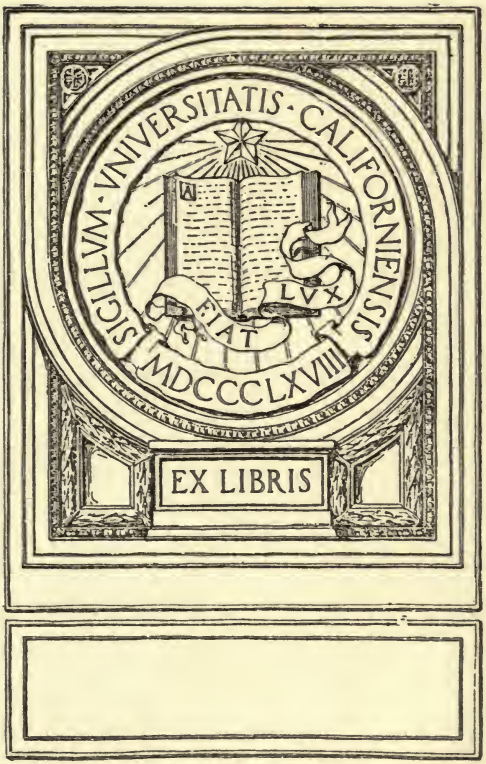
PRODUCTS OF THE EMPIRE

BY

J. C. CUNNINGHAM

OXFORD
AT THE CLARENDON PRESS


SIGILLVM · VNIVERSITATIS · CALIFORNIENSIS
FIAT LVX
MDCCCLXVIII
EX LIBRIS

PRODUCTS OF THE EMPIRE

BY

J. CLINTON CUNNINGHAM, B.A.

OXFORD
AT THE CLARENDON PRESS
1921

OXFORD UNIVERSITY PRESS
LONDON EDINBURGH GLASGOW NEW YORK
TORONTO MELBOURNE CAPE TOWN BOMBAY
HUMPHREY MILFORD
PUBLISHER TO THE UNIVERSITY

PREFACE

The best way to study plants is to grow them for ourselves. Even when our attempt is a failure, and they fog off and die, that chastening experience at least teaches us that the 'environment' we provided was not suited to our poor victims, while the joy of success can be realized only by those who have tasted it. Many 'economic' plants, of course, require great heat, and can be grown in this country only under glass, but many others do quite well in the border of an ordinary school garden. Dr. Jamieson B. Hurry, of Reading, has both kinds growing in his 'educational' garden at Westfield, and I should like to offer him my warmest thanks for the pleasant hours I have spent there, while my friend, Miss Buchanan, made sketches of some of the most interesting specimens in the 'economic' border. Mrs. Grieve, too, of Chalfont St. Peter, kindly allowed me to visit her Herb Farm, and gave me much useful information. She has published a large number of pamphlets, each dealing with one particular plant.

The chapter on 'Fisheries' is based on the information contained in 'Marketable Marine Fishes' by my brother, Mr. J. T. Cunningham, M.A., and on an article by Professor Stanley Gardiner, of Cambridge, on the 'Geography of British Fisheries', published in the June number of the *Geographical Journal*, 1915. I wish also to offer my thanks to Professor Gardiner for reading

through the chapter, and giving valuable criticism and advice.

To Mr. Dean, late of the Delta Works, Greenwich, my thanks are due for reading the chapter on 'Metals', and to many other persons for permission to reproduce drawings and photographs.

A list of the chief authorities and books of reference will be found at the end of Part II.

The numerous statistics which occur have been inserted, not so much as being valuable in themselves, but in order to support general statements and to give point to such phrases as 'much' and 'little', 'great' and 'small'.

J. CLINTON CUNNINGHAM.

GREENWICH.
March 1920.

CONTENTS

PART I

FOOD, DRINK, OIL-SEEDS, DRUGS, AND TOBACCO

PART II

RAW MATERIALS AND THE PRODUCE OF MINES

LIST OF ILLUSTRATIONS

PART I

PART II

PART I

FOOD, DRINK, OIL-SEEDS, DRUGS, AND TOBACCO

CHAPTER I

THE ASSETS OF A NATION

THE word 'assets' originally meant 'sufficient for' (*ad satis*), and was used by lawyers to signify the property of a person, sufficient for paying his debts, or meeting the claims made upon him. Later on the word was used to mean the entire property of a man, his wealth, or what he was worth, taking into account everything of every kind that could be said to belong to him. In the same way, the 'assets' of a nation is the whole wealth of the nation derived from every possible source.

Until recently we were content to go on from year to year without taking the trouble to ascertain what our resources were, content if only we could supply our needs cheaply at the moment.

When we reflect that the empire stretches from Pole to Pole, and contains within it every variety of soil and climate, so that there is scarcely a commodity which it cannot produce, when, moreover, we remember that the area of the empire is 14,272,782 square miles, and that the population numbers in all some 445 million souls, we must realize that to estimate our resources is a task of great difficulty and complexity. As a matter of fact no complete survey of the resources of the empire has ever been made. Yet, although we do not possess a complete survey, we are not at present in such a lamentable state of ignorance as we were in the past, for in 1912 a Royal Commission was appointed to carry out these investigations

with regard to certain portions of the empire, and the reports which the Commissioners have issued from time to time within the last few years have given us much valuable information.

It is evident that in estimating the wealth of a nation one of the first considerations is the amount of **food** which it can produce. 'Can you grow enough wheat to supply your children with bread?' 'How rich are your fishing-grounds?' are some of the questions which at once occur to us.

Next we must consider the **raw materials** available for manufactures. 'How much wool do your sheep produce? Are you dependent on other countries for cotton and flax?'

And then we go on to coal and iron, tin and copper, and so on through a never-ending list of commodities, which are usually summed up as **food, raw materials,** and the **produce of mines.**

But all this is only the beginning. In studying the resources of a nation we are very soon brought face to face with the question of **labour.** Fertile though the soil may be, and favourable the climate, still the seed must be sown and the crops reaped before we can obtain a supply of food, and for this labour is necessary, so that after we have considered the extent of land available, and the suitability of its climate and soil, we must go on to inquire how many men there are and whether they are willing to work. Coal, too, and iron may lie buried in the earth, but unless men are willing to dig them out and bring them to the surface they are useless.

There is another point. While the land is being ploughed and the crops reaped, no profit is being obtained, yet the labourers must be fed; and so, too, in the case of mines, expensive machinery has to be bought and carried a long distance, and numbers of men have to work for many months, before the mine begins to pay, and in almost every other enterprise money has to be spent and work done before any result can be obtained; we must, therefore, have a store of money saved up for this kind of outlay before we can

make use of our resources, in other words we must have **capital.**

The extent of the land, then, the suitability of its soil and climate, the abundance of minerals, the number of inhabitants, the amount of capital, are some of the points to be considered in estimating the resources of a country.

One thing more. We must never forget when making up our accounts that the world does not stand still ; circumstances are constantly changing, so that what is true to-day may not be true to-morrow. To-day, the primaeval forest stands, and its priceless treasures are carried thousands of miles to the people of other lands ; but to-morrow the ordered plantation has taken its place, and scientific cultivation has superseded the reckless profusion of nature.

And, again, the mine which to-day seems inexhaustible and is the wonder of the world, to-morrow is empty and forgotten. To a certain extent even the boundless sea may fail us, and fish, which were at one time plentiful, may become rare. Nations, too, may change their customs, and those which have hitherto imported their manufactured goods may gradually build factories of their own and elect to supply their own needs.

So that it is not enough to know where we stand, supremely important as that knowledge is—we must know also the direction in which we are tending ; and if we are to remain a great nation we must cultivate the habit of adapting ourselves to changing conditions and to less favourable circumstances.

Bearing all these considerations in mind, we may surely reckon, as not least among the assets of a nation, the intelligence of her sons ; the clearness of vision, which enables us ‘ to perceive and know what things we ought to do ’, and the firmness of purpose, which enables us ‘ faithfully to fulfil the same ’.

CHAPTER II

CEREALS

Ceres was the Roman name of the Greek goddess, *Demeter* (Mother-Earth). After her daughter Persephone was carried off by the god of the Lower World, Demeter left Olympus, the abode of the gods, and dwelt on earth among men, conferring blessings when she was kindly treated, but punishing severely those who neglected her. As of all the products of agriculture **edible grains** are the most important, she came to be more especially regarded as their protector, and they are hence called **cereals.** The most important cereals are **wheat, barley, oats, rye, maize, rice,** and **millet.**

CORN (A.-S. *Corn*). 'Except a corn of wheat fall into the ground and die, it abideth alone.'—St. John xii. 2.

The word **corn** properly means any **hard edible seed,** but its use is generally restricted to the seeds of cereals. In England we use the word to mean **wheat,** in Scotland **oats** are referred to as corn, and in the United States **maize.** Americans say, 'It is a good year for wheat and rye, but bad for corn.'

WHEAT (A.-S. *hwoete,* white). 'But the wheat and the rye were not smitten for they were not grown up.'—Exodus ix. 32 (1491 B. C.).

This quotation from the book of Exodus refers to the plague of hail which smote 'throughout all the land of Egypt all that was in the field'. From time immemorial **wheat** has been a staple crop in **Egypt**, and to-day it still holds its own, especially in Upper Egypt, though even in the Delta more than one-third of the land is under wheat.

Cultivated wheat is a plant of the genus *Triticum* belonging to the order *Gramineae* (Grasses). It grows to about three feet high, sending up from its root several erect and hollow **stems.** Each of its few **leaves** consists of a long sheath, wrapped closely round its stem, and a long blade which narrows gradually to a sharp point. At the end of each stem is a **spike** or **ear** of grain.

The **spike** consists of a central axis, and spikelets (or groups of flowers) arranged alternately on each side of it. There are sometimes as many as five flowers in a group, but often only three, and as the top flower is always barren, the **grains** or seeds in a **spikelet** vary in number from **two** to **four**. Each grain is enclosed in two light papery husks called pales, and at the base of the spikelet there are two more called glumes.

There are many varieties of wheat, two of the chief in England being winter wheat and summer wheat. The former is sown in the autumn and reaped the next year, the latter is sown in the spring of the year in which it is harvested. Summer wheat is bearded, that is, one of its pales has a long awn or bristle.

When the wheat is cut down in the field it is bound into bundles called **sheaves,** and a small collection of these (in England twelve) set up together on the ground is called a **stook.**

CULTIVATED WHEAT

In former days the husks were removed by threshing the ears with a flail, and this primitive method is still practised in remote country districts, but in most places the threshing is now done by machinery. The wheat grain thus released is of a bright yellow colour, rounded on one side and with a groove down the other. The **husks,** i.e. the pales and glumes when separated from the grain, are called **chaff,** and the stalks **straw.**

The grains are ground and the coarser and darker bran (the outside covering of the seed) is bolted (i. e. sifted) from the finer white flour. Bread made from the unsifted meal is known as *brown bread*, that made from the white flour as *white bread*. Of all the cereals wheat is the most nutritious, and it contains a substance called *glutin*, which enables it, when made into dough, to hold together ; bread made from other grains has a tendency to fall to pieces.

MACARONI (from the Greek, *makar*, blessed, hence a very dainty food) is composed of long slender tubes made of wheat flour. **Vermicelli** (from Latin *vermicellus*, a little worm) is prepared in the same manner as macaroni, but the tubes are slenderer. **Semolina** is also prepared from wheat grains. **Starch** is obtained from coarsely ground wheat. The meal is steeped in water for two or three weeks, at the end of which time the liquid, which has now become acid, is drawn off, and the substance which remains in the vat is an impure form of starch. This is subjected to other processes of washing and drying, and finally pure starch is obtained.

CULTIVATION. Wheat requires a moderate amount of moisture while it is growing, and plenty of warm sunshine to ripen the grain after it is formed. Of soils it prefers a rich clay, but it will grow well on chalky ground, and also on alluvium provided they are not too poor.

SOURCES OF SUPPLY

Britain.[1] The soil and climate of the east of **England**[2] are admirably suited to the growing of wheat. The average rainfall is under 30 inches (in some parts less than 25), and the summer temperature ranges from 64° F. in the south to 60° F. in the north. Yorkshire, Lincolnshire, Cambridge, Essex, Norfolk, Suffolk, Huntingdon, and Bedford are our chief wheat-producing counties.

[1] In 1914 Britain (i. e. the United Kingdom) produced 31 million cwt.; in 1918, 46 million.

[2] In 1914 England and Wales produced 29 million cwt.; in 1918, 42 million.

Scotland and Ireland also grow wheat; but the quantity produced is small.

Canada. As the traveller from Eastern Canada enters the Prairie Provinces in the winter time, and gazes out from the carriage windows on the apparently limitless expanse of monotonous snow, it is difficult to imagine a more dreary scene. Later on in the season, however, these same level plains present a very different appearance: north and south, and east and west, as far as the eye can see, they are covered with ripening grain, for this is indeed the land of wheat, and here lies our hope for the future.

The first of these provinces is **Manitoba** (area 73,732 square miles). The winters here are very cold, but the summers are hot, and the grain ripens before the frost can injure it; the rainfall is moderate, but sufficient, and the soil is a rich, deep, alluvial loam.

Saskatchewan, larger than Manitoba, has in the south-east a similar climate and soil, but in the south-west suffers occasionally from insufficient rain; her yield of wheat is, however, greater than that of Manitoba.

Alberta, situated on the eastern slopes of the Rockies, was at one time considered unsuitable for the production of wheat owing to lack of rain. It has, however, been found that by means of irrigation (here easy on account of the slope of the land, and the numerous streams flowing down from the mountains) wheat can be grown very successfully. The plains here are about 3,000 feet above sea-level, but the mild Chinook wind blows over from the Pacific, and makes the cold less intense than it is farther east.

In these provinces there are three chief lines of railway, the **Canadian Pacific,** the **Grand Trunk Pacific,** and the **Canadian Northern.** The latter has built short branches west and north of Edmonton, the capital of Alberta. The grain is sent by rail eastwards as far as Lake Superior, whence it is sent by water to Europe. When the railway from Winnipeg to Hudson Bay is built it will be possible in the summer

time to send us wheat even more expeditiously than at present.

Farther north, beyond the railways and beyond the prairies, in the valley of the Peace River, there are magnificent wheatlands, and even in Yukon Territory in latitude 63° N. wheat is cultivated. This is almost as far north as Archangel and Iceland.

The other provinces also produce wheat, though not in such abundance as the Prairie Provinces, and Ontario, which

REAPING WHEAT

produces the most, uses a large part of it for feeding stock.

The Dominion produces more than 162 million bushels of wheat a year, and she is capable of producing much more than this. It has been stated on high authority that if one-fourth of the suitable lands in Manitoba and the southern parts of the other two Prairie Provinces were annually under wheat the yield would be more than 812 million bushels.

'At the present time Canada stands fifth on the list of the wheat-producing countries. It is difficult to see why in years

to come she should not be first among the countries of the world in the amount of her exportable surplus of wheat, if not in total production. If by the development of new routes such as the Panama Canal and possibly the Hudson Bay routes, and if by the improvement of the old routes such as the St. Lawrence River, the cost of the transport of wheat from the great Prairie Provinces of Canada to the markets of the United Kingdom can be reduced, the problem of feeding the industrial masses of Great Britain will be more than half solved.'[1]

WHEAT IN STOOK

Australia.

1. New South Wales. Westwards from Sydney rise the **Blue Mountains,** steep and difficult of access. They form part of the Great Dividing Range, which stretches from Cape York to Wilson's Promontory, and which separates the Coastal Plain from the interior of the Continent.

