be used to make the fire which runs the engine. The place for "feeding" unthreshed rice into the machine is at the upper left-hand corner of the picture. The threshed rice comes out at the bottom, near one of the larger wheels. There is a very important part which is not all shown in the picture. You may see one end of it on the left-hand side of the picture. This part is the broad leather strap or belt which connects with the engine. The engine is placed about one hundred feet away from the threshing-machine so that there will be no danger that the sparks from it will set fire to the rice. The other end of the belt passes around a wheel on the engine, so



STEAM-ENGINE.

that, when the engine turns this wheel, the wheels of the threshing-machine are also turned. In the same way, when you ride a bicycle, the energy of your legs turns a small wheel, and the turning of that small wheel causes the hind wheel of the bicycle to turn at the same time, for these wheels are connected by a chain. The chain carries the energy of your legs to the hind wheel.

You have learned that it is the threshing-machine which does the work of threshing the rice. You have learned that it is the steam-engine which gives the energy for doing this work. The energy of a steam-engine comes from the heat of a fire which changes water into steam. You have learned that it is the belt which carries the energy of the steam-engine to the threshing-machine. You know that the unthreshed rice is the material upon which this work is to be done. You know that threshed rice is the finished product of this work.

Now if you understand this outline of the work of a threshing-machine, it will help you very much in understanding the next chapter, which is about the work of green leaves. The work of green leaves may be very well compared with the work of a threshing-machine.

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## CHAPTER XV.

### THE WORK OF GREEN LEAVES.

The work of green leaves is one of the most important kinds of work done in the world. It is more important than the work men do in building houses, or in making roads, or even in working on their farms. All these are kinds of work which make our life easier and more comfortable, but if the work of green leaves were to stop our lives themselves would stop. Without the work of green leaves all the work of the farmer would be in vain. He would never get a crop. The work of green leaves is not the making of food

for the plants alone. It is the work of making food for all the world. Could any work be more important than this?

This is a work which nothing else in the world can do except green leaves. Men have invented wonderful machinery which can do wonderful things. Men can build engines which travel more than one hundred miles an hour. Men can send messages around the world in a few minutes. They can send messages through the air for hundreds of miles without even a wire between the place from which the message is sent and the place where it is received. But nothing in all the wonderful inventions of men is able to do the work of a green leaf. The machinery which is at work in a green leaf when the sun is shining on it is more delicate and more wonderful than any of the inventions of men. It is the only machinery in the world which is able to receive things from the soil and things from the air and out of these things make food which is good food for plants and animals alike.

Can you understand how it is that all our food and all the food of animals comes from the work of green leaves? We eat the seeds of rice, but it is in the leaves of rice that the food which is stored up in the rice-seed was made. In the same way all the nourishment which is in fruits comes from the work of the leaves. If you cut off all the leaves of the mango-tree, do you think the mango-tree will bear fruit? We eat the flesh of cattle and of hogs, but do not cattle and hogs get their food from plants? We use fish for food, and perhaps you can not so easily understand how the food of fish comes from the work of plants, but it is true. The large fish eat small fish, and the small fish eat smaller fish, and the smallest fish of all get their food from the millions and millions of very small plants which live in the water. Many of these plants are too small for the eye to see. So, wherever you get your food, you may be sure that it has come in the first place from the work of plants; work like that which goes on in the green leaves all around us.

It is very fortunate for men that the leaves make more than enough food for the plants alone. If the plants died when we take food from them, there would very soon be none left, but the green leaves produce enough food to keep the plants alive, and all the world of animals besides. We may say, then, that men and animals live on the surplus of food produced by green leaves.

You have already learned that the materials out of which the green leaves make food for the plant come from the soil and the air. In studying about papaya you learned that the little root is the first part of the young papaya to begin work, and that its work is to find in the soil the things out of which the leaves can make food, and have them all ready for the leaf when it has unfolded in the sunlight. The material which the roots get from the soil is like the unthreshed rice which is fed to the threshing-machine. The material from the soil passes along the stems and is fed to the machinery of the leaves.

We must next understand where the energy comes from to run the delicate machinery of the leaf and make food out of the materials of the soil and the air. Have you ever noticed that green leaves can not live without sunlight? If you put a board upon the grass and lift it up after a few days you may see that all the grass has turned yellow. It has lost its green color and has begun to die. We may be sure from this that the green color of leaves has something very important to do with the light. When a plant is growing inside of a house its leaves turn toward the window. They seem to be trying to reach the light. Now if you should take a piece of black paper and fasten it very gently to the surface of a large, green leaf, so that it would not injure the leaf, you could prove that without the light no food is made in the leaf. Light can not pass through the black paper. If the plant is in the sunlight all day long there will be a good deal of food made in the leaves, but you will find that under the part which was covered by

the black paper no food has been made at all. When you study botany you will learn how we may examine leaves to see what parts contain food and what parts do not, but even now you can understand how we may prove that without light no food is made in the leaves. Also, you understand that the first thing which happens to green leaves when they are in the dark is that the green color all disappears. So you know that the green color of plants can not do its work without sunlight. When the light does not shine upon it, it soon disappears. This green substance in plants is called chlorophyll, a word which means leaf-green. The chlorophyll has a very important part to do in the work of making plant food.