Beyond the mountains are tablelands, and farther west still, the western slopes. These slopes have an elevation of

[1] Dominions Royal Commission, 1917.

between 800 and 2,000 feet, and a rainfall of from 18 to 30 inches.

Next come the **Western Plains** where the land is only a few hundred feet above sea-level, and the rainfall varies from 13 to 20 inches. The part of the plains between the Murray and Darling Rivers is called the **Riverina.**

All this land west of the Dividing Range was at one time pastoral land and supported millions of fine merino sheep. But of late years, though sheep-farming still forms the chief industry, wheat-growing, especially on the slopes and plains, has made enormous strides, and the area under cultivation is constantly increasing.

This revolution has been brought about by various circumstances, first perhaps in importance being the production of new varieties of wheat, varieties which will thrive under the conditions here presented, namely, greater heat and less moisture. The heat in the middle of the day is sometimes 100° F. and the rainfall, as already stated, varies from 30 inches to 13. Wherever there are 20 inches of rain wheat can be grown without risk, and such places are said to be within the **Safety Belt;** but as new varieties of seed are produced, cultivation is pushed farther and farther west into drier lands.

Besides the production of new varieties of seed, the growing of wheat in dry lands has been further facilitated by the introduction of a new method of farming known as **dry farming.** The farmer ploughs up his land in July or August, and does not sow his seed until the following April or May. During that time the ground on the surface is frequently broken up, so that the rain which falls may sink in, and not evaporate, as it would if a hard crust were allowed to form. By this system the moisture is retained in the land so that each crop gets two years' rainfall instead of one.

The yield of wheat per acre is less than in moister climates, but the cost of production is not so great owing to various circumstances, chiefly perhaps to the use of labour-saving machines.

One Australian invention worthy of notice is the **Complete Harvester.** This machine not only cuts down the wheat, and threshes the grain from the chaff, but also winnows the grain and puts it into bags, so that it only remains to sew these up and the grain is ready for market.

The **Riverina** at present is the chief wheat-growing district, but, as less than one-tenth of the land within the Safety Belt is under cultivation, it is evident that there is room for a great expansion of this industry in the future. New lines of railway are constantly being built, so that transport will soon cease to be a difficulty.

2. Victoria. Of the crops grown in Victoria wheat stands first, and the districts in which it is chiefly cultivated are the **Northern, Wimmera,** and **Mallee** Districts. The Northern District, with a rainfall of from 20 to 25 inches, is situated to the south of the west bend of the Murray River, and contains the towns Echuca and Bendigo. The Wimmera and Mallee are to the west of it.

Both in South Australia and Western Australia wheat is one of the principal crops. In the former state it is grown chiefly in the neighbourhood of the Spencer and Vincent Gulfs, in the latter south of 28° S.

Queensland also, like New South Wales, has on her western tablelands and plains vast areas with a soil and climate suitable for wheat, and there is little doubt but that in the future these lands will be covered with crops of grain.

Although Australia's contribution to the empire's supply of wheat is no mean one, it is evident that it bears but a small proportion to her capacity of production.

In this connexion again it should be noted that easy communications are absolutely necessary to the success of grain-growing, which cannot be profitably undertaken at a distance of more than twelve miles from a railway station on account of the great cost of haulage. Therefore, there are great areas awaiting the plough that can be put to no practical use until they are traversed by railways.'[1]

[1] Dominions Royal Commission.

The Union of South Africa. Wheat is grown in the south-west and north-east of the **Cape Province,** and in the **Orange Free State** and the **Transvaal,** but in most parts of the Union the rainfall is insufficient, and the chief hope for wheat-growing in the future lies in the adoption of the system of dry farming.

Rhodesia. By irrigation everywhere, and in some districts without irrigation, wheat can be grown in Rhodesia.

Kenya Colony. Wheat is now successfully grown at **Njoro,** and it is considered certain that a variety of wheat more suitable to the climate will be produced and that in the future the wheat-growing industry will be a very flourishing one.

India. The **Punjab** (*punj-ab,* five rivers) lies to the south of the Himalayas and to the east of the Sulaiman Mountains ; except in its northern part it has very little rain. The great bare tracts of land between its rivers are terribly hot and dusty in summer, though in the winter the weather is cool and sometimes frosty. The rivers, however, fed by the snows of the mountains, make irrigation possible, and innumerable canals bring water to the parched fields. Much of the soil is clay or loam, and in consequence this is one of the chief wheat-growing districts of India. **Kurachi** is its port.

The **North-West Frontier Province** lies on the west side of the Indus, and its Lowlands resemble those of the Punjab ; it also produces wheat.

In the **Deccan** the **Central Provinces** have a deep, rich, black soil, and a hot and dry climate. Great quantities of wheat are grown here and exported from **Calcutta.**

The problems and difficulties which perplex us in India are altogether different from those in other parts of the empire. There are 200 persons here to the square mile, the wants of the labourers are few and their wages low. Transport by rail, and river, and canal is easy and cheap.

New Zealand. The provinces of **Canterbury** and **Otago** on the lee side of the mountains are sheltered from the rain-

bearing winds and produce excellent wheat, but though the yield per acre is high, New Zealand does not at present produce enough grain for any considerable export.

Cyprus suffers from uncertain rainfall, but on her central lowlands produces wheat in sufficient quantity for export.[1]

SUMMARY. In the year before the war **Britain** grew not much more than **one-fifth** of the wheat she needed.

Of her imports about **one-half** [2] were from **foreign countries,** chiefly from the United States and the Argentine Republic, though a considerable quantity came from Russia.[3]

Of countries within the empire, **Canada, British India,** and **Australia** sent her the largest supplies.[4]

'In foreign countries, both European and extra-European, the increase of the wheat area is proceeding at practically the same rate as the increase of population; in the British Empire the wheat area is developing far more rapidly, so that the Empire as a whole is becoming more self-supporting.'[5]

It has been estimated that the amount of wheat actually **produced** within the **empire** is sufficient to supply the needs of the **empire** to the extent of over **95 per cent.,** but at present much of this produce is sold to foreign countries.

BARLEY (*Hordeum vulgare*). Few things in nature are more beautiful than a field of ripening barley swaying gently in the summer sunshine. It is a plant closely resembling wheat in its growth, but its spikes, instead of standing erect, droop downwards, and it always has one leaf close to its spike.

[1] The production of wheat in the empire during the five years (1909–13) averaged about 705 million bushels a year, made up as follows: United Kingdom, 59·6 million; British India, 356·6 million; Canada, 184·3 million; Australia, 90·5 million; New Zealand, 6·9 million; South Africa, 5 million; Cyprus, 2 million.

[2] During the war the amounts have varied; in 1917 two-thirds of our imports were from foreign countries, chiefly from the United States.

[3] In 1913 from the United States 34 million cwt.; from the Argentine 14 million; from Russia, 5 million.

[4] In 1913 from Canada 21 million cwt.; British India, 18 million; Australia, 10 million.

[5] 'The total production of wheat within the British Empire, which was 227,500,000 cwt. in 1901, had risen to 399.700,000 cwt. in 1911, an increase of 75 per cent.'

The spikelets have usually only one flower. They are arranged in sets of three on each side of the axis of the spike, but only the middle one as a rule is developed, so that each set produces only one seed or grain. The grain is enclosed

BARLEY

in two pales, the lower one of which is extended into a long awn.

Barley, as usually sold, is the grain enclosed in its pales (or husks); this corresponds to wheat before it is threshed. **Scotch barley** is the grain without its husks. **Pearl barley,** in addition to having had the husks removed, has been

divested of the outer covering of the grain ; it has also been polished and rounded. **Patent barley** is the meal obtained by grinding pearl barley to powder ; it corresponds to the flour from which white bread is made.

Barley is much less nutritious than wheat, and though it is largely used to feed stock, its chief use is for the preparation of **malt,** which is obtained by steeping barley in water until it begins to grow and then drying it in a kiln. **Beer** is a decoction of malt and hops. **Whisky** is a spirit distilled from barley.

Sources of Supply. Barley can be grown on lighter soils than wheat, and it requires less heat to ripen it ; consequently, even when the summers in the east of England are too cool for successful wheat-growing, good crops of barley can be obtained ; nevertheless, it is a less important crop in England than either wheat or oats. In **Scotland** and **Ireland** the contrary is the case, more land being under barley than under wheat. The variety chiefly grown in Scotland is that known as **bere ;** in this kind the two spikelets which are usually barren are developed.

In the higher parts of **British India** barley is grown as a winter crop.

All the provinces of **Canada** grow barley, but **Manitoba** produces most, and **Ontario** stands second. Though a large proportion of the crop is used for feeding stock, a very considerable amount remains over for export.

In **Australia** the states of **Victoria** and **South Australia** are the leading barley states.

Summary. We are able in **Britain** to produce **60 per cent.** of our requirements.

Of our imports from empire sources **British India** and **Canada** supply us with the largest amount, Cyprus and Australia following next in order.

Of foreign countries Russia, the United States, Turkey, and Roumania send us the largest supplies.

CHAPTER III

CEREALS (*continued*)

OATS (*Avena sativa*). The oat plant sends up stems similar to those of wheat, but its flowers are not arranged in the same manner. Each stem ends in a cluster with many irregular branches.

The spikelets usually consist of two flowers, but the upper one is generally undeveloped. The spikelet is joined to the stem by a very slender stalk, so that it nods in the slightest breeze.

The glumes are large and quite enclose the flowers. Each flower is surrounded by two pales, and on the lower pale, a little above the middle, is a long awn which projects far beyond the glume.

Oats, such as we give to horses, are enclosed in their pales, but the grains which are ground to make oatmeal have been divested of them ; they still have, however, a skin or outer coating, and the meal obtained by grinding them after this coating has been removed is generally known as *groats* : it corresponds to white wheaten flour.

Oats rival, or even excel, wheat in nutritive qualities, and they contain more oil than any other grain except maize.

CULTIVATION. They need a cooler and moister climate than wheat or barley, and can be grown in more northern lands. Almost any kind of soil suits them, though they thrive best on a rich one.

SOURCES OF SUPPLY. In **Scotland** oats form the most characteristic crop and they are grown as far north as the Orkneys.

In **Ireland,** too, large crops are produced, while in **England** the acreage under them is greater (or was in 1913) than that under wheat.

In our empire **Canada** stands first in the production of oats ; they form, indeed, her second greatest crop, and she stands **fourth** among the oat-producing countries of the **world.**

Saskatchewan has the most land under oats, **Ontario, Manitoba,** and **Quebec** following next in order; but the moister eastern provinces, especially little **Prince Edward Island,** also grow large quantities.

OATS

Newfoundland, with her cool moist climate, is able to grow oats successfully, though not the other cereals.

Of the states in the Commonwealth of **Australia, Victoria** stands first and **New South Wales** second in the production of oats.

New Zealand has a climate eminently suited to them, and produces nearly as large a crop as the whole of Australia.

SUMMARY. We are able to produce in **Britain 75 per cent.** of our requirements.

Of our imports in 1913 we bought from foreign countries (mainly from the Argentine, Germany, Russia, and the United States) 15 million cwt., and from British possessions 2 million, chiefly from **Canada**, New Zealand and Australia contributing smaller amounts.

MAIZE (*Tsa Mays*). Among the items of expenditure in the palace of the Mexican emperor in the fifteenth century we read of 4,900,000 fanegas of maize. (A fanega was equal to about 100 lb.).

The word **maize** is supposed to be derived from the Haytian word *mahiz*, and Mexico is considered the probable home of the plant, though now it is grown in nearly all warm countries.

It is thus described by a writer in the year A. D. 1600:

'This Mais will grow in a moyst fatty and hot ground, and branche twice a yeare, it is not sowed like other corne, but it is thrust into the ground as we used to do beanes in our Countrey: it lieth not long in the ground, but soone springeth up, and groweth higher than a man's length above the ground, like to great Reeds that grow in the water, or in drowned land, wherewith husbandmen used to cover their sheds: every Reed hath his eares whereon the corne groweth, and notwithstanding that they are very heavy eares, as big as yong cucumbers, and sharpe above like the top of a steeple, yet every Reed hath seven or eight eares upon it. I have told five hundred and fifty graines upon one Reed, which came of one Graine alone. They are of divers colours, as White, Blacke, Yellow, Purple, etc., and sometimes you shall have three or foure colours thereof in one eare. There are two sorts thereof, great and small, the great Graine is stronger than the small. They use the Reed to cover their houses.'[1]

It was introduced into Europe by Columbus, and in this country is often called **Indian Corn,** this being the name

[1] *A Description of Guinea*, A. D. 1600.

given to it by the first settlers in America, but the Americans themselves call it simply **corn.**

It forms a handsome-looking crop; under favourable circumstances its great strong stalks grow to a height of eighteen feet, 'higher than a man's length', but in other places they do not attain more than three feet.

At the end of the stalk is a cluster of slightly drooping stems, and along these the male spikelets are arranged in pairs. Lower down and occupying the space between one of the leaves and the main stem of the plant occurs a spike having the female flowers arranged along its axis. The flowers are very numerous and closely packed, and each has a curious long silky style which extends beyond the leafy bracts in which the spike is sheathed. When the seeds are ripe they are generally of a rich bright golden-yellow, and arranged on their solid thick axis form a 'cob' varying in length from three inches to a foot. These seeds or grains, when ground with their skins or outer coating left on them, form what is variously called **maize meal, hominy,** or **polenta.** It is yellow in colour. The fine white flour, made by grinding the grains when they have been divested of their outer coating, is called **corn-flour,** and makes excellent cakes and blancmanges, but, as it is deficient in glutin, bread made from it will not hold together. Large quantities of **starch** are manufactured from maize, and of all the cereals it is the richest in fatty matters.

Sources of Supply. It is not a British crop; our sun is not hot enough to ripen it satisfactorily, and though a certain amount of it is grown it is generally cut as a green crop for fodder.

South Africa at present is the chief maize-exporting country within the empire, and, in addition to the grain she exports, she grows large quantities to supply the natives with food, and large quantities to feed stock, so that 'mealies', as it is called, is a very characteristic product of South Africa.

It flourishes in most of the wheat-growing districts and also in the lowlands of the **Transvaal** and **Natal** where the sun

would burn up wheat. Large quantities, too, are produced in **Kenya Colony,** while in **Southern Rhodesia** it is the staple crop.

Southern Rhodesia, which is considerably larger than the United Kingdom, lies entirely within the tropics, but in the

MAIZE. A, in flower. B, open cob. C, cob

central part of the country, running roughly from west to east, is a large stretch of elevated land (rising in its highest parts to 7,000 feet), which slopes northward to the Zambesi and southwards to the Limpopo. Above 4,000 feet the climate on these high plateaux is altogether delightful; the heat in summer is never unbearable, and in the winter day after day

the weather is warm, and bright, and sunny, though the nights are cool.

The rain falls in the summer, from the end of October until the beginning of April, but during the rest of the year it is dry, and one can live entirely out of doors. All kinds of

FIELD OF MAIZE, SOUTH AFRICA

cereals can be grown in Southern Rhodesia, but maize, both on the plateaux and in the lowlands, forms the most luxuriant crop.

Before the war we bought less than 1 million cwt. from British possessions, and over 48 millions from foreign countries, mainly from the **Argentine,** though the United States, Roumania, and Russia sent us considerable amounts. During the war the imports from the Argentine decreased, while

those from the **United States, South Africa,** Canada, and British India increased

RICE (*Oryza sativa*). Rice, like wheat and the other cereals, is a grass, and sends up long hollow stems varying from two feet in height to ten feet. The lower stems have many branches which send out roots from their joints. They grow in water,[1] so that the cultivation of rice is never a very healthy occupation.