You have learned that food is made only while the light is shining on the leaves. It is the light of the sun which gives the energy for doing this work. The sunlight is like the steam-engine which gives the energy for running the threshing-machine. It is the chlorophyll or green substance in leaves which catches the light of the sun and carries the energy of sunlight to the delicate machinery of the leaf. It is like the belt which carries the energy of the steam-engine to the threshing-machine. The chlorophyll does not do the work itself, but without the chlorophyll and without the sunlight the delicate living machinery of the leaf would be quite unable to do the work of making food. Just so the threshing-machine would be quite unable to do the work of threshing rice without the belt and the steam-engine. Just so a bicycle can not run without the energy of your legs and a chain to carry that energy to the hind-wheel.

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## CHAPTER XVI.

### THE LANTANA.

The lantana is a shrub which is common in the Philippine Islands and in many other parts of the world. It is a very successful plant, spreading rapidly wherever

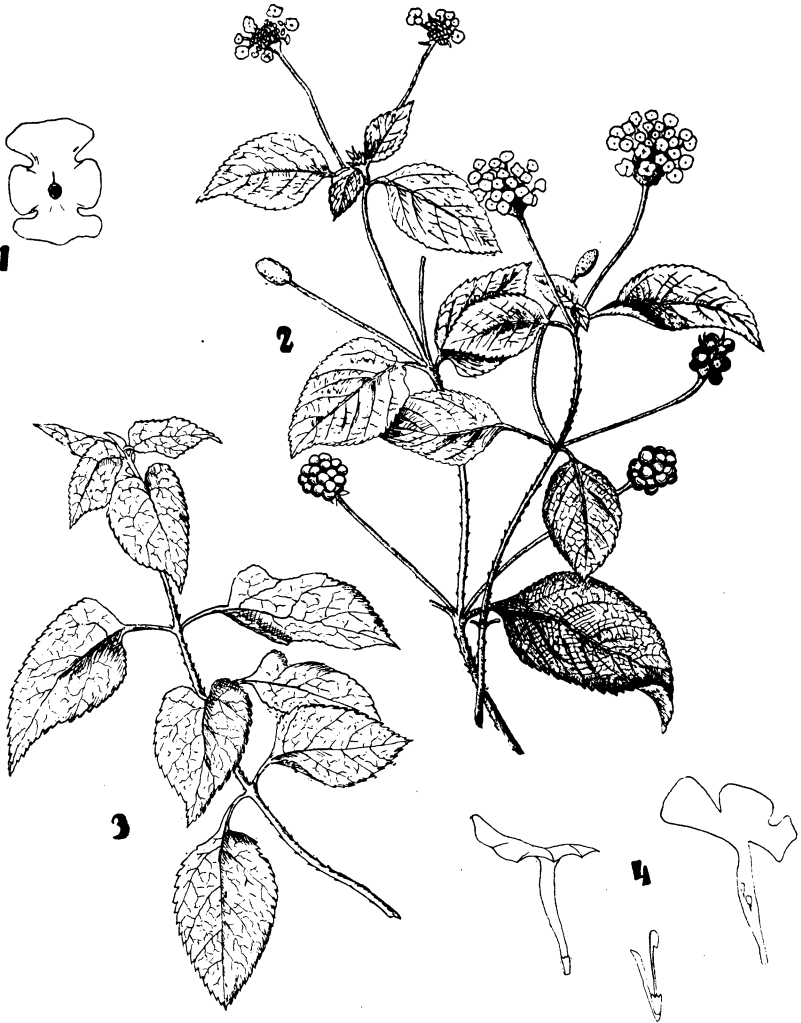
it begins to grow unless it is carefully cut out. It is not a plant which has any plant products which are valuable to man, and in some parts of the world it is one of the worst enemies of the farmer. In the Hawaiian Islands the farmers would give many thousands of dollars if there were no lantana growing on their farms, for it crowds out and kills many valuable plants. In the Philippine Islands the lantana is not so common as it is in the Hawaiian Islands, yet there is danger that it may become so common that it will cause much loss to the farmers. The lantana is a plant which is very good to kill. Its seeds are scattered everywhere by the birds, so that it spreads rapidly from place to place.

Although the lantana is a very troublesome plant for the farmer, it is a very convenient plant to use in learning about the structure of flowers and the way in which seeds are scattered. In the picture you can see the little, round fruits of lantana which grow in a close cluster, and when they are quite ripe they become black and juicy. Many kinds of birds are very fond of eating the little fruits or berries of lantana. In the center of each little fruit is one hard seed, and when the bird eats the fruit it also swallows the seed. It does not injure the seed of lantana to be eaten by birds. The birds fly away and after awhile the seed is passed from their bodies, and, if it falls in a good place, it soon begins to grow into a young lantana plant.