At the end of each stem is a cluster of branches with spikelets arranged along them. Each spikelet produces one grain which is surrounded by two pales; these are slightly hairy on the upper part.

The rice usually sold in our shops is the grain without its husks (i.e. pales or glumes); when the pales are left on it is called **paddy.** The grains when ground are not usually called rice-flour but **ground rice.** Of all grains it is the one grown most extensively for food, yet it is less nutritious than any of them. It is light and easy of digestion, and is sometimes used instead of potatoes, for which, however, it forms a very poor substitute.

CULTIVATION. Great heat and abundance of moisture are necessary for the growth of rice, and it is cultivated in all the low-lying rainy lands within the tropics. India is usually considered to be its home, and it has been one of the chief crops there and in China from the remotest ages.

SOURCES OF SUPPLY. The great **Deltas** of the rivers flowing into the **Bay of Bengal** are the chief rice-growing lands in the empire; here the rice-fields cover millions of acres of moist land, the rainfall is everywhere abundant, but nowhere more so than in **Assam,** where it sometimes reaches the astonishing total of 600 inches in a year.

Yet though so much rice is grown in Bengal, the population is so great that enormous quantities of it are required for

[1] There is a variety which grows on the slopes of hills, inland, but it is not of such importance as the lowland kind.

home consumption, and it is from the low-lying lands of **Burmah** that we receive our chief supplies. **Rangoon** is the chief centre for export.

We import about 5 million cwt. from **British India,** and a certain amount from foreign countries, chiefly from French Indo-China and Siam.

RICE CULTIVATION, MALAY STATES

MILLET (*Sorghum vulgare*). 'The Millie hath long eares, and is a seed of colour like Hempe-seed, and long like Canarie-seed, it hath no shels, but groweth in a little huske, and is very white within. . . . It groweth and is ripe in three months, and when it is cut down, it lyeth a month after in the fields to dry, and then the eares are cut off and bound in sheafes, and so carryed home to their Houses. They use the straw to cover their Houses withall. This Millie is a very excellent graine, hath a good taste and is wholesome to eate, it is sweet in your mouth, but gnasheth in your teeth, which cometh of the stone wherewith they grind it.' [1]

[1] 'A Description of Guinea, A. D. 1600' (*Purchas, His Pilgrimes*).

Millet is sometimes called **Guinea corn** or **durrah.** It is largely grown in Africa and India for home use, but is not exported to other countries.

CEREALS

SOURCES OF SUPPLY

	Foreign.	*British.*	*Remarks.*
Wheat.	**United States,** Argentina, Russia.	**Britain, Canada, British India, Australia,** New Zealand.	Britain produces about **one-fifth** of the wheat she consumes. Of imports **46 per cent.** are from empire sources. The empire actually produces **95 per cent.** of the amount required by the empire: at present much of this is sold to foreign countries.
Barley.	**Russia,** United States, Turkey, Roumania.	**Britain, British India, Canada,** Cyprus, Australia.	Britain produces **60 per cent.** of her requirements. Of imports 27 per cent. are from empire sources.
Oats.	**Argentina,** Germany, Russia, United States.	**Britain, Canada,** New Zealand, Australia.	Britain produces **75 per c nt.** of her requirements. Of imports 12 per cent. are from empire sources.
Maize.	**Argentina,** United States, Roumania.	British South Africa, British India, Canada.	Of imports about 3 per cent. are from empire sources, but recently the percentage has become higher.
Rice.	Russia, Siam.	British India (**Burma**).	Of imports about 60 per cent. are from empire sources.

CHAPTER IV

SAGO, LENTILS, ARROWROOT, TAPIOCA

SAGO. Our word *Sago* is a form of the Malay word *sagu*, which means *bread*, for sago forms the chief food of thousands of the natives of the Malay Archipelago.

The tree from which sago is obtained is a palm, called *Metroxylon Sagu*. *Metro* is from *metra*, meaning marrow or pith, and *xylon* is the Greek for tree, so the sago palm is the tree with a pith. It grows to a height of thirty or forty feet,

and, like all palms, its trunk is marked with the scars of fallen leaves, but these do not fall off until the tree is many years old, and, as they have great sheaths at their bases which wrap it completely round, the trunk appears to be shorter and thicker than it really is. The leaves are enormous, measuring as much as twenty feet in length. They are pinnate-shaped with very numerous leaflets, the middle ones of which are often as much as two or three feet long.

In its natural condition, when about ten or fifteen years old the tree blossoms and then dies. But on a sago plantation the trees are felled just as they begin to flower, because the pith is considered to be in the best condition at that moment. The trunks are cut open and the white pith inside is bruised into a coarse powder. It is then removed from the trunk, thrown into water, and stirred about until the starchy constituents are dissolved. This starchy water is then drained through a sieve and allowed to settle. After a time the clear water is drawn off and the starch at the bottom of the tank is dried ; it is called sago-meal.

For export the moist sago is rubbed through sieves of different degrees of fineness, and is thus formed into grains, called according to their size *pearl*, or *medium*, or *bullet*. A single tree produces as much as 900 lb. Sago is a light, nutritious, and easily digested food.

Cultivation. The sago-palm, like rice, grows in swampy places where there is plenty of rain and great heat, so that rice and sago plantations are often found side by side. The tree sends up suckers from its roots, and it is from these that new trees are obtained.

Sources of Supply. The **Malay Peninsula** is considered to be the home of the sago palm, and it is from there that we obtain our chief supplies.

LENTILS (*Lens esculenta*). 'And Esau said to Jacob, "Feed me, I pray thee, with that same red pottage. . . ." Then Jacob gave Esau bread and pottage of lentils.'—Gen. xxv. 30, 34.

Those lentils which Jacob gave Esau were the Egyptian

kind, which have a dark skin, but within are of a bright-red colour. There is another variety which has a grey skin and is yellow inside.

They are the seeds of the *Lens esculenta*, a slender little plant resembling our vetch. It grows about a foot high, and has pinnate leaves ending in a long curling tendril. The flowers are pale blue, in form like those of a pea. The pods, which are about an inch long, contain usually two dark-looking seeds.

ARROWROOT

As a food lentils are exceedingly nutritious, though not very digestible.

The plant requires only a moderate amount of heat and will grow in a fairly poor soil.

Sources of Supply. British India (especially the **Central Provinces** and **Madras**) is at present our chief source of supply. Here they are grown as a winter crop and often follow rice.

Large quantities are also grown as a winter crop in **Egypt,** and considering the modest needs of the plant, it would seem that it could be grown in many other parts of the empire.

ARROWROOT is a white powdery substance which when rubbed between the fingers produces a curious crackling noise. It is obtained from the tubers of the *Maranta arundinaceae*, a plant which grows from two to three feet high, and has long pale-green leaves and yellow flowers.

It is a native of the **West Indies** (where it is grown extensively, especially in **St. Vincent,** the **Bermudas**, and **Jamaica**),

but it is now cultivated in Bengal, the East Indies, and other tropical countries.

The name *arrowroot* is a corruption of *araruta*, which in the language of the South American Indians means *mealy root.*

Great care is taken in preparing the meal from the tubers. These are first peeled and then crushed to a milky juice. Water is then added and the mixture is allowed to settle. The sediment after further washing is what we call arrowroot.

All our imports are from British countries, mainly the **West Indies.**

TAPIOCA is a starchy granular substance obtained from the poisonous tubers of the *Janipha manihot*, a native of Brazil, though now grown in many tropical countries. The tubers are heated and pressed ; during this process the poisonous elements are eliminated, and the wholesome food which we call tapioca is obtained.

Our imports come chiefly from **Malaya** and **Java.**

Summary

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Sago.	Siam, Java, and the Netherlands.	**Malaya.**	Practically *all* our imports are from Malaya.
Lentils.	Germany, Russia.	**India.**	More than three-quarters from India.
Arrowroot.		**West Indies.**	None from foreign countries.
Tapioca.	Java and the Netherlands.	**Malaya.**	A little more than half of total imports are from Malaya.

CHAPTER V

MEAT AND DAIRY PRODUCE

BEEF. We produce in Britain about 60 per cent. of our requirements, the rest we have to import.

Practically all the chilled meat came from the **Argentine**, and of the frozen meat the Argentine supplied over half the

total quantity, the rest coming from British possessions, so that not only did we not produce enough for our needs, but of our imports less than **one-sixth** came from countries within the **Empire.**

Of empire countries **Australia** is the largest exporter of frozen beef, and in Australia **Queensland** is the chief cattle state. The Coastal Belt and the land near the Gulf of Carpentaria are the principal cattle districts, though in the extreme west also there are a large number. Brisbane, Rockhampton, Gladstone, and Townsville are some of the towns from which the frozen beef is exported. **New South Wales** stands next to Queensland as a cattle country, and in many other states there is good pasture, so that the export of meat might be greatly increased.

Next in importance comes **Canada.** In former days over the open prairie land of **Alberta** there roamed countless hosts of bison and other bovine animals, and the abundant natural food of those lands and the dry healthy atmosphere, which made life possible for them, has in recent times made of Alberta the great ranching province of Canada. It is true that nowadays wheat has to a certain extent taken the place of grass, yet thousands of acres still remain covered with their natural grasses and could support vast herds of cattle.

In Ontario, and nearly all the other provinces where mixed farming is carried on, there are great numbers of cattle, and there is nothing to prevent Canada from becoming a much larger exporter of meat than she is at present.

South Africa. The eastern coastal lands of the **Cape Province** and **Natal** are at present the chief cattle lands of South Africa, but probably in the near future **Rhodesia** will become the chief meat-exporting country, and already many large ranches are in existence. One authority considers that it is capable of supporting ten million head of cattle ; at present there are about 750,000.

One of the difficulties against which Rhodesia has to contend is an insufficiency of water, but in most places there

are underground streams, and these can be tapped by bore-holes generally at a depth of 100 feet or so.

Once a good supply of water is guaranteed for the animals, the dryness of the climate is an advantage, for it saves them from many diseases which a moist climate is apt to engender.

The **Sudan** covers an area of one million square miles and is a great pastoral country, and although at present there is

MOB OF HEREFORD COWS, QUEENSLAND

but a small export of cattle, except from Egypt, the possibilities of the future are practically limitless.

MUTTON. Of frozen mutton in 1913[1] we bought over 5 million cwt., and of this nearly 4 million came from British possessions, i. e. **New Zealand** and **Australia.**

The number of sheep in **New Zealand** had increased from 1½ million in 1858 to over 24 million in 1913. No country in the world has richer pastures, but, though wool has always been a valuable article of export, until recently little use could

[1] During the war the amount imported declined from 5 million to 2½ million cwt.

be made of the carcases of the animals. All this, however, has been completely changed by the adoption of the freezing process, whereby meat may be sent thousands of miles over the sea without deteriorating. The freezing factories of New Zealand are among the finest in the world; those at **Wellington, Oamaru,** and **Timaru** are some of the most celebrated.

To an Australian, until recently, sheep meant wool, and, as in the case of New Zealand, all the energies of the pastoralists were concentrated on producing the largest amount and finest quality of wool. 'Before freezing works were established, boiling down was the one resource, the tallow, hides, and sheepskin giving a meagre return, while the carcase went to the pigs.' And we read of a leading pastoralist bringing down a draft of sheep from his Darling Downs Estate to Brisbane to be boiled down, and during the process going round daily with a handcart selling the legs of mutton at sixpence apiece.

All that is now altered and large quantities of frozen mutton are exported, the bulk of which comes to the United Kingdom. **Queensland** and **New South Wales** are the chief exporting states.

In **Victoria** great freezing works have been established in the sheep-raising district of **Wimmera,** and in **New South Wales** in the **Goulburn Valley.** During the journey from the inland pastures to the sea-coast the animals lose weight. Also the cost of carriage for frozen meat is less than for live sheep, so that by slaughtering them on the spot, and having inland freezing works, a great economy is effected.

Before the days of railways, wool took six or nine months by bullock drays to reach the coast, and the cost of carriage was more than the value of the wool. Though this state of things has long since passed away, and railways now run from the coast inland, yet many more are needed, and when these are built the export of frozen meat will receive a great incentive.

Summary. Until recently we had always looked to the United States for our chief supplies of imported meat, but during the first ten years of this century her stocks of animals

decreased and her population increased, so that instead of exporting her surplus to us, she has herself become a competitor for supplies from the meat-producing countries.

We now import **beef** mainly from the **Argentine** and **Australia**, and the imports from Australia are increasing.

Of **mutton**, our supplies come chiefly from **New Zealand**, the **Argentine**, and **Australia,** and the supplies both from New Zealand and Australia continue to increase.

In the case of pork, bacon, and hams, before the war the imports from the Dominions showed a tendency to decline, and we imported most of our fresh pork from the Netherlands, salted pork and bacon from Denmark, and hams chiefly from the United States.

There seems every reason to hope that in the future we may become self-supporting with regard to meat, and that we may receive supplies not only from Australia and New Zealand, but also from Canada, Rhodesia, and the Sudan.

DAIRY PRODUCE. Butter, cheese, and eggs.

1. Butter. We import more than 4 million cwt. of butter, of which over 3 millions come from foreign countries, no less than ten contributing to our needs. Among these Denmark stands pre-eminent, though Russia, Sweden, France, and the Netherlands send us large supplies.

Within the empire **Australia** and **New Zealand** are our largest exporters and Canada comes third.

2. Cheese. We are considerably more self-supporting with regard to cheese than to butter. **Canada** supplies us with more than a million hundredweights, and New Zealand sends us considerable amounts, so that our imports from foreign countries are not very great. **Ontario** is the chief cheese-producing province of Canada.

3. Eggs. Out of the £5,000,000 which we spent on imported eggs in 1917 over £2,000,000 went to Denmark. Less than two-fifths of our imports were from British countries, mainly from Canada and Egypt.

CHAPTER VI

FOOD FISHES

'THE shipmen sounded, and found it twenty fathoms.'—Acts xxvii. 27–8. As you stand on the sea-shore and watch the tide come in, you notice that gradually a strip of sand or pebbles, where an hour or so ago you could walk in perfect safety, becomes covered with water until at last all the beach is hidden, and you say the tide is in. Yet, though you cannot see it, you know that under the water the beach is there, and if you were in a boat you could let down a line weighted with a piece of lead and measure how deep the water was at any particular spot.

Just in the same way beyond low-water mark there is a sea-floor, and, though the water never recedes and makes it visible, we can measure its depth in the same way as we did that of the beach. Of course, the farther away from the land you go the deeper becomes the sea, and the longer the line you will have to let out, yet you will find that the depths vary, and that, just as we have hills and plains on shore, so at the bottom of the sea there are heights and hollows, places where the sea is shallow and where it is deep.

For many years men have patiently 'taken soundings', as it is called, of the seas of the world, until now they can map out the floor of the sea almost as accurately as the surface of the land. Looking at such a map we notice that round the British Isles the sea is nowhere deeper than 100 fathoms, i. e. 600 feet. Beyond this shallow area the water gets deeper and deeper until far out in the ocean depths of 3,000 and 4,000 fathoms have been sounded and even in some places more than 5,000.

The edge of this 100-fathom area is called the 100-fathom line. It runs close into the coasts of Spain and Portugal, branches towards the north-west in the Bay of Biscay, and then runs round the west of Ireland and north of Scotland.

From the north of the North Sea it turns southwards towards Denmark, passes into the Skager Rak, and then back again along the coast of Norway and north of the White Sea towards the Arctic Ocean. The Hebrides and the Orkneys and Shetlands are contained within it, and, though Iceland and the Faroe Islands are beyond it, and stand out in the deeper ocean, yet for a considerable distance round their shores the water is not deeper than round ours.

The importance of this large area of shallow water[1] so near to us can hardly be exaggerated, for it abounds in food fishes of almost every sort and kind, and forms, indeed, one of the richest fishing grounds of the world.

Fish may be divided into two great classes: those which live on, or near, the bottom of the sea, and those which live in middle waters or near the surface.

Of this latter class the most important are **herrings,** and members of the herring family, such as **pilchards** and **sprats. Mackerel,** too, are surface swimmers, though they do not belong to the herring family.

HERRINGS. 'Fowl of the heaven and fish that through the wet Sea-paths in shoals do glide.'—MILTON. **Herrings** abound in all the shallow waters from the White Sea to the Bay of Biscay, but they are most abundant in the **North Sea** on the coasts of Scotland and England. In these regions countless multitudes of them swim together in great shoals moving rapidly to and from the coasts. The upper surface of their bodies is greenish-blue, like the sea, but the sides and lower parts are silvery-white, and the whole glittering mass of them is so bright that it is often reflected in the sky, and fishermen, by observing this reflection, are enabled to locate a shoal. Gulls, too, and gannets betray them, for they and large numbers of other sea-birds hover over them, diving every now and then to seize their prey.

As soon as the whereabouts of a shoal is known, the fishing

[1] Of late years the area fished has been extended, and the 200-fathom line now forms the boundary.

boats go out and let down their nets. Several of these are joined together, making one long meshed wall several hundreds of yards in length. A rope is run through the upper side, and corks and floats are fastened to it, so as to keep this side uppermost; the other side is weighted with lead to keep it down. The nets are shot across the tide and allowed to drift. After a time the fish, swimming against the current, dash

HERRING BOATS, ABERDEEN

their heads through the holes, but they cannot withdraw them, for their gill-covers catch in the meshes and hold them fast.

Millions of herrings are thus caught in the sea every year, yet so great is their number that those caught by fishermen form only one or two per cent. of the total number in the sea. Countless myriads are devoured by sea-birds, by whales, and seals, and dog-fish and cod, and by many another of their numerous enemies.

And what do herrings themselves live upon? Besides

the fish with which we are familiar, there exist in the sea millions and millions of living creatures so small that many of them to the naked eye appear as mere specks, and their exact shape and form can only be seen under a lens.

The commonest and most abundant of these tiny animals are the **Copepods,** small shrimp-like or prawn-like forms which are exceedingly rich in oil, and therefore highly nutritious. The largest of these sometimes measure a quarter

ABERDEEN FISH WHARF

of an inch in length, but generally they are smaller than this.

Besides the copepods, and other similar minute creatures, there are the countless hosts of the **larvae** of the lower forms of animal life, which live on the floor of the sea, or in the water just above it ; all these swim about in myriads in the upper waters of the sea, and supply herrings and similar fish with food. As these creatures are all so small, obviously a very great number must be devoured by the fish which live upon them, and it would be impossible for them to be seized one by one.

If you open the mouth of a herring you may feel, it is true, numerous small teeth, both on the tongue and sides of the mouth, but these are of no great importance. If, however, you lift up the gill-covers you see what at first sight looks like the underside of a mushroom. These are the gills, and just inside them are the white gill-rakers of the fish. If you examine them carefully you will find that there are four curved pieces of bone joined together at the top and bottom. These are called the *gill-bars*. On the outside of each bar are two rows of soft red gills, and on the other, or inner side, are horny projections like the teeth of a comb, and each of these teeth again is uneven at the edge like a saw. These are the *gill-rakers*, and they are arranged in such a way that, when the fish in breathing takes gulps of food-laden water into its mouth, the food is strained out by the gill-rakers, and goes into the animal's stomach, but the filtered water passes on over the gills (which absorbs the oxygen dissolved in it) and out again into the sea. Herrings, then, are abundant where there is an abundance of food, i.e. of copepods, and the larvae of the various creatures that live at the bottom of the sea, and these again abound where there is food for them.

Sometimes on the surface of the sea you notice a pinkish kind of scum. This consists of myriads of **tiny plants,** on which the microscopic animals live; then, again, there are other sea-plants like little yellow-brown rods, these are the **diatoms ;** others, again, are globular in shape and sea-green in colour. So numerous are they that in places they render the sea turbid, or colour it pink or green.

The **Eggs** of many kinds of fish are transparent and float upon the surface of the water, but those of the herring are **heavy** and **sink.** Each egg is about the six-hundredth part of an inch in size, and together they form sticky masses, which, when they reach the bottom, adhere to the rocks, or gravel, or plants near the shore. The fish, therefore, come into shallow water to spawn, and it is when they are approaching the land for this purpose that they are taken in the greatest quantities.

The fishery begins in the north of Scotland in February, but on other parts of the coast it is later, and at Yarmouth it is not at its height until November.

Nearly every port on the North Sea is a herring port, but the largest ones are **Wick, Peterhead, Fraserburgh, Aberdeen, Grimsby, Hull, Lowestoft, Yarmouth,** and **London,** while on the west side of Scotland **Inverary** is the port for the

FISH CURING, NEW BRUNSWICK

celebrated **Loch Fyne** herrings and Mallaig and Stornoway have important fisheries.

In Aberdeen and most of the Scotch ports large numbers of herrings are pickled in brine and exported to the Continent of Europe, while in Yarmouth and also in Aberdeen thousands are salted and dried in wood smoke, when they are known as **kippers** and **bloaters.**

On the other side of the Atlantic also there are very valuable herring fisheries, especially in the **Bay of Fundy** and in **Fortune Bay** (Newfoundland). The chief port is **St. John** (New Brunswick).

Two other kinds of fish, belonging to the herring family, and caught like herrings in nets, are pilchards and sprats.

The **Pilchard** fishery is carried on off the coasts of **Cornwall** and **Devon,** and **Penzance, Falmouth,** and **St. Ives** are noted ports in connexion with it. At **Mevagissey** the fish are preserved in oil in the same way as sardines (which are small pilchards) are preserved off the coasts of France and Portugal.

Sprats are caught in many places round our coasts, but especially in the estuary of the Thames, where, mixed with tiny young herrings, they form the **whitebait** for which Greenwich is famous.

Mackerel do not belong to the herring family, but they are surface swimmers, and, like herrings, are caught in drift-nets At **Plymouth** mackerel fishing is carried on to some extent all the year round, but in the colder months the fishermen have to go farther out to sea for them, to places where the water is warmer. They are caught in the early summer off the coasts of **Norfolk,** and **Suffolk,** and the **west** coasts of **Scotland,** and **Ireland,** and the **south-west** of **Norway.** It would seem, therefore, that they followed the inflowing Atlantic water up the Channel into the southern part of the North Sea, and round the north of Scotland to the coast of Norway. **Plymouth** and **Lowestoft** are the two chief ports for them.

Since herrings and similar fish depend ultimately for their food on diatoms and other minute floating plants, and these in their turn are chiefly dependent on light for their development, it follows that one of the circumstances which determine whether the catch of fish will be great or small is the amount of sunlight two or three months earlier in the year.

COD. Tiny young codfish (two or three inches long) are often to be found in summer time nestling under the umbrella-like covering of the soft, big, jellyfish which float about the sea, and no one would imagine from their appearance at that stage that they would develop into the great, ugly, voracious fish which they afterwards become. A full-grown cod measures from two to four feet in length, and many are even longer.

They have large mouths with strong teeth, and they prey upon dead fish, and on most of the lower animals [1] which inhabit the sea-floor, as well as upon herrings, which live in the middle waters. Attached to the chin they have little tentacles (barbels) hanging down, with which they feel their way along the floor of the sea, as, with head bent downwards, they move along ready at any moment to pounce upon their unfortunate victims.

Cod were formerly caught by long lines, but (though lines are still used) they are now principally taken by the trawl. These lines sometimes measure as much as nine miles, and attached to them are numerous smaller ones, each holding a hook and baited with whelks or other fish. These are shot down into the sea across the tide, a float at each end showing the fishermen the position of their lines, and so voracious are the cod that a man has been known to catch as many as five hundred in ten hours. On each boat there is a well, so arranged that the sea-water can flow through it, and the fish when caught are put into this, and brought alive to shore.

Cod inhabit the **northern** seas wherever the floor is **rocky** or **stony**, and on the English coast **north** of the **Humber,** and on the **Great Fisher Bank,** as well as farther afield off the coast of **Iceland,** and the **Faroe** Islands, large quantities are taken.

Sailing smacks from **Grimsby** and **Harwich** work the North Sea grounds, but the more distant ones of Iceland and the Faroe Isles are worked by steamboats [2] from **Grimsby, Fleetwood, Aberdeen,** and **Hull.**

Important, however, as these fisheries are, they are of small account compared with those of the **Lofoten** Islands off the coast of Norway, and those of the **Grand Banks** to the south-east of Newfoundland.

From the Arctic Ocean, borne down by the Labrador

[1] Such, for instance, as hermit-crabs (which the cod drag out from the whelk shells which they inhabit) and swimming crabs, shrimps, common squids, and sea-mice.

[2] One steam trawler often lands seventy or eighty score from a week's fishing.

Current, the great icebergs from Greenland and the northern islands come floating towards the south, until meeting with warmer water they gradually melt away. Frozen in with the ice are lumps of rock, and stones, and gravel, torn off from the valleys of the lands down which the parent glaciers slid, and all this accumulated débris, set free by the melting of the ice, has formed great submarine banks towards the south-east of Newfoundland. They are known as the Grand Banks, and cover an area of 120,000 square miles.

This meeting of the currents has also another result. For, wherever cold and warm currents meet, the lighter warm water floats on the top of the cold, and the tiny delicate food-plants, together with the myriads of creatures which feed upon them (and which in their turn afford sustenance to other forms of animal life) being unable to withstand the sudden change of temperature are killed, or, if not killed, find themselves unable to pass through the lower layer of dense water, and so accumulate in large numbers in the upper layers. The consequence is that there is a vast bulk of dead and living food available for such fishes as **cod** and **haddock, herrings, mackerel,** and many other kinds of fish, which inhabit these waters in enormous multitudes. It is this abundance of food which makes the Grand Banks, and also the eastern waters of the United States, such valuable fishing grounds.

Of all the teeming population on the **Grand Banks, cod** are the most abundant, and the cod fishery here is the most important in the whole world. The fishery lasts from June to November and fishermen of all nations take part in it, but the men of Newfoundland are the most numerous, as the Banks are only one day's sail from their shores and their coasts abound in the creatures which are used for bait, such, for instance, as whelks, and limpets, and mussels, and squids.

Nearly everybody in the island is connected in some way with the fishing industry, 90 per cent. of their exports consisting of fish, of which cod form more than half. As you walk along through the fishing villages you see everywhere

the frames on which the great fish are hung to dry, and even the preparation of the bait gives employment to thousands of the population, being sold to fishermen of other countries as well as to Newfoundlanders.

The **livers** of the fish are boiled, and the oil which collects upon the surface is collected, and after further purification forms the **Cod liver oil** with which we are familiar.

The capital of Newfoundland, **St. John's,** has a fine deep harbour, and it is from here that the produce of the fisheries is exported.

Haddock belong to the same family as cod, which they greatly resemble, but they are smaller, and they have on their shoulders a curious black patch, while their dorsal fin is pointed and curved like a sickle. They abound in the **northern** part of the **North Sea,** those of **Loch Findon,** in Kincardineshire, being especially famous. They are found on sandy bottoms, and hence in association with flat-fish, especially plaice.

'In the northern part of the North Sea the staple produce of the trawl always consists of **haddocks** and **plaice.** Without these two kinds of fish, especially haddock, the enormous fleets of steam trawlers which now range these waters could not be kept at work at all. From one hundred and fifty to two hundred boxes of haddock are often landed at **Grimsby** after a week's fishing or even less on the **Dogger Bank.'** [1]

Ling, coalfish, and hake also belong to the cod family. The **Ling** is a fish measuring from two to four feet and often more in length. It is found in all the western seas of Europe, and off the shores of Newfoundland, but it is most abundant in the north near the **Orkney** and **Shetland** and **Faroe** Islands.

The **Hake** is not quite so large, and is a southern rather than a northern fish, being taken in greatest numbers on the **southern** coasts of **England** and **Ireland,** and on the American side as far south as Cape Hatteras. It is a deep-water fish and only occasionally approaches land.

PLAICE. Of all the curious and wonderful creatures which

[1] *Marketable Marine Fishes,* Cunningham.

live at the bottom of the sea, the most curious and wonderful perhaps are the flat-fishes. The larva of plaice resembles that of cod. It is hatched from eggs which float upon the surface of the sea, but during its transformation it sinks towards the bottom where, as a very young fish, it swims about in a normal manner. Gradually, however, its body becomes flattened, and it makes towards the shallower waters of the shore, where it acquires the habit of lying on its left side; at the same time the exposed top side assumes the colour and appearance of the pebbly or sandy ground on which it is lying (being generally of a greyish-brown dotted over with orange-red spots) and the left eye moves round to the top side. And there for the rest of its life at the bottom of the sea it remains, sometimes slowly swimming about among its fellows, at others almost completely buried in the pebbly sand with only its head and extremely mobile eyes projecting.

It feeds on such creatures as the solen or razor-shells, of which there are several kinds, some measuring as much as eight inches, others much less. They bury themselves in the sand, but the plaice digs them out, and either devours them whole, crushing their thin shells with its strong flat teeth, or it drags them out of their shells and eats the part which suits it. Another little creature on which it feeds is the *mactra subtruncata*, whose pretty little shells we find in abundance on all our sandy beaches; and sea-worms and star-fishes, too, form part of its diet.

Plaice are abundant in all the shallow waters in the north of Europe, but they are caught in greatest numbers in the **North Sea,** on the **Dogger Bank,** and the **Great Fisher Bank,** and the English coast north of the Humber, and also off the shores of **Iceland.**

Steam trawlers from **Grimsby** and **Hull** and many other places fish these waters and land enormous catches at their respective ports.[1]

[1] In the spring and summer, multitudes of small plaice are caught off the German and Danish shores of the North Sea and landed at Grimsby, Hull, and London.

Another northern, right-eyed flat-fish, with great jaws and powerful teeth, is the enormous **Halibut.** It is caught by long lines off the shores of **Iceland** and the **Faroe** Islands, and is the largest flat-fish known, measuring from two to six feet, and sometimes even more than this. The fishermen from **Grimsby** and **Hull** tie them up by their tails, and put them into great salt-water wells at the bottom of their boats, and so bring them alive to shore. 'It is a striking sight to see the long rows of immense halibut and other fish laid out upon the Grimsby pontoon when one of these vessels lands her catch from the deep northern grounds.'

Two other **flat-fish** belong to the **south.** They are the **Sole** and **Turbot;** the former a right-eyed, and the latter a left-eyed fish. The turbot is larger than the sole and rounder in shape; it sometimes measures as much as three feet, though its usual size is between one and two feet; the sole is never more than one and a half feet in length, and is not often so large as this. They both live on ground consisting of sand or gravel or other loose material in shallow waters (not more than forty fathoms), and are taken by trawls in large numbers in the **Bristol Channel,** the **English Channel,** and the **southern half** of the **North Sea.** Cornishmen, and men from Plymouth and Brixham, in the English Channel, and from Lowestoft and Ramsgate, in the North Sea, take part in the fishery.