You may always tell a lantana plant by its pink and orange colored flowers which grow close together in a group or inflorescence. The leaves are stiff and hairy. If you look on their under side you can see the veins very plainly. They are very delicate and beautiful. Is it a netted-veined leaf like the leaf of papaya or a parallel-veined leaf like the leaf of rice or of banana?

The leaves are arranged upon the stem in a very regular way. They are in pairs, each leaf with another leaf just across from it on the other side of the stem.

When leaves are arranged like this they are said to be opposite. Do you know any other plants whose leaves are opposite?



LANTANA.—(1) Front view of flower, showing irregular shape of corolla.—(2) The plant. Notice that the outer flowers of the inflorescence open before the inner ones.—(3) Notice that the leaves are arranged so as to shade each other as little as possible. Each pair is at right angles to the pair above and the pair below.—(4) Shows the parts of a single flower and their arrangement.

Many people think that the lantana has an unpleasant odor, but it is not a strong odor and should not keep you from looking at it very carefully. Many people call it the cemetery plant, because it is nearly always to be found in cemeteries.

You have already learned that the lantana uses the birds to scatter its seeds. If you watch a lantana for a little while on a sunny day you are almost certain to see many small, yellow butterflies flying from one flower to another. The lantana uses these butterflies to carry its pollen from one flower to another. Just as we called the pandan a wind-lover, we may call the lantana a butterfly-lover.

Now let us look carefully at the flowers of lantana and see whether we can learn how the butterfly gets the pollen. We find that the little pink petals of each lantana flower are united together to form a tube. There are four of these petals and they are not all the same size. Two are larger than the other two. If we open one of the tubes of the little flower we may see that the stamens are fastened to the inside and that they are about half way between the bottom and the top. How do you suppose the butterfly reaches them? Certainly he can not enter the tube, for at the top it is hardly large enough to let an ant enter. To answer this question we must first catch a butterfly. You can do this easily with your hat. Then, if you hold the butterfly very carefully and look on the under side of its head, you will find in the place where the mouth ought to be something which is rolled up tightly. This is the very peculiar tongue of the butterfly. When it is unrolled it is almost as long as the butterfly's body. With the point of a pin you can carefully unroll the tongue of the butterfly and you will find that it is almost exactly as long as the corolla tube of the lantana flower. Now you see how the butterfly reaches the pollen.

But is it for the pollen alone that the butterfly visits the lantana? Why should the butterflies spend their time



in carrying pollen from one flower to another if they get nothing for it? If they eat the pollen then they are the enemies of the flowers and not their helpers. If the butterflies go to the lantana flowers only to get pollen, then why should their tongues be long enough to reach to the bottom of the tube when the pollen is only half way down?

There is one answer for both these questions. The butterflies do not carry pollen from one lantana flower to another for nothing. They are the servants of the lantana and do this work for them, but they get well paid for it. The flowers pay them by giving them plenty of nectar. The nectar is at the bottom of the corolla tubes, so that the tongue of the butterfly must be as long as the tube or it could not reach it. While the tongue is reaching for the nectar it must always rub against the stamens and the top of the little pistil which is just beneath the stamens. So, while the butterfly is getting its food, it is certain to carry the pollen of one flower to the pistil of another and this is just what the flowers want.

If you pull off the corolla tube of lantana and hold it upside down, when you squeeze it you will see a little drop come out of the lower end of the tube, unless the butterfly has already visited the flower and taken this sweet drop away. This drop is the nectar.

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## CHAPTER XVII.

### PANDACAQUI.

The pandacaqui is another shrub. It is sometimes just about the size of lantana, but usually it is larger. Its stems are more woody than the stems of lantana.

Pandacaqui is common in nearly all parts of the Islands. After you have once learned to know it, you can always tell it by the bright white flowers. The petals are united into a tube just like the petals of lantana, but there are five of them instead of four, and they are much

larger. The flowers do not grow quite so close together as the flowers of lantana, and the petals are all the same size. Only two or three of the flowers in an inflorescence of pandacaqui are in bloom at the same time.

This plant has one thing which is quite different from any plant you have yet studied. If you break the young stem a white juice, like milk, comes from the broken end. This white juice is very sticky and after a little while it becomes hard. There are some trees which grow in the Philippine forests which have a milky juice like pandacaqui. Rubber and gutta-percha are made from a milky juice which looks much like the juice of pandacaqui when it first runs out of the trees. The natives cut the stems of these trees with their bolos, and after the juice has run out and become hard it may be taken away and sold for a good price. Have you ever seen any trees whose stems are cut with bolos in this way? Why do men cut the stems of mango trees with their bolos?

Do you find that the leaves of pandacaqui are much like the leaves of lantana? Are they arranged in the same way on the stem? Are the veins parallel or like a net?

There are many animals which use the leaves of plants for food. How many kinds of animals have you ever seen eating the leaves of plants? Of course the animals which eat the leaves of plants are enemies and the plants must try to protect themselves as well as they can. The grass protects itself from being all destroyed by the horses and the cattle by being able to grow up again very rapidly after the leaves have been eaten. It does not kill the grass to have its leaves eaten down. Very soon new ones are put up from the roots.

There are other plants, like lantana and pandacaqui, which must protect themselves in other ways from the leaf-eating animals, for if their leaves were all destroyed they would soon die. How do you think the leaves of these plants are protected?

Some of the very worst of leaf-eating animals are different kinds of insects. In tropical America the ants



PANDACAQUI.—(1) The fruit. Two fruit-parts come from one flower.—(2) The flowers. Only a few of the flowers develop into fruit.—(3) The leaves. These are opposite leaves, arranged to catch as much sunlight as possible.—(4) A flower cut open. The stamens are near the top of the corolla tube.—(5) Front view of flower, showing its twisted shape and the rim at the top of the tube.

often eat all the leaves off a large tree in one day. Now the leaves of lantana are well protected both from leaf-eating

insects and larger leaf-eating animals like horses. After you have once rubbed your hands on them you can understand why horses and cattle and even insects do not care about them for food. They are hard and tough, and are covered with stiff, little hairs. This is one of the reasons why lantana is such a successful plant. The leaves of pandacaqui are not so well protected as the leaves of lantana, and perhaps this is a reason why it does not spread so rapidly. The leaves of pandacaqui are smooth and rather soft, but they are protected by the milky juice which is in them. The milky juice gives them a very bad taste. Many other kinds of plants are protected from the leaf-eating animals by having in them juices which either taste very badly or else are poisonous. Animals are able to tell which plants are poisonous and which are not much better than men can.

The pandacaqui has a very peculiar flower and a very peculiar fruit. The petals of the flower always look as though they had been twisted. They are all the same size, but they are not straight like the petals of other flowers. If you cut through the bud or very young flower of pandacaqui you may see how the petals are closely twisted together before the flower opens.

The opening of the corolla tube of pandacaqui is even smaller than that of lantana, and around the edge of it you may see a hard little rim, like the curb around the top of a well. The stamens of pandacaqui have sharp points, and you will find them about one-third of the way down the tube. Have you ever seen butterflies visiting the flowers of pandacaqui? When you cut open the twisted tube of the flower you will find that the stigma is very close to the pollen-sacs or anthers. From this we may think that pandacaqui does not have cross-pollination like lantana, but that the pollen falls on the stigma of the same flower.

The fruit of pandacaqui is even more peculiar than the flower. If you pull to pieces one of the flowers you will find

at the bottom the little green ovary which is to become the fruit. It seems to have just one part, but, after the work of the flower is done and it has fallen off, this ovary begins to separate into two distinct parts which bend away from each other. You can see this plainly in the pictures. Each of these parts has the shape of a crescent, like the moon when it is young. They bend further and further apart as they grow larger, so that when the fruit is ripe there seem to be two very distinct fruits, which have come from one ovary.

When the fruit of pandacaqui is ripe it changes its color from green to red. Can you think why it does this? How do you think the seeds of pandacaqui are scattered? When the fruit bursts open the seeds are very easily seen for they have a different color from the rest of the fruit. Do you know what this color is?

You should understand very well why it is necessary for seeds to be scattered. All the successful plants have very good ways of scattering their seeds. No matter how many good seeds a plant might produce, they would do very little good if they all fell to the ground beneath the plant which produced them. There would not be room for more than a very few of them to grow up into good plants.

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## CHAPTER XVIII.

### ILANG-ILANG.

Of all the flowers in the Islands the ilang-ilang has the sweetest odor. There is no flower which gives greater pleasure to the Filipino people than ilang-ilang. It gives profit as well as pleasure, for from the extract or essence of the flowers valuable perfumes are made. This essence of ilang-ilang is one of the most valuable plant products in the world. From about seventy-five pounds of flowers one pound of the best ilang-ilang essence is obtained, and this first quality of essence is worth about forty dollars, gold.