Skates and **Rays,** of which there are several kinds, in appearance and mode of life resemble other flat-fishes such as the plaice and turbot, but in structure they are altogether different, and in this respect they are nearly allied to the **Sharks.** They are found in all parts of the world and are taken in great quantities round our coasts.

SALMON. One of our most beautiful and valuable fish is the salmon. On the top side it is bluish grey in colour, while underneath it is silvery white. It is a large and powerful creature sometimes four or five feet in length, and it preys upon all other fish which are weaker than itself.

In the spring it leaves the sea and ascends a river until high up in some clear gravelly pool it scrapes out a hole and deposits its eggs. These are much fewer than those of most other fish, for in these quiet inland waters, though otters and numerous other enemies are on the look-out for the young salmon, they have a better chance of surviving than out in the open seas, where the struggle for existence is so fierce that the eggs of most fishes are reckoned by the million. The cod, for instance, deposits nine million.

Some of our most famous salmon rivers are the **Spey** and the **Tay,** the **Severn,** and the **Eden,** the **Bann** and the **Shannon,** while in **British Columbia** the **Fraser** and other rivers have become proverbial for their enormous catches. **New Westminster** in British Columbia is the head-quarters of the tinned salmon industry.

EELS. As you gaze out over the level cornlands in the midst of which the glorious cathedral of Ely now stands, it is interesting to remember that all this fertile plain was once watery fenland and abounded in eels to such an extent that the biggest island was called Eel Ey (eel island), and that rents in this neighbourhood were paid, not in so much money, but in so many eels.

These slippery, snake-like fish live in muddy ponds and rivers, and feed on frogs and worms, and whatever else they can swallow.

Unlike the salmon, which come up the rivers to deposit their eggs, the eels go out to the deep sea to spawn, and, after the eggs are hatched, thousands of young eels, or 'elvers' as they are called, may be seen making their way back in great processions up the rivers, but the parents do not return.[1]

[1] The little ribbon-like transparent fish called *Leptocephalus,* which is caught out in the Atlantic, is now known to be the larva of the eel. These little creatures are swept towards western Europe by the Gulf Stream. During their shoreward journey they develop into little round eels with fins. These 'elvers' make their way up our rivers or are carried up the Channel into the North Sea towards Denmark and the Baltic; others are carried round the north of Scotland and then southwards.

The **Bristol Channel** is especially celebrated for ordinary eels, but the gigantic **Conger,** which sometimes measures as much as ten feet, inhabits the rocky coasts of **Cornwall,** where it is caught at night by long lines baited with pilchards, and brought to Plymouth.

Lobsters and **crabs,** and **prawns** and **shrimps,** belong to the order of *Crustaceans,* so called because their body is encased in a hard shell or crust. This shell does not increase in size with the growth of its owner, and therefore every year it has to be cast off and a new one formed.

LOBSTERS inhabit rocky pools, and are caught in the greatest numbers off the **north-west** of **Scotland,** and **Ireland,** and on the coasts of **Newfoundland,** where tinned lobster now forms an important article of export.

Crabs and prawns and shrimps are found on all our sandy beaches, and are especially plentiful in the **Wash** on the east coast.

Both lobsters and crabs are caught in wicker baskets called creels. These have rounded sloping sides leading up to a hole in the top, so that, once the animals crawl in, escape is impossible.

OYSTERS belong to the class of lower animals called *Molluscs,* a word which means soft, for though the shell which encloses them is hard, their bodies inside are merely a soft mass of flesh. They live in the mud of estuaries or in the shallow waters of the coast, attached by their flat shell to some rock, and feeding on what the tide brings them: the microscopic larvae of tiny marine creatures, the spores of seaweeds, and the minute plants which float about in the sea, all these being taken in with the water breathed by their gills.

We have always been famous for our oysters; even in the time of the Romans they were exported to Rome and there fattened up to tempt the dainty palates of wealthy epicures. At the present time the beds of **Whitstable** and those of the Colne and Blackwater estuaries are the most productive.

To the same class of molluscs belong **Mussels** and **Scallops,**[1] **Cockles** and **Whelks ;** the mussels are attached to rocks by their beards, but the cockles and scallops are able to move about slowly. The molluscs which have two shells joined together by a hinge are called bivalves ; those with only one shell univalves. To the former class belong oysters and scallops, and to the latter cockles and whelks.

Fish, then, are dependent on their environment. Some inhabit the sandy or rocky floor of the sea, others swim in the middle or surface waters, but all kinds have to seek out those places where their food is abundant, and where the temperature of the water and its salinity and density are such as suit them. So that a great variety of conditions is matched by a corresponding variety of fish. Not only so, but at different stages of their development they require entirely different conditions ; thus the eggs of plaice, to take only one instance, float upon the surface of the sea, but the larvae in their final stage have to fall to the bottom in very shallow water, and here they develop into fish, and henceforth live upon the floor of the sea, though, as they grow bigger, they gradually seek deeper and deeper water.

The currents of the sea, too, play an important part in the life-history of fishes, for all eggs and larvae (and sometimes even full-grown fish) are entirely at their mercy, and the number of fish produced depends largely on whether the currents carry the eggs or larvae to places where the temperature of the water, and other conditions, are suitable for their development, and where there is an abundance of food for the young fishes.

These great movements of the sea also serve another purpose ; they keep the water aerated and sweet, and this is one reason why open seas, such as the North Sea, are richer in fish than enclosed areas such as the Black Sea and Mediterranean.

[1] Scallops are plentiful on the coast of Palestine, hence pilgrims and palmers used to wear them on their caps to show they had visited the Holy Land.

The summoned Palmer came in place, . . .
The scallop shell his cap did deck.—*Marmion.*

And, again, the meeting-place of warm and cold currents is, as we have seen, always a rich feeding-ground for fish.

SUMMARY. Near the land at the mouths of warm estuaries are the **Oysters** and **Mussels,** while farther off, but still in the shallow water of the shore, are the **Crabs** and **Lobsters, Prawns** and **Shrimps.** Farther off again, though not in really deep water, are the various kinds of bottom fishes, the **Halibut** and **Plaice,** the **Cod** and **Haddock** of the cold **northern** seas, and the **Turbot** and **Soles** of the **south**, while far off in the deep waters of the west and only occasionally approaching the land is the great **Hake,** and the **Ling** and **Coalfish.**

Above all these, swimming in the middle or surface waters, are the **Herrings, Sprats, Pilchards,** and **Mackerel.**

Grimsby and **Billingsgate** are the great fish markets of the kingdom, but all round the coast there are fishing ports, and as soon as the fish are landed they are packed in ice [1] and sent away to all parts of the kingdom, so that inland towns as well as those at the sea-side are able to have fresh fish.

Yet so abundant is the supply [2] that not only do we provide our own population with all that it requires, but we also export considerable quantities to foreign countries.

'Fishing, next to agriculture, is the greatest of British industries, judged by the number of men engaged, the amount of capital invested, and the importance of the product to the food of the people. It is an industry which has its risks, but it breeds a race of healthy men. The forces of nature teach self-reliance, and it is this quality which causes fishermen to be the least fostered class of the nation, yet perhaps the most valuable. The fishing community is little recruited from outside, and it can never adequately be replaced. It is prolific, and three-quarters of its excess population enter the navy and merchant service. Its men possess an hereditary instinct for the sea, and the war is surely demonstrating the

[1] We import from Norway every year thousands of tons of ice: in 1913 over 233,000 tons. Hull is the port of entry.

[2] The total value of the fisheries of the United Kingdom in 1913 was over £14,000,000. Their importance in order of weight is: herring, cod, haddock, whiting, hake, mackerel, skate and rays, ling, sprats, turbot, sole, pilchard. Plaice and halibut are included with other flat-fish, but in the returns of English fish plaice comes fourth in the list and halibut eighth.

fact that the value of such men is as great even in this age of mechanics as in the times of Drake and Nelson. . . .

'The total number of the whole-time fishermen is upwards of 125,000, while there are as many half-timers. Taking the whole industry, fishermen, curers, distributing agents, &c., it may be estimated that it gives support to one-twentieth of the population, while the capital sum directly invested must be about 200 million pounds.'[1]

Summary

'DEEP-SEA' FISHERIES

Family.	*Name of Fish.*	*Regions in which Found.*	*Method of Capture.*	*Chief Ports connected with the Fisheries.*
Herring.	Herring.	The seas of Western Europe, and of Eastern America, from Cape Race to Cape Hatteras. Most abundant in the North Sea, the Firth of Clyde (Loch Fyne), the Irish Sea, and the Bay of Fundy and Fortune Bay.	Drift-nets.	Stornoway, Wick, Fraserburgh, Peterhead, Aberdeen, Yarmouth, Grimsby, Lowestoft, St. John's, N.B.
	Sprat.	Seas of Western Europe. Most abundant in mouth of Thames, the Wash, the Solent, the Firths of Forth and Tay, and Moray Firth.	,,	Billingsgate.
	Pilchard.	From the south of the British Isles to Madeira. Most abundant off coasts of Cornwall and Devon and Portugal.	,,	St. Ives, Porthleven, Mevagissey, Newlyn.
Mackerel.	Mackerel.	The Eastern and Western Atlantic from 58°N. to 30° N.; but most abundant in the western part of the English Channel, and the southern part of the North Sea, and south coast of Ireland.	,,	Plymouth and Lowestoft.

[1] *Geography of British Fishes*, by Professor J. Stanley Gardiner, F.R.S., a paper read before the Royal Geographical Society, March 8, 1915.

'DEEP SEA' FISHERIES—*continued*

Family.	*Name of Fish.*	*Regions in which Found.*	*Method of Capture.*	*Chief Ports connected with the Fisheries.*
Cod.	Cod.	On the eastern and western sides of the North Atlantic. Most abundant in the North Sea north of the Humber, the Grand Banks of Newfoundland, and the coasts of Ireland.	Chiefly by trawls, sometimes by long lines.	Aberdeen, Fleetwood, Grimsby, Hull, St. Johns, N.B.
	Haddock.	On eastern and western sides of North Atlantic, but most abundant in the North Sea (especially on the Great Fisher Bank and Dogger Bank) and the coasts of Iceland.	Chiefly by trawls, sometimes by lines.	Aberdeen, Grimsby, Hull.
	Whiting.	The eastern side of the North Atlantic, but most abundant off south coast of England.	Usually by trawls.	
	Ling.	On the eastern and western side of the North Atlantic, but most abundant in the northern part of the North Sea (Great Fisher Bank, Orkneys and Shetlands), the Faroe Islands, Iceland, and Newfoundland.	Usually by lines, sometimes by trawls.	
	Hake.	On the eastern and western sides of the North Atlantic, but most abundant on the south coasts of England and Ireland.		Milford and Cardiff.
Flat-fishes.	Plaice.	On the eastern side of the North Atlantic (not on the western). Abundant all round the coasts of British Isles and of Ireland, but especially abundant in the North Sea.	By beam-trawls.	Grimsby, Hull, Lowestoft.

'DEEP SEA' FISHERIES—*continued.*

Family.	*Name of Fish.*	*Regions in which Found.*	*Method of Capture.*	*Chief Ports connected with the Fisheries.*
Flat-fishes·	Halibut.	A northern fish specially abundant off the coasts of Iceland, the Faroe Islands, and the Orkneys and Shetlands.	By long lines.	Grimsby, Hull.
,,	Sole.	On the eastern side of the North Atlantic, but most plentiful in the Bristol Channel, western part of the English Channel, and the southern half of the North Sea.	By beam-trawls.	
,,	Turbot.	In the same places as soles.	By beam-trawls.	
		RIVER FISHERIES		
Salmon.	Salmon.	Scotch, Irish, and English rivers, especially the Tay, Spey, Tweed, Bann, Severn, and Eden.		
		The rivers of British Columbia (especially the Fraser) and the western rivers of Newfoundland.	Trap-nets.	For tinned salmon, New Westminster, B.C.
Eels.	Eels.	In most of the rivers of Europe, and on east of North America.	Eel-weirs.	
		SHORE FISHERIES		
Crustaceans.	Crabs, lobsters, prawns, shrimps.	In the shallow shore waters of our coasts.	Pots and trawls.	
Molluscs.	Oysters.	In warm estuaries, especially off Kent and Essex.	Dredges.	
	Mussels.	Specially in the Firth of Forth, the Wash, and Morecambe Bay.		

CHAPTER VII

FRUITS

APPLES. We buy over three million hundredweight of fresh apples every year, about **half** of which come from **British possessions, Canada** supplying by far the largest quantity. In **Ontario** apples thrive everywhere, and at present there are about seven million trees in bearing, each of which ought to produce one barrel of apples a year, and though they are not skilfully enough cultivated to produce quite so many as this, still the number they do produce is enormous. The **Lake Peninsula** between Lakes Huron and Erie is the chief fruit-growing district of Ontario. 'These are my babies', said a farmer whom I was visiting a few miles north of the lake. We were standing on a hillside; behind us, running up to the summit, was a dense wood of maple and elm; before us, sloping down to the farmyard was a great undulating stretch of brown earth dotted at wide intervals with little trees. They looked so small and insignificant and helpless that 'babies' seemed the only fitting word to describe them.

'Now come and see the grown-ups', he continued. We struck across the baby orchard and presently found ourselves among their adult relations. The trees were not tall or imposing in size, they had purposely been kept down in height, so as to avoid difficulty in picking the fruit from the topmost boughs, but they were all strong and in perfect health. From some the fruit had already been picked; others were loaded with big apples till the branches almost touched the ground.[1]

Not only is the fresh fruit exported, but also tinned and dried (or evaporated) apples. It is interesting to read in this connexion that before the war the very peelings and cores of the apples were dried and sent over to Germany in the form of pulp or chop for use in making cheap jam, and that millions

[1] B. H. Kennedy, *The Heart of Canada.*

of ' culls ' (apples too small to peel, being less than two inches in diameter) were sliced and dried and shipped to Havre to be used, it is supposed, in making cider.

Nova Scotia is another apple-growing province. The sheltered land near the Bay of Fundy is covered with orchards, especially in the **Valley of Annapolis.**

The best apples of **British Columbia** grow in the Valley of the **Okanagan,** a tributary of the Columbia, in the southern

APPLE ORCHARD IN BLOOM, CANADA

part of the province: but there are many other apple districts.

In nearly all the **Australian States** the cultivation of apples is increasing, but at present the most extensive orchards are in **Tasmania**. The **County of Kent** in the south of the island, and especially the **Huon Valley,** are the most noted districts. The fruit is exported in large quantities, and from **Hobart** alone in the season a dozen or more large ocean steamers leave the docks loaded with apples as their cargo.