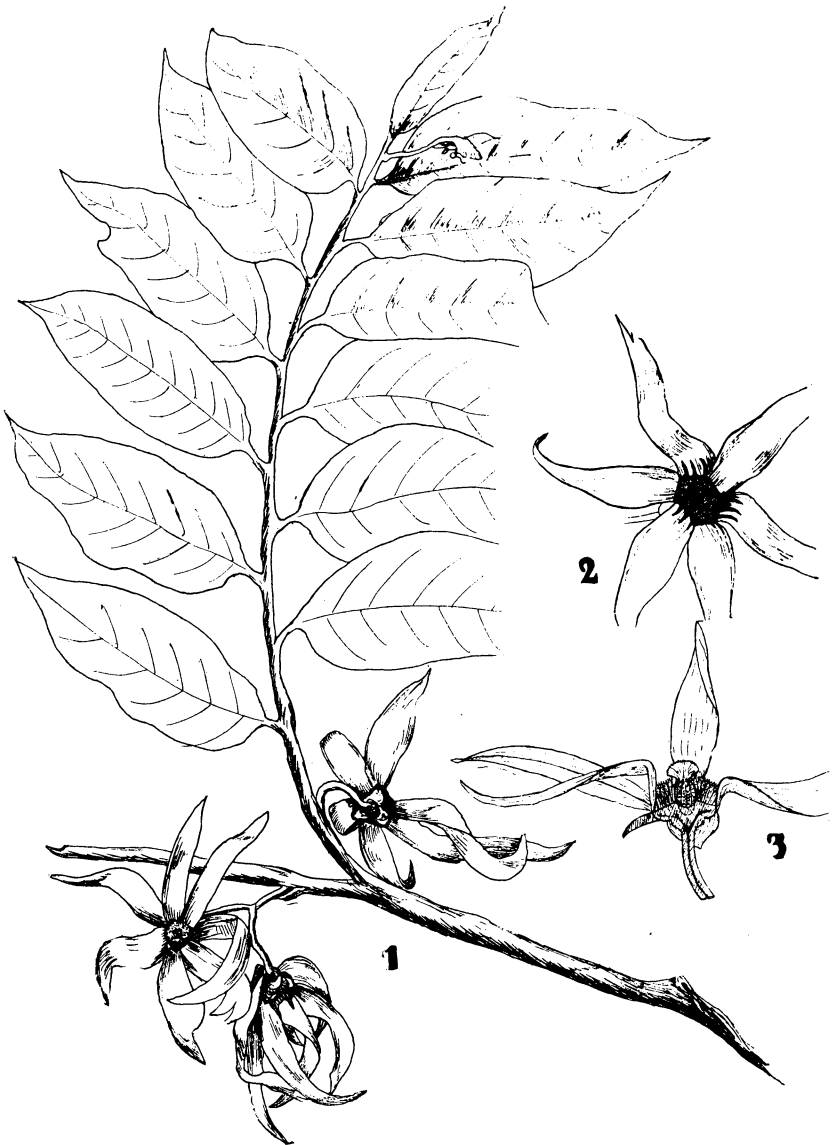
The ilang-ilang is a good sized tree with rather large, smooth leaves. It is often grown as a shade tree for cacao plants. A farm which has good cacao trees and good ilang-ilang trees growing together should be very profitable.

You will find that the flowers of ilang-ilang have a structure which is very different from any flowers you have yet studied. Yet, like all other flowers in the world, the purpose of the ilang-ilang flower is to produce good fruit and seeds. It is like a different invention to do the same kind of work.

The outermost part of the flower is called the calyx. You can see it best when you turn the flower upside-down. Then you can see three, short, thick leaves which are triangular in shape. These leaves form the calyx. The calyx is for the purpose of protecting the very young flower, or bud.

Perhaps the most interesting as well as the most valuable part of the flower is the corolla. It is from the corolla that the valuable essence of ilang-ilang is made. The corolla consists of six long and narrow petals which have a greenish-yellow color. It is quite peculiar that the bud opens while these petals are quite short. They gradually increase in length until they have about the shape of a wide strap. You may see quite plainly that the petals are arranged in two different sets or whorls, three in each. One whorl is outside the other. A whorl is a set of parts of a plant, either leaves or flower-parts, which is arranged in a ring around the stem. Many plants have their leaves arranged in whorls. In the common kind of ilang-ilang the three petals of the inner whorl are marked by red stripes at the bottom. Can you find these stripes? They seem to be for the purpose of guiding the visiting insect to the place where the nectar may be found, and where he will be sure to get some of the pollen on his body. They are called nectar-guides.

Do you think that if you had plenty of ilang-ilang flowers you would know how to get the valuable essence



ILANG-ILANG.—(1) Part of a flower-bearing branch. The leaves are alternate.—  
 (2) Flower showing nectar-guides. Many stamens and carpels in the center.—(3) Flower  
 cut open.

out of the petals? Perhaps you have seen how this is done, although you may not understand it. You know that when water is very hot it begins to boil, and presently it passes into the air as steam. You know that if you hold something cold, like the blade of a knife, in the little cloud of steam presently you will see drops of water forming on it. The cool surface of the knife changes the steam, which is a kind of gas, back into a liquid again. This process of changing a liquid into a gas and then changing it back to a liquid again is called distillation. The water which collects on your knife blade when you hold it in a cloud of steam is distilled water.

The valuable essence of ilang-ilang is obtained by this same process of distillation. The essence is in the petals in liquid form, but if you tried to get it out by crushing the flowers you would get it mixed with other liquids which spoil its value. But when you heat the flowers the most fragrant essence is the first to be changed into a gas. Different kinds of liquids are changed to gas by different amounts of heat. Since the best essence of ilang-ilang is changed to gas by less heat than the other kinds of liquids in the flower this is a way by which we may separate it from them. So when a man is trying to get the best essence of ilang-ilang he must be careful to collect the first gas which comes from heating the flowers, and keep it separate from the rest. When this gas touches a cold surface it changes to drops of liquid, and these first drops are the best distilled essence of ilang-ilang.

Now the parts of the ilang-ilang flowers which are most different from the flower-parts you have already studied are not the most valuable parts to man, but they are the most important parts to the flower. They are the parts which are necessary for the making of the fruit and seeds, and you already know that the sweet fragrance of the flower is only to help them do their work. These necessary parts are in the very center of the flower. When



you first look at them you see nothing which looks like stamens, and nothing which looks like a pistil. Yet you know that if the flower makes good fruit and seed these parts must be there.

The part of the flower inside of the corolla has the shape of a triangle. In the center of this triangle there is a round, green part, like a small button. Do you find that part? If you take a sharp knife and cut through the very center of a mature flower, right through the little green button, you will have a view of the flower which will help you to understand its parts. In the picture of this view of the flower you may see that the parts to right and left of the center contain very small grains, which are just dots in the picture. You can see them better, perhaps, if you cut open a real flower. These dots are the grains of pollen. The stamens which contain them are very different from any stamens you have yet studied. The flower of ilang-ilang contains more than a hundred stamens.

In the very center of the flower you find other small round bodies, a little larger than the grains of pollen. These are the ovules or very young seeds. The ovules are not contained in a single part, as in all the other flowers you have studied, but there seem to be about fifteen very small parts, each one of which contains a number of ovules. These small parts unite at the top to form the green button you have already seen. Each of these parts is called a "carpel". In all the flowers which you have already studied the carpels have been united into one part, which we have called the pistil, but there are a few flowers, like ilang-ilang, in which the carpels are separate. Just as we say that the corolla is composed of petals, and the calyx composed of sepals, we may say that the pistil is composed of carpels, although these carpels are usually so closely united that they seem to form a single part, as in the lantana and pandacaqui which you have just studied.

## CHAPTER XIX.

## CACAO.

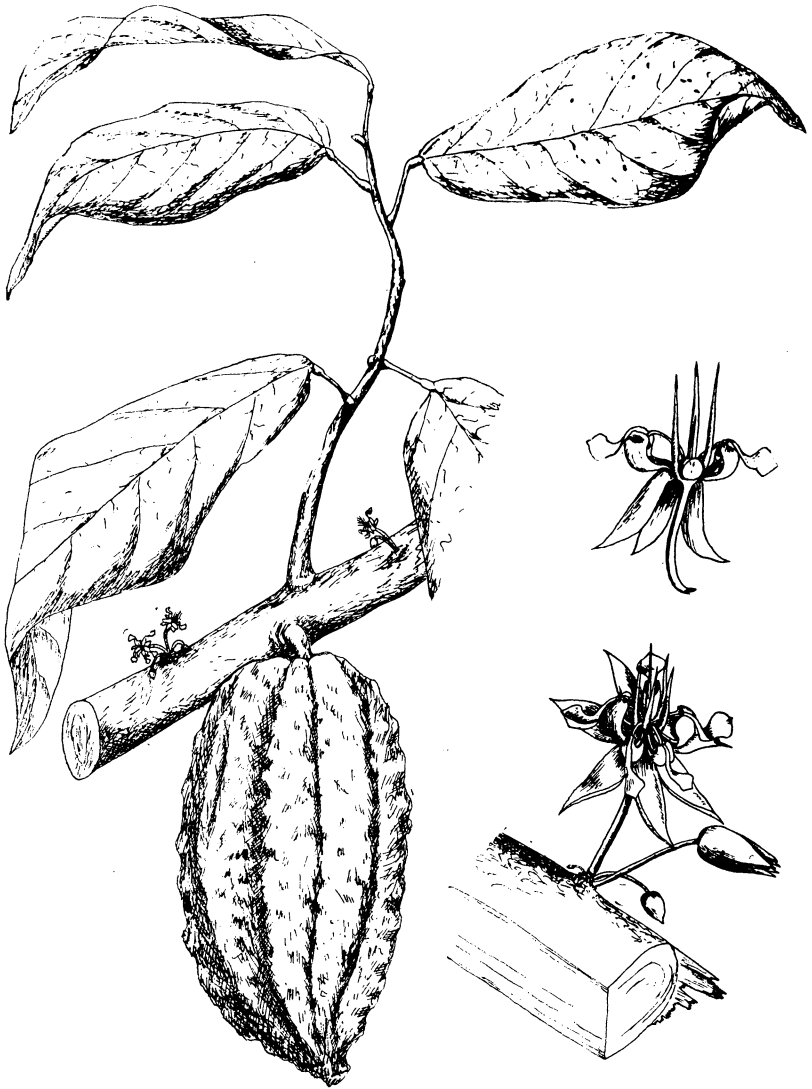
Have you ever known a boy or girl who does not like chocolate? If Filipino boys and girls do not like it they are very different from the young people of America. Chocolate candy and chocolate ice-cream are two of the things most precious to the appetites of American children. A boy or girl who does not like them would be as hard to find in America as a cacao-tree itself.