BANANA (Natural Order *Musaceae*). This great plant, which

looks like a palm tree but is in reality a herb, belongs to the ginger family. It is thus described by a traveller in A. D. 1600 :

'Bannana is the fruite whereof John Huyghen writeth and calleth it Indian figs, this tree hath no branches, the fruit groweth out of the tree and hath leaves at least a fathome long and three spannes broad. Those leaves among the Turkes are used for paper, and in other places the houses are covered therewith ; there is no Wood upon the tree, the out-

APPLES

side (wherewith the tree is covered when it beginneth to wax old) is like the middle part of a Sive, but opening it within there is nothing but the leaves, which are rolled up round and close together, it is as high as a man, on the top the leaves begin to spring out, and rise up on end, and as the young leaves come forth the old wither away, and begin to drie untill the tree cometh to his growth and the fruit to perfection : the leaves in the middle have a very thick veine, which divideth it in two, and in the middle of the leaves out of the heart of the tree, there groweth a flowre as bigge as an Estridge Egge, of a russet colour, which in time waxeth long like the stalk of a Colewort whereon the Figges grow

close one by the other, when they are still in their huskes, they are not much unlike great Beanes, and so grow more and more until they be a span long and four thumbes broad like a Cucumber, they are cut off before they are ripe, and are in that sort hanged up in bunches, which oftentimes are as much as a man can carrie. . . . having hanged three or four dayes they are through ripe, the tree beares but one branch at a time, whereon there is at least one hundred Figges and

BANANA PLANT

more, and when they cut off the bunch of Figges the tree also is cut down to the ground, the root staying still in the earth, which presently springeth up againe and within a moneth hath his full growth, and all the yeare long, no time excepted.

'The tree beareth fruit, the fruit is very delicate to eate, you must pull off the husk wherein the fruit lyeth, very delightfull to behold, the colour thereof is whitish and somewhat yellow, when you bite it, it is soft, as if it were of Meale and Butter mixed together, it is mellow in byting. . . . Some are of opinion because it is so delicate a fruit, that it was the same

tree which stood in Paradise, whereof God forbade Adam and Eve to eate. It smells like Roses, and hath a very good smell, but the taste is better.'

1. 'The fruit groweth out of the tree.' When the banana has attained its full height, and the leaves their full size, from the underground tuberous stem a flower-stalk begins to grow. It pushes its way up through the hollow tube (which looks like the trunk of a tree, but which is in reality formed by the overlapping of the bases of the leaves) and shoots forth from the top.

BUNCH OF BANANAS

'At the end of the stalk there groweth a flower as bigge as an Estridge Egge.' This is in reality not one flower but many clusters of flowers, and each cluster is covered and protected by a russet-coloured bract. These bracts overlap one another and form a compact mass like an 'Estridge Egge'. Gradually the 'Egge' lengthens and the bracts one by one turn back and reveal their cluster of flowers, after which both bract and flower wither and die. The first flowers to appear are the female ones which produce the fruits. Towards the end of the stalk are male flowers. When these male flowers wither no fruit is left, so that there is always a bare space between the fruits and the end of the stalk.

When the fruits are formed their weight causes the stalk to bend and hang down from the plant. A bunch of bananas contains usually more than a hundred bananas and weighs from 80 to 100 lb.

'When the bunch is to be cut, the stem is partly cut through five or six feet from the ground and then the whole plant slowly topples over. . . . Several book-keepers on a large estate will thus be entering the bunches, while the overseer or manager riding from one to the other controls the number cut for delivery that night or in the early morning at the wharf. The bunches are wrapped in trash and handed up by two men

to another on a waggon, who packs them in carefully so that there shall be no bruising. It is singularly picturesque to ride through the shady rows of bananas with here and there rough majestic heads falling and figures swiftly moving at their work, to note the quick movements of the men, the stately walk of the women with a bunch balanced on their heads, all accompanied by the noise of the large leaves in their descent, the cries of the men and the peculiar call for the women when they are wanted.'[1]

Cultivation. Bananas produce no seeds, but from their underground stems they send forth shoots, and, when new plantations are required, these shoots are cut off from the parent plant and set in the earth. They are cut when about six months old, and ten months afterwards they begin to flower. Bananas require heat and moisture, a rich soil, and sheltered situation. Wind and rough weather would soon play havoc with their great broad juicy leaves.

Varieties. There are many different kinds of bananas; the height of the smallest is about five feet, but large varieties attain a height of twenty feet or more. *Musa sapientium* is a large kind and *Musa Cavendishii* a small kind. The former grows in Jamaica, and the latter in the Canary Islands and Barbados, while one known as the *claret variety*, of a very delicate flavour, grows in Trinidad.

In the East all bananas are called *plantains*, but in the West Indies a distinction is made. The plant there known as the plantain produces larger fruits, and the length of bare stalk on a bunch is less than on a bunch of bananas. The fruit is always cooked before it is eaten; it takes the place of bread or potatoes. The plantain is more valuable than the banana and requires a richer soil to grow in.

Sources of Supply. We buy over nine million bunches of bananas in a year, and at present nearly eight million of these are bought from foreign countries, chiefly from *Costa Rica*, the *Canary Islands*, and *Colombia*.

[1] W. Fawcett, *The Banana: its Cultivation, Distribution, and Commercial Uses.*

In our own empire our chief source of supply is the **West Indies,** more especially **Jamaica,**[1] but many other British countries grow them although they do not export them to us. In **Queensland,** for instance, both the climate and soil of the eastern lowlands are admirably suited to the cultivation of bananas, and millions of bunches are produced every year, but these are all exported to the southern states of the Commonwealth. In the **Kenya Colony** inferior varieties flourish

TWENTY-DOZEN BUNCH OF BANANAS, QUEENSLAND

everywhere in the coastal belt, and as soon as better kinds have been introduced they will doubtless form an important article of export. In **Nyasaland**, too, bananas do exceedingly well.

CITRUS FRUITS, i.e. **Oranges, Lemons, Limes, Citrons.**

1. The **Orange**. The fruit of the *Citrus aurantium* or Golden Citrus, a rather small and round evergreen tree, growing to a height of about fifteen feet ; it bears beautiful white, five-petalled, wax-like flowers, each having a large number of bright-

[1] Since 1893 the export of fruit (chiefly bananas) has steadily increased, until now it forms half the exports of the island

yellow stamens. These flowers occur singly at the axils of the leaves and are very abundant; and later on the round golden fruits seem to be dotted all over the tree. As many as 20,000 have been gathered from a single tree in a year, though 2,000 is the more usual number. Orange trees begin to bear fruit when about four years old, and go on bearing for a great number of years.

CITRUS ORCHARD, SOUTH AFRICA

Though now one of the most characteristic trees of **Spain** and the **Mediterranean** countries, it was not known in these regions before the fifteenth century, when it was introduced by the Portuguese from Asia. It is now cultivated in nearly all warm countries where the winter temperature does not fall below 40°.

There are many varieties of oranges, some of the most famous being the **St. Michael** (named after one of the islands of the Azores), the **Maltese** (with pulp of a blood-red colour),

and the **Jaffa.** The **Seville,** or bitter orange, is rather darker in colour than the other kinds and larger, though the tree which bears it is smaller. The **Tangerine** is a small orange broader than it is long, with the rind loosely attached to the fruit.

Sources of Supply. In 1915 we bought over six million hundredweight of oranges, of which considerably over five million hundredweight came from **Spain** and **Italy**. The

TANGERINE ORANGE

United States and Asiatic Turkey also sent us large quantities, and the rest came from countries in our own empire, chiefly from the **West Indies** and **South Africa.**

In nearly all the British West Indies oranges are abundant, but in **Jamaica** they grow luxuriantly, without cultivation, in almost every part of the island, and they form an important article of export.

In South Africa, the **Cape Province** grows excellent oranges, especially near **Fort Beaufort,** and great care is taken in the

grading and packing of these for export. It is one of the ambitions of this province to be an extensive exporter of oranges and other citrus fruits, and both climate and soil seem to justify the ambition. **Natal** (on the coastal plain and also in the midlands), the **Transvaal** (especially in the neighbourhood of Pretoria), **Nyasaland, Southern Rhodesia,** and **Kenya Colony** (especially at Changamwe, about six miles or so from Mombasa), all grow considerable quantities of oranges, and their number could be greatly increased.

Not only South Africa but probably Australia will send us large supplies of oranges in the future. In **New South Wales** about sixteen miles from Sydney are the famous **Paramatta** Groves, where in the season every second man, woman, or child you meet is eating oranges. In October enormous quantities are sent down to Sydney. The **Hawkesbury Valley,** too, is famous, and many other places, especially the **Murrumbidgee Irrigation District,** which of late years has begun to grow oranges on a large scale for export.

In **South Australia** (especially in the neighbourhood of **Adelaide**), in Victoria (in the Goulburn Valley), and in Western Australia (near Brisselton), oranges are extensively cultivated, while in **Queensland** not only are there many beautiful groves already in existence, but on the coastal plain there are thousands of acres suitable for cultivation which are not yet utilized. The rainfall here is sufficient without irrigation, and there are never any frosts to check the growth of the trees, so that this one state alone, it is estimated, might supply all our needs.

As the seasons south of the Equator occur at different times from those in the Northern Hemisphere, the produce of the Australian and South African groves is available when no fruit is forthcoming from other countries.

2. The **Lemon** (*Citrus limonum*). This is a smaller and less robust tree than the orange ; sometimes, indeed, it is not much more than a bush. The flowers are similar to those of the orange, but they are smaller, and their petals are pinkish

on the outside. They have a very pleasant scent. Though, like the orange, the lemon tree is now a characteristic tree of Mediterranean countries, especially of Sicily, it was not introduced into those countries until the fifteenth century. At present we import the bulk of our lemons from **Sicily,** but nearly all the British Dominions which grow oranges also grow lemons, and their production could be greatly increased.

PACKING CITRUS FRUIT FOR EXPORT, SOUTH AFRICA

3. The **Lime** (*Citrus limetta*). This is a pale yellow fruit very much like the lemon but round in shape. Its flavour is considered to be more delicate than that of the lemon. It requires a warmer climate than do oranges and lemons, and is not so extensively grown in Mediterranean countries. The **West Indies,** especially **Dominica,** are famous for their limes, but they also thrive in the coast lands and midlands of **Natal,** and the coast lands of **Queensland.** In **Dominica** many old sugar-cane lands have been planted in limes and cacao,

and very often sugar-canes are planted among the young limes, and afford them shelter whilst growing.

There are very many varieties of lime trees and some are spineless, but most kinds have sharp spines in the axils of the leaves, so that it is necessary to burn all prunings at once lest the spines injure the feet of the bare-footed labourers. Citrus trees are surface feeders, and their rootlets honeycomb the surface of the ground in which they grow.

Limes for export are gathered before they are ripe and ripen during the voyage, but in all other cases the fruit is allowed to remain on the tree until quite ripe, when it falls to the ground and is then gathered.

Lime-oil is obtained by pressing ripe limes against blunt spikes when oil and moisture ooze out. **Lime-juice** is obtained by squeezing the ripe limes between rollers ; very often the old sugar mills are used for this purpose. Concentrated lime-juice is merely ordinary pure lime-juice boiled down. **Lime-juice Cordial** is a beverage made by adding other ingredients to the pure lime-juice. **Citric acid** is obtained both from lemon-juice and lime-juice ; it is used in dyeing and calico printing.

4. The **Citron** (*Citrus medica*). The citron-tree is a small straggling evergreen tree. It bears clusters of pink flowers, and large oblong warty yellow fruits, with a very thick rind and not much pulp.

It was extensively cultivated by the Jews in Syria and was the only citrus known to the Greeks and Romans. It is cultivated in the south of Europe and other places, but not to any great extent ; the lemon has ousted it.

FIGS (*Ficus carica*). The fig-tree is a small straggling tree with very numerous, large, dark-green, irregularly-shaped leaves. In the axils of the leaves there grow curious green pear-shaped figs with a stalk at one end and a little opening at the other covered over with small scales. The tiny numerous flowers are attached to the inside of this receptacle, which at first is full of a rather bitter juice, but as it ripens the outside changes from green to purple and the inside juice

solidifies into a sweet pulp. The flowers have developed meanwhile into minute seeds, which are the real fruits of the tree.

What are called green figs are merely these fresh ripe figs; dried figs, such as we buy in boxes, are the ripe figs dried in the sun or in ovens. No sugar is necessary to preserve them as they themselves contain from 60 to 70 per cent. of grape sugar.

Smyrna, in Asia Minor, exports most dried figs, but the tree thrives in nearly all warm and temperate climates, though for its fruits to ripen it must have a hot dry season. On the western downs of **Queensland** fig-trees grow well, and also in the south-west of **Western Australia** and in the **Cape Province** and **Natal.**

DATES, the fruit of the date palm, *Phoenix dactylifera.* The date palm grows to about a hundred or a hundred and fifty feet high, and like other palms has no branches, but consists of a long straight trunk, bearing at its summit an enormous mass of large feathery leaves.

In the midst of these great leaves there shoot forth spikes of flowers, each spike being enclosed in a sheath. The number of these spikes varies; sometimes there are as many as twelve, but from two to six is the more usual number, and each spike bears between one and two hundred dates. A bunch or spike of dates weighs about twenty-five pounds, and its heavy weight causes it to bend over and hang down.

There are many different kinds of date palms, and the fruit varies in shape and colour. Some of the best kinds are yellow when ripe and about two inches in length, others are red. They consist of a sweet pulp and inside is a hard stone. They are eaten either fresh or dried.

On the walls of ancient Thebes there are paintings dating from 1600 B.C., and in these are to be seen date palms in fruit showing that more than three thousand years ago these trees flourished in the Valley of the Nile as they do now. At present there are millions of date palms in Egypt and the Sudan, but the bulk of the fruit is eaten by the inhabitants of the country

and comparatively little is left over for export. It is from the Valley of the **Euphrates** that the chief export of dates takes place. Here are the famous groves of **Bussorah** which form 'an almost unbroken line of from one to three miles in

DATE PALM AND FRUIT

depth along both banks of the Euphrates and Shat-el-Arab, from Medinhab to the sea, that is for more than 140 miles'. They yield from 40,000 to 60,000 tons of dates annually.

Not only are there these millions of date palms in the Valleys of the Nile and Euphrates, but they are also found

growing in the Sahara and eastwards through Persia and North India. The date is indeed the tree of the hot deserts, but only of the oases of the deserts. Though it thrives in burning hot dry sunshine, its roots must have water. As the ancient proverb says, 'The date must have its head in the

FRUIT OF DATE PALM

fire, and its roots in water.'.

Though the Sahara and the dry hot lands of the Northern Hemisphere are the original home of the date palm, there seems no reason why it should not flourish in similar soils and climates in other parts of the world, and in the **Western Plains of Queensland** trees have already been planted and are thriving

satisfactorily. Their number could be multiplied indefinitely wherever artesian wells are available to supply the necessary water for their roots. Not only would their fruit be very valuable, but the shade which they would afford to man and beast out on those wide stretches of sun-scorched land would perhaps be of even greater value.

GRAPES, the fruit of *Vitis vinifera*, the wine-yielding vine. In Italy and Greece and Asia Minor and Persia the wild vine is to be seen by the side of streams climbing up over other trees, and in Italian vineyards the cultivated plant is still trained up trees pruned for the purpose, but in France and other wine-producing countries the vines are not allowed to grow higher than three or four feet, and instead of trees there are short poles to support them.

Grapes will not ripen in countries which have a cool summer ; on the other hand, in the burning hot tropics the vines produce no fruit. In Britain, in sheltered places and in favourable seasons, grapes ripen out of doors, but for the most part we grow them under glass. One of our most famous vines is the one at Hampton Court, which was planted in George III's reign and still produces more than a thousand bunches of grapes every year.

The unfermented juice of ripe grapes is called *must*, after fermentation it is called **wine.** **Brandy** is a spirit distilled from wine. **Raisins** are grapes which have been dried in the sun. They are of two kinds, muscatel raisins, which are the fruit of the muscatel vine, and Valencia raisins. The former are not separated from their stalks, but dried whole in bunches ; Valencia raisins are dried singly. **Currants** are the dried stoneless grapes of a vine which grows abundantly in the Greek Islands ; they are round, and small, and very sweet. They were called Corinth raisins, because they were first imported into England from Corinth.

At present we buy our **wine** principally from **Spain** and **Portugal** and **France,** our **raisins** from **Spain**, and our **currants** from **Greece.**

Of countries within the empire we buy most **wine** from **Australia.** From very early days colonists from wine-growing countries, finding a climate and soil similar to their own, began to grow vines, and others followed their example. But they lacked the knowledge and skill necessary for the production of good wine, and for many years Australian wine was of poor quality. Gradually, however, knowledge and experience were gained, and now the wine which Australia produces and exports is considered excellent. **South Australia** stands first as a **wine-producing** state. The vineyards are

PICKING GRAPES, SOUTH AFRICA

chiefly in the country round **Adelaide,** where thousands of tons of grapes are produced every year. About half of these are used for making wine ; the others are either dried or sold fresh for table use. At **Renmark,** on the Murray River, great irrigation works have been established, and here, in addition to many other kinds of fruit, large quantities of **raisins** and **currants** are grown. **Victoria** comes next in order. Her vineyards are many thousands of acres in extent, but the bulk of her crop is dried, and **raisins** and **currants** are exported in large quantities. **Mildura** on the **Murray River,** the largest irrigation settlement in Australia, is the centre of this industry. In **New South Wales, Newcastle** and **Albury** are the chief grape-producing districts, though there are vineyards in many

other parts of the coastal plain. In **Queensland** good grapes are produced near **Brisbane,** but the best wine-grapes grow at **Roina,** in the south of the state, on the western slopes of the Dividing Range. In **Western Australia** the south-western corner, especially the valley of the **River Swan,** is the chief grape-producing district.

In the **Union of South Africa,** the south-western district (**Stellenbosch** and **Paarl**) produces excellent **raisins** and some wine.

Nearly all the grapes which Canada produces are grown in the Lake Peninsula, especially at the western end of Lake Ontario; but though there are many thousand acres under vines at present, there are not enough grapes for export.

Cyprus also exports **wine** and **raisins.**

PEACHES. The original home of the peach is China, but it was introduced into Europe from Persia, hence it is called *Aurydalus Persica.* It was not known to the Greeks and Romans before the first century of our era.

The peach-tree resembles the almond in many ways; it bears the same exquisitely beautiful pink flowers, but whereas the peach-stone is covered with a delicious juicy pulp, the almond has a thin tough skin and it is the kernel inside the stone (the nut) which is eaten.

In England, peaches, like grapes, will ripen out of doors in sheltered sunny positions in favourable seasons, but for the most part we grow them under glass.

Of those we import, the largest number come from **France,** but many parts of the empire have a soil and climate exactly suited to them, and there is every reason to suppose that their cultivation will be greatly extended in the future.

In the **Cape Province of South Africa** the orchards are in the south-west, and there is a considerable export.

In **Canada** the bulk of the peaches produced are grown in the **Lake Peninsula**. Near **Hamilton,** on the shores of Lake Ontario, there is a sandy strip of land covered with peach orchards, and in the spring-time when the trees are in flower

their pretty pink blossoms and the glorious blue of the sea-like lake make an exquisitely beautiful picture. Besides the fresh fruit, there is also a considerable export of tinned peaches from Ontario.

In **Australia** in all the mainland states peaches grow abundantly, and **Victoria** exports dried peaches.

PINEAPPLES (*Ananas sativus*, Natural Order, *Bromeliaceae*). In London a good pineapple costs five shillings or more, but

PEACH TREES, QUEENSLAND

in Queensland you can buy a dozen of the best for one shilling and sixpence, while ordinary kinds are sold at a penny each.

The pineapple plant grows to a height of about three feet. It has no stem, but sends up from its roots numbers of long, stiff, sharp-pointed leaves. In some kinds the edges of the leaves are smooth, as, for instance, in the Cayenne, or Kew Pine, in others serrated, as in the Ripley Queen.

From the centre of the plant a flower-spike shoots up with separate flowers growing along it, each nestling in a little bract, but gradually bracts, calyces, and fruits all unite into

one juicy mass, and form what we call a pineapple. At its top is a tuft of leaves called the *crown*.

'It is as great as a Mellon, faire of colour, somewhat yellow, green and carnation, when it begins to bee ripe, the greenenesse thereof turneth into an orange colour, it is of a pleasant taste, and hath a fine smelle like an Apricocke, so that it is to be smelt farre off, when you see the fruit afarre off, being greene, it sheweth like Artichokes.' (A.D. 1600.)

CULTIVATION. The pineapple is a native of the north of South America, and in its wild state grows in sandy places not far from the sea. In cultivation it thrives best where these conditions prevail, but it will grow well almost anywhere so long as it has warmth and sufficient moisture. It is exceedingly sensitive to cold, and, though it does not need the great heat of the tropics, the least frost kills it at once. In **Florida,** where pines are extensively grown, sheds are erected to protect the plants from the occasional frosts which occur.

After fruiting the plant dies down, but suckers grow up and take its place. When new plantations are required, these suckers are cut off and set in the earth. They bear fruit about a year after they are planted. The weight of a pineapple varies: on a Queensland plantation 2½ lb. is considered a fair average (though some weigh as much as 12 lb.), and an acre will produce twelve thousand of them.

SOURCES OF SUPPLY. Pineapples are grown in nearly all countries where the climate is warm and moist enough to suit them, but they are most extensively cultivated in **Cuba, South America,** and the **Hawaiian Islands.**

In the British Empire the **West Indies** used to be famous for their pines, but of late years the export has fallen off, though considerable quantities are still exported from the **Bahamas** and **Montserrat.**

The growing of pineapples forms an important industry in the **Malay Peninsula**, and **Singapore** is one of the great world centres for the export of tinned pineapples.

Queensland. 'If there is one fruit which Queensland can

grow to perfection it is undoubtedly the pineapple.' Large quantities are produced, especially in the neighbourhood of **Brisbane**, and it is confidently expected that the number will be greatly increased in the future and that a trade will be developed in tinned pineapples.

In **Africa, Natal** and the eastern districts of the **Cape Province** export pineapples, and though not at present exported

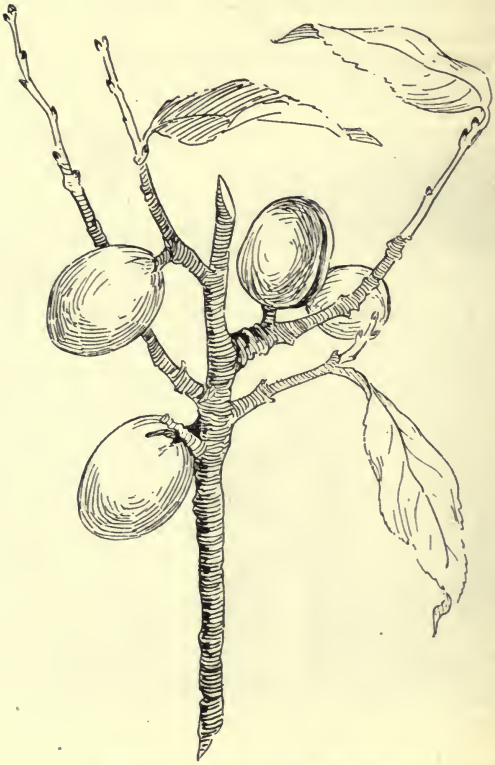
PINEAPPLE FIELDS, SINGAPORE

they are successfully grown in the Gold Coast, Nigeria, and Kenya Colony.

ALMONDS. 'And, behold, the rod of Aaron for the house of Levi was budded, and brought forth buds, and bloomed blossoms and yielded almonds.'—Numbers xvii. 8.

The almond tree is considered to be a native of Syria and Persia and Turkestan, and the best kind of almonds are still called Jordan almonds though they are now grown chiefly in Spain.

The tree is a handsome shapely tree and the pale pink flowers are borne on the branches of the previous year ; they appear before the leaves. An almond orchard in blossom is



BRANCH OF ALMOND TREE

a wonderful sight. The fruit is rather like an olive-green downy plum, but it is flatter and has a furrow down one side, which splits open when it is ripe and reveals the almond-stone inside. This stone is light brown in colour, smooth, and with little dents all over it. Inside is the kernel or almond.

There are two kinds of almonds—bitter and sweet. The latter are the ones usually eaten for dessert; they are larger than the bitter ones. Almond oil is made chiefly from bitter almonds; it is a pale yellow fluid.

Spain, Morocco, Italy, Portugal, and France supply us at present with most of our almonds, though we do buy even now a certain amount from British possessions.

In the fruit-growing districts of **Victoria** almond trees abound, and on the coastal tablelands of **Queensland** they do well.

SUMMARY. Thus, although we still import the bulk of our supplies from foreign countries, there is an increasing production of all kinds of fruit in our own Dominions; especially is this the case with regard to apples, bananas, pineapples, citrus fruits, raisins and currants, and various kinds of dried and tinned fruits, so that there seems every reason to hope that, year by year, larger quantities of fruit will reach us from **Canada**, the **West Indies, South Africa,** and **Australia.**

SUMMARY. **Fruit.**

Fruit.	*Sources of Supply.*		*Remarks.*
	Foreign.	*British.*	
Almonds.	Spain, Morocco, Italy, Portugal, France.	Possible sources of future supply: Victoria, Queensland.	
Apples.	The United States and other countries.	Britain, Nova Scotia, British Columbia, Ontario, Tasmania, the Channel Islands.	About half our imports are from British sources, and of these Canada is the most important.
Bananas.	Costa Rica, Canary Isles, Colombia.	Jamaica. Possible future sources: Queensland, Kenya Colony, Nyasaland.	Our chief imports are from foreign countries, but those from Jamaica are considerable.

Fruit.	Sources of Supply. Foreign.	British.	Remarks.
Citrus fruits: i. Oranges.	Spain, Italy, the United States, AsiaticTurkey.	The West Indies, South Africa. Possible source of future supply: Australia.	Most of our imports are from foreign sources, but empire production is increasing rapidly.
ii. Lemons.	Sicily.		The bulk of our supplies come from Sicily, but production within the empire could be extended.
iii. Limes.		Dominica.	
Dates.	**Asiatic Turkey.**	British India, Egypt. Possible future source: Queensland.	Asiatic Turkey is the most important source of supply, but imports from India have increased during the war.
Figs.	**Asiatic Turkey**	Possible sources of future supply: Queensland, Western Australia, the Cape Province, Natal.	
Grapes: i. Fresh.	Spain and other countries.	Britain, the Channel Islands, the Cape Province.	
ii. Raisins.	AsiaticTurkey, Spain.	British India, the Cape Province, Australia, Cyprus, Egypt.	During the war imports from India have greatly increased.
iii. Currants.	**Greece.**	Australia.	Most of our imports are from Greece, but production is rapidly increasing in Australia.
iv. Wine.	France, Portugal, Spain, and many other countries.	Australia, South Africa.	Our best wines are still foreign, but Australian and African wines are improving both in quality and quantity.
Peaches and apricots (fresh).	France, the United States.	The Cape Province, Ontario. Possible source of future supply: Australia.	Most of our imports come from France at present, though the Cape sends considerable amounts, and Ontario besides fresh peaches sends also tinned ones.

Fruit.	Sources of Supply. Foreign.	British.	Remarks.
Pineapples (tinned).	Siam, Hawaii, the United States.	The Malay Peninsula, Australia.	In England excellent pine-apples are grown under glass, but the chief sources of tinned pineapples are as shown; **Singapore** is one of the chief centres.
Plums and apricots (dried).	**The United States** and other countries.	Australia, South Africa, Canada.	Of British possessions before the war Canada sent us most, but now Australia and South Africa have outstripped her.

CHAPTER VIII

SUGAR

SUGAR (from the Arabic, *suk kar*). The **sugar-cane** (*Saccharum officinarum*) is a kind of grass which grows from ten to twenty feet high. At intervals up the stalks (or canes) there occur joints, and from these joints spring the long flat leaves. The leaves themselves each have a sheath about a foot in length, and a blade three feet or more long. They are about three inches wide, and their edges are finely indented and cut like a sharp saw.

The joints up the stalk are at first about two inches apart, but they occur at longer and longer intervals and at last there is a long straight unjointed piece of stalk, which is called the arrow. This arrow, or flowering stem, bears a grey, feathery mass of blossom about two feet in length. The flowers themselves are tiny but very numerous. They are placed all along the stems which grow out from the arrow, and at the base of each flower are long white silky hairs.

From each joint sprouts a bud, and it is from these buds that the new canes are produced. The ground is cleared and

holes are made a foot or so apart, and into each hole is put a plant, that is, a piece of cane containing a bud. In about fifteen months the canes are ready for cutting. By this time some of the leaves have dropped off from the lower joints, but many still remain attached to the stalk; and the task of the labourers who have to cut down all this sugary jungle is no light one, for the rind of the canes is hard, the mass of vegetation dense, and the weather hot. They use great curved knives about two feet long called *machetes*, and with these they cut down the canes close to the ground and remove the leaves or trash. From the roots spring up fresh canes (*ratoons* as they are called) and no more planting need be done for two or three years.

As soon as the canes are cut down they are taken to the mill. Here they are passed under rollers and the juice is crushed out; it is greenish grey in colour and opaque. It has next to be purified. This is done by heating it in tanks and adding some lime to it. The lime combines with some of the impurities and sinks to the bottom, and the clarified pale yellow juice is drawn off. The juice is boiled until it becomes a syrup and is then allowed to stand until it crystallizes. The sugar crystals form what is called **raw sugar**; it is either packed in bags and shipped to other countries, or sent to refineries near at hand.

The sugar which will not crystallize is allowed to drain off and is called **molasses.** The crushed cane from which the juice has been extracted is called **megass**, and mixed with molasses it makes a very good food for cattle. Megass itself makes excellent fuel.

On arrival at the refineries the raw sugar is subjected to various other complicated processes all with the object of still further purifying it, and at last it emerges in the various forms with which we are acquainted.

Loaf-sugar. Formerly purified syrup was poured into conical moulds and then allowed to solidify. These cones or sugar-loaves were then cut up and the little cubes of white

sugar were called loaf-sugar, and the syrup that trickled out was called **treacle**. Nowadays the moulds are square and shallow, but the name for the white sugar still remains the same. **Golden syrup** has to a large extent taken the place of treacle ; it is lighter in colour than treacle and clearer, and is generally supposed to be purer.

We take immense care and trouble to purify our sugar, but

SUGAR CANE IN ARROW

in sugar-cane countries the natives are not so particular. In India, for instance, in the bazaars, you can buy a nice piece of sugar-cane for ½*d.*, and children, and grown-up people too, just suck it as it is with no thought of its impurity. In the West Indies people do the same and they are all said to look very sleek and well fed and happy during the sugar harvest, for, although sugar by itself will not sustain life, it is nevertheless very nutritious.

As soon as we think of sugar our thoughts fly to the **West Indies**, for we feel that here indeed is the real home of the

sugar-cane, and we know that the prosperity of the islands is largely dependent on its successful cultivation. Yet strange to say the sugar-cane is not native to these islands; it was unknown there three hundred and fifty years ago.

Sugar is believed to have come originally from Bengal, but in many other parts of India it has been cultivated from the remotest ages of antiquity. From India its cultivation spread westwards, and it was introduced by the Arabs into Mediterranean countries, wherever the climate was hot enough. In the eighth century it was introduced by them into Spain, and some years after the discovery of America by Christopher Columbus (1492) the cane was planted by the Spaniards in the West Indies, where it flourished beyond their wildest dreams.