No doubt you know that chocolate comes from the cacao-tree and that this tree grows in the Philippine Islands. Perhaps you do not know that it never grows in the countries of temperate regions. This is one of the reasons why chocolate is so valuable. It is used all over the world, yet it can be produced in only a small part of the world.

Cacao is one of the most important economic plants of the Islands. Economic plants are those whose products have a money-value. The value of the product of one good cacao plant is sometimes as much as four or five dollars in Philippine money in one year. This is one of the plants which should be cultivated much more than it is today. Its cultivation is not difficult, and some of the best places in the world for growing it are to be found in the Philippines.

The cacao is a small tree with rather large leaves. Its leaves and stems are much like the leaves and stems of other trees, but its flowers and fruit are very different. The tree carries them in a peculiar manner. The flowers of most trees are borne upon special stems which come from the ends of the branches, but the flowers of cacao are not to be found at the ends of the branches. You will find them upon the rough coat or bark of the branches, and even upon the main stem or trunk of the tree. It seems quite strange to find the delicate pink and white flowers of cacao fastened directly to the rough bark. This is an arrangement of the flowers

which is never seen upon the trees of temperate regions, although it is not uncommon in the tropics. Do you know any other trees which bear their flowers and fruit on the bark?



CACAO.—Notice that the fruit is very many times larger than the flowers. In the smaller pictures the peculiar structure of the flowers may be seen. These pictures are enlarged.

It would not be difficult for you to understand why flowers sometimes grow from the bark of tropical trees, but never from the bark of the trees of temperate regions, if you could see the bark of these two kinds of trees side by side. The bark of trees which grow in tropical countries is usually quite soft and smooth, while the bark of trees which grow where winter comes is nearly always thick and heavy. Can you see the reason for this? Now when flowers are borne on the bark, it is necessary for the delicate little branch which carries them to first push its way through the bark. It can not do this when the bark is thick and tough.

If the cacao-tree grows near your home you should certainly get some of the flowers and fruit and examine them carefully. No flowers are more graceful and pretty than the little flowers of cacao. On the right hand side of the picture the flower is drawn, enlarged to about three times its natural size. The five straight and pointed parts at the bottom are the sepals. The form of the petals you can see best in the picture of half of the flower. On the left hand side of the picture you may see very plainly the shape of one of these gracefully curved parts. Now can you see that there is something which bends over from near the centre of the flower and seems to be fastened to the middle of the curved petal? That is one of the stamens. Each of the petals has a rounded, hood-like part in the centre, and each of them seems to be holding down the head of one of the stamens. The five stamens which stand up so straight, and are pointed, seem to be more for decoration than for use, for these stamens carry no pollen. You can plainly see that there are no pollen-sacs or anthers at the ends of them. But each of the five curved stamens, which seem to hide their heads in the petal-hoods, carries good pollen.

Cacao loves plenty of heat, a good deal of shade and water, a deep soil, and as little wind as possible. It should not be grown very near the sea. Some of the valleys of the Islands, sheltered from the winds of the coasts, and with

a good deal of moisture the year round, are ideal places for cacao. It is better to grow it on flat land than on the slopes. The best places seem to be in Mindanao and the Visayas, yet there are many excellent places in the sheltered valleys of Luzon. Many good cacao trees are in Pasay, near Manila.

The cacao may be planted close together, for it does not need much light, and it loves to "swelter in its own heat," like people in a crowd. You can always tell when the fruit is ripe by the pleasant odor of chocolate which comes from it then. There are two or three kinds of cacao in the Philippine Islands and the ripe fruit is either red or yellow.

The many seeds are arranged inside the fruit in very regular rows. It is from the seeds that chocolate is extracted. The fruit must be gathered by cutting it, not by twisting or pulling, for the cacao is a very tender tree. It is almost certain to be injured by the wounds made from pulling off the fruit, since, if the bark is torn, this gives a good place for the entrance of the insects which attack the wood.

After the fruit is picked, it needs to be piled in heaps in a closed room, or put in bags, and left for a few days. This is the process of "sweating." After the sweating, it is much easier to separate the seeds from the fruit. The seeds now have a rich brown color, and need to be carefully dried in the sun. After that is done, they are ready to be ground up and have the valuable extract taken from them. Most cacao-farmers sell the cacao-seeds without grinding them.

Monkeys, rats, and parrots, as well as insects, are enemies of the cacao and the cacao-farmers.

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## CHAPTER XX.

### THE AURORA; A VINE.

The aurora or morning-glory is one of the commonest and most beautiful of Philippine flowers. It is well called the "glory of morning," for in the morning you may see its

hundreds of delicate purple, or blue, or pink corollas, but in the afternoon they have wilted, and their glory is gone.

Aurora is the first plant you have studied which has the habit of climbing upon other plants or upon the sides of houses. Such plants are called vines. The stems of vines are not strong enough to stand alone. They must have some other support to help them get their leaves up into the life-giving sunlight.

The difference between erect plants and vines may be compared to the difference between wind-loving and insect-loving flowers; each has some advantage over the other. You can see that vines have an advantage over erect plants because they do not have to spend a great deal of their strength in making stiff and woody stems. They make other plants do for them the work of holding their leaves up in the light. Have you not seen mango-trees almost covered by an aurora vine? On the other hand, if the aurora can not find anything to climb on, then it is not so well off as if it had a stiff, strong stem of its own, no matter how hard work it may have been to make that stem. In that way the erect plants certainly have an advantage over the vines. They are more independent.

Some vines climb by twisting their stems about the supporting branches of other plants, while others have special little holders which are called "tendrils." The aurora climbs by its twisting stem, but you can probably find near your house a vine with tendrils. Tendrils come out of the stems like leaves, and in truth they are leaves which have been very much changed in shape so that they can do this special kind of work. Tendrils have a wonderful power of feeling and holding. They are long and slender, almost like a piece of green string, and, as soon as their delicate tips touch something which seems to be good for giving support, they begin to wind about it. Sometimes you find tendrils twisted round and round into a perfect spiral. It takes them only a few hours to get a firm hold.



THE AURORA

Perhaps the commonest kind of aurora in the Islands is the one with purple flowers, though that is not the kind which is drawn in the large picture. The one with purple flowers has leaves which are divided into five parts, somewhat as the hand is divided into five fingers. The leaves of aurora always have long "petioles." The stem part of a leaf is called a petiole, and leaves which do not have petioles are called sessile. Do you remember any plant you have studied which has sessile leaves?

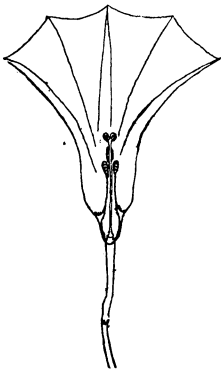
Long petioles are very useful to aurora, or to any other kind of vine. If you look at aurora closely you may soon understand the need it has for them. The young leaves always have a regular place for coming out from the stem. You remember that in pandacaqui and in lantana the leaves are in pairs, and each pair is arranged at right angles to the one above and the one below it so that they do not shade each other. This is a very good arrangement for erect plants, but it would not do at all for vines. Vines must always have one side against their support, and so away from the light, yet the leaves must all be on the light side if they are to do their work. Now you will see when you look carefully at aurora that the leaves are fastened first to one side of the stem and then to the other, although the broad, flat part of the leaf, which is called the blade, always seems to be on the sunny side. It is the work of the petioles to carry the leaves which are fastened to the shaded side around to the sun-lit side. You can easily see that, if the leaves of aurora were sessile, those on the shaded side would have a very bad time of it. You may often find petioles of aurora which have twisted clear around the stem in trying to keep their leaves in the light. The stem of aurora keeps twisting as it grows and that makes the work of the long petioles all the more necessary.

You may often find on the aurora two small leaves just at the place where the petiole joins the stem. These small leaves are called "stipules." The stipules have just the



same shape as the large leaves. Although they are so small, they seem to be for the purpose of catching and using any light which shines past the larger leaves.

The flowers of aurora are borne on slender branches which arise one from each leaf-axil. The axil of a leaf is the place where the leaf or its petiole joins the main stem. The flower-bearing branch is called the "pedicel." The pedicels are just about the same length as the petioles, for the flowers, as well as the blades of the leaves, must be in the sunlight. You will notice that there is one flower for each leaf, but that the leaves last much longer than the flowers. Do you know how many days a flower of aurora lasts? The blossom of today is always a certain distance from the end of the stem, while the faded flower of yesterday or the day before is to be found in the axil of the leaf just behind it, and the bud of tomorrow's flower is in the axil just ahead.



THE FLOWER OF AURORA  
CUT OPEN.

The picture of the flower cut open shows very plainly the arrangement of its parts. The pretty corolla has the shape of a bell and is composed of five united petals. You can tell this from the five pointed parts, like a star, which form the thicker part of the corolla. The stamens are not all the same length and grow very close to the pistil. The stigma has two parts. Do you know whether the aurora produces good fruit or whether it produces its young in some other way?

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