To the poor natives of the islands, however, its presence seemed a questionable blessing, for the Spaniards themselves took no share of the toil involved in its cultivation, beyond appointing overseers to superintend the labours of the natives. These, unaccustomed as they were to such harsh conditions, sank under their burdens, and it was to relieve them that negroes were introduced as slaves to work on the plantations. By this slave labour the crop was produced year after year, and enormous fortunes were made by the owners of sugar estates. But later on came a change.

After fifty years or more of work and agitation, in 1833 we passed a law by which all slaves in British Dominions were set free. From that time forward labourers on our sugar plantations had to be paid wages, and, in consequence, sugar cost more to produce, and, therefore, had to be sold at a higher price than formerly.

In other countries, however, slave labour remained, and they could in consequence sell their sugar at a lower price than the West Indian planters could.

England, to her eternal honour, freed her slaves; but to her eternal shame she continued to buy, because it was cheap, slave-grown sugar produced in foreign countries, thereby aiding and abetting the practice of slavery, and at the same

time ruining her own countrymen. Many West Indian estates went out of cultivation.

Next came **Sugar Beet.** The beetroot sugar industry was established by Napoleon I in France in order to render her independent of supplies from British colonies. It has ever since been pursued with the greatest care and intelligence.

Later on other countries took up the industry, notably Germany. Continental Governments encouraged beet-growers in every possible way, giving them a bounty on every ton of sugar they were able to export. As a result of this, and the fact that the abolition of slavery had disorganized the West Indian industry, beet sugar could be sold at a price lower than cane sugar, and, as cheapness, to the exclusion of every other consideration, made an unfailing appeal to us, we bought beet sugar, with the result that we became dependent on foreign supplies and our preference for beet sugar almost completed the ruin which the abolition of slavery had begun.

In spite of all this, however, sugar is still the chief industry of the West Indies. The partial abolition of the bounty system in 1903, improved methods of cultivation, and the preference granted by Canada to British grown sugar, have all helped to improve the condition of affairs, though as late as 1913 we spent £23,066,621 on sugar, of which money only £930,933 went to British possessions.

Sugar requires a rich soil and a hot moist climate; it can be grown successfully in all parts of the world where these conditions obtain, though it does best on land not too far from the sea.

Sources of Supply. In our own empire, besides the **West Indies, British Guiana** and **Mauritius** are our most important sources of supply.

British Guiana lies between Venezuela and Dutch Guiana in the north of South America. From the coast inwards stretches a belt of hot moist lowland on which are situated the sugar plantations. **Demerara**, the name of one of its rivers, and of one of the three counties into which the colony

is divided, has given its name to all sugar refined in a certain manner, whether it comes from Demerara or not. This colony of British Guiana is almost as large as the British Isles, and its lowlands, if they were all cultivated, could supply us with all the sugar we need, and a great deal more.

Mauritius. This little island has an area of only 720 square miles, but, lying as it does in the Indian Ocean, in latitude 20° S., it has an ideal climate for sugar cane, and sugar-growing is its one and only industry. It used to export most of its supplies to countries near at hand, but of late years we in Britain have bought a large proportion of them.

British India has many thousands of acres under sugar, but a great deal is required for home consumption, and our imports from there are not so great as from other places. **Bengal,** the **Punjab,** and the **United Provinces** of **Agra and Oudh,** have the most extensive plantations.

Egypt. Both the climate and the soil of Egypt are eminently suited for sugar, especially in the Delta, and here many acres are planted with it, but hitherto we have not imported much.

Queensland. Many sincere friends of Australia counsel her to employ coloured labour on her tropical lands, which they refer to now as a 'wasted heritage'. India, they say, is over-populated, and this surplus population could very profitably be employed on the sugar plantations of Queensland. By this means not only would the population difficulty of India be solved, but enormous supplies of sugar and other tropical produce would be added to the wealth of the empire.

On the other hand most Australians are passionately attached to the opposite policy—a white Australia. They desire to keep their country for the white races only, and they maintain that white men can endure the heat, and that sugar and similar products can be cultivated by their labour alone.

The first plantations in Queensland were worked by coloured labourers, Kanakas, brought in from the Pacific Islands, mainly from the New Hebrides; but in 1901 the Commonwealth

Parliament passed a law saying that these men were to be sent back to their homes, and from that time forward the sugar produced in Queensland has been produced almost entirely by the labour of the white man. The idea is, instead of enormous plantations worked by gangs of unskilled, poorly-paid coloured labourers, to have small estates worked by their owners and a few highly-skilled well-paid assistants.

Queensland has an area of 688,000 square miles (i. e. it is more than five and a half times as large as the British Isles). Two-thirds of it lie within the tropics. From south to north her coast extends for nearly a thousand miles, and 'at intervals along this great distance are large areas under cane, and a number of considerable towns almost entirely dependent on the sugar industry'. **Mackay**, between Rockhampton and Townsville, is called the *sugaropolis* of Australia.

In 1903 over 2,000,000 tons of cane were harvested, from which were obtained over 200,000 tons of sugar. Scarcely any coloured labour was employed, and the adherents of the White Australia policy look forward to a time when they will be able not only to supply all the sugar which is required in Australia, but also have large quantities over to export to other countries.

Union of South Africa. There is a narrow belt of tropical country on the coast of Natal where sugar is grown, but at present most of this is either used at home or exported to other parts of South Africa. Indian coolies work on the plantations.

In the low-lying veld of the Transvaal, too, the soil and climate are suitable and some sugar is grown, but the supply of labour is a difficulty.

Fiji. These islands are situated in the Pacific Ocean in latitude 20° S. They are remarkably fertile, and sugar is one of their most important crops, but we import very little from them.

Kenya Colony. Sugar is grown here only to a small extent at present, but there are rich alluvial lands in the

deltas of the principal rivers and elsewhere along the coast very suitable for sugar.

In the **Malay Peninsula** sugar used to be one of the principal products, both soil and climate being all that could be desired, but of late years rubber has taken its place.

Sugar Beet is produced from seed, and grows in temperate climates. It is sown in the spring and dug up in the autumn. It is white in colour, not red, as are the ordinary beets with which we are acquainted. A sugar beet looks rather like a large parsnip. When the roots have been washed the juice is extracted from them. There are two or three different methods by which this is done: one of the most usual is to mash the roots up to a pulp and then press the juice out of them by machinery. The other processes for refining the juice and obtaining sugar are the same as those followed in the manufacture of cane sugar.

In **England** we have at present (i.e. in 1918) 269 acres under sugar beet, mainly in Lincoln, Suffolk, and Cambridge.

Canada. In the south of **Ontario,** in the peninsula between lakes Huron and Erie, several thousand acres are under beet, and in **South Alberta**, too, it is cultivated.

In **Australia** the sugar-beet industry is receiving attention, especially in New South Wales, and beet sugar is also produced in New Zealand.

SUMMARY. In 1913[1] we imported over twenty-three million pounds' worth of sugar (£23,066,621), of which less than one million pounds' worth came from British possessions. The bulk of the imported sugar came from Germany, though Austria-Hungary, the Netherlands, and other countries sent us considerable amounts.

Of countries within our own empire we received the largest supplies from the West Indies, Mauritius, and British Guiana, as well as a small amount from India.

Yet there seems no reason why in the future the empire

[1] In 1917 we imported £36,000,000 worth, of which £6,000,000 came from British countries.

should be dependent on foreign countries for its sugar, seeing that enough cane sugar can be produced in our tropical dependencies to supply all our needs, while in addition to this beetroot and maple sugar can be produced in the more temperate parts of the empire.

CHAPTER IX

TEA, COFFEE, CACAO

TEA (*Thea camellia*). Chinese, *tsha*. 'I did send for a cup of tee (a China drink) of which I had never drunk before.' This entry occurs in Pepys' Diary under the date October 25, 1660. Tea had been introduced by the Portuguese into Europe in the sixteenth century, but it was not until nearly a hundred years later that it was brought by the Dutch to Amsterdam, and from there was exported to London. It is amusing to read that 'tea was then so scarce in England that the infusion of it in water was taxed by the gallon, in common with chocolate and sherbet. Two pounds and two ounces were in the same year formally presented to the king by the East India Company as a most valuable oblation'.[1]

Still earlier we hear of two old people who boiled the leaves and spread them upon their bread, but the water, in which the leaves had been boiled, they threw away. For many years the price of tea was high, some of the best kinds costing as much as £10 per pound.

As to the original home of the tea-plant, authorities differ; some maintain that it is a native of China, others that its real home is Assam, and that it was introduced from Assam into China at a very early date. However this may be, it was China which supplied the world with tea until 1833, and no one suspected that the plant grew in any other country. In that year it was decided to make tea plantations in Assam. The ground was cleared and plants and experienced growers

[1] *Quarterly Review*

were sent for from China, when lo! it was discovered that the very plants, which were being ruthlessly destroyed to make way for the new-comers, were in very truth tea-plants themselves, and that the hills of Assam were covered with them. All unknown and forgotten they had been living and dying

TEA PLANT

there for centuries, while similar plants had been cherished and cultivated in China.

Cultivation. The tea-plant if left to itself, or grown for seed, attains the size of an ordinary apple-tree, but when grown for its leaves it is pruned flat every year to a height of four feet. About eight weeks after pruning (i. e. towards the end of February or the beginning of March) all over the bush fresh young shoots, four or five inches long, sprout forth, and during

the height of the season these 'flushes', as they are called, occur every week or ten days. Women and children then, day by day, pluck the bud and two of the tender undeveloped leaves; sometimes the first three leaves are gathered, sometimes even the fourth, but the tiny leaves at the top of the shoot produce the most delicately flavoured tea. In the height of the season, when there is a 'rush' of leaf, that is when the fresh shoots are very numerous and very frequent, men are employed to help gather the leaves, so that they may not be left too long on the bush, and the quality of the tea be thus spoiled.

In October the pretty white flowers with yellow centres appear on the bushes, and in December the 'flushes' cease and the tea season is over.

TEA FLOWER

Preparation of the Leaf. Before the tea is ready for export it is subjected to various processes, the chief of which are withering, rolling, fermenting, and firing.

As soon as the coolies bring in their baskets full of leaves to the tea factory, the leaves are spread out thinly on wire trays and kept in a temperature of about 80° for about twenty hours. At the end of this time they are soft and pliable, and are said to have been **withered.** These soft, aflbby leaves are then spread between two flat uneven boards, which are moved by machinery in different directions. By this means the leaves are **rolled,** and the moisture in them is brought to the surface.

Next they are taken to the **fermenting** room. Here they are kept in a moist atmosphere at a temperature of between 78° and 82° for three or four hours, and during this time the oxygen of the air acts upon the moisture of the leaves, so that their colour changes from green to a copper colour.

After this they are passed through a drying machine, whence they emerge dry and crisp and brittle. They are now what we call *tea.* It only remains to separate the tiny leaves from

the larger ones. This is done by passing them through sieves, having meshes of different sizes. The very finest form the **Orange Pekoe** teas of commerce ; next come the **Pekoes** and **Souchongs** and **Congous.** These names merely indicate the grade of leaf. Other names are given according to the districts in which the tea is grown, and sometimes teas are named after the firm which grows them.

ROLLING TEA

Green tea is made from the same plants as black tea ; the difference between them arises from the difference in treatment after the leaves are gathered. In the case of green tea the leaves are roasted almost immediately after being gathered ; they are not fermented.

With regard to the vexed question as to the relative wholesomeness of Indian and China teas the truth seems to be that, although an ounce of Indian tea contains slightly more tannin than the same amount of China tea, yet the ounce of Indian tea goes farther, so that a teapot of infusion of Indian

tea should contain a slightly less amount of tannin than one of China tea. The other advantages of Indian tea are that the manufacture of it is conducted with scrupulous attention to cleanliness in well-ordered factories, and the rolling is done

WITHERING TEA

by machinery, whereas in China it is a domestic industry and the rolling is performed by the hands or by bare feet.

Sources of Supply. At present **India (Assam, Darjeeling, Punjab, Travancore,** and **Nilgiri**) and **Ceylon** are the chief tea-producing countries in our own empire; but tea is also grown in **Natal**[1] and **Fiji,** and there seems no reason why it

[1] The Natal tea has a peculiar flavour, and is only exported to places in South Africa.

should not be grown in many other places which possess a suitable soil and climate. The plant is hardy, and different varieties of it are found growing in the hot damp plains near the equator, and in the colder lands of northern China. It would seem to flourish best, however, on the gently sloping sides of wide valleys, in a damp warm climate, where the rainfall is at least between 70 and 100 inches a year. The more rain the better, apparently, so long as the moisture is not allowed to clog its roots.

With regard to the climate of Assam, this is what Mr. D. Crole says of it :

'As many as 10 inches of rain have been registered in 9 hours. . . . Till one has stood in a tropical downpour the full significance of the word rain cannot be appreciated. Macintoshes and umbrellas are perfectly futile attempts against the sheets of water if one has to be out and about all weathers as planters have. Instead of putting on more covering it is wiser to don as little in the way of clothing as is compatible with convenience, unless of course you are very strong and like carrying a few odd pounds or so of water about with you for pure exercise and amusement.'

In the early days in Assam roads and bridges were very bad. 'The old order of things more often than not consisted of a flimsy swaying construction of bamboos tied together with strips of cane, the roadway being merely composed of bamboo matting tied on top of the transverse bamboos. To cross such a bridge on horseback was a distinctly exciting adventure from the momentary uncertainty of the next step.'[1]

In spite of these difficulties, however, the cultivation of tea has gone on increasing, and now good roads and railways exist, and by the clearing away of swamps and other means much has been done to render the climate more healthy.

The tea plant requires a rich soil, and in order to grow it successfully there must be plenty of labour available. As in the case of cotton, it is difficult to see how any machine could successfully pluck the tiny leaves from the plant, so that

[1] D. Crole, *Tea, its Cultivation and Manufacture.*

it would seem useless to attempt to grow tea in places which cannot provide a good supply of cheap labour.

COFFEE (*Coffea arabica*). 'They have in Turkey a grain called coffee . . . this drink comforteth the brain and heart and helpeth digestion.'—Bacon.

Our word coffee is in Spanish and French *café*, which is a corruption of the Arabic *Qahveh*.

The coffee-tree if left to itself attains a height of twenty feet or more, but when cultivated it is not allowed to grow higher than eight or ten feet. It has handsome, shiny, evergreen leaves, which grow on opposite sides of the stem. The flowers are white, and very fragrant; they are arranged in threefold clusters, and as many as three of these clusters are often crowded together at the base of a leaf-stalk. Each flower has five petals united at the base to form a tube; the seed vessel contains two cells with one seed in each.

The fruit when ripe is dark purple, somewhat resembling a small Kentish cherry.

The tree goes on flowering for eight months, so that flowers and fruit, in varying degrees of ripeness, all occur in a plantation at the same time; consequently there have to be two or three gatherings in a year.

The seeds (or berries as they are erroneously called) after roasting become dark brown in colour, and the quality of the coffee depends a good deal on the skill displayed in this operation. In France most families roast their own berries, and warm sunny days, scented with the delicious fragrance of roasting coffee, remain in the visitor's mind as one of the characteristic charms of that pleasant land. The grinding of the beans follows next, but this should not be done until the infusion is required, as ground coffee very quickly loses its aroma. Unfortunately coffee is often adulterated, usually with chicory, which, though an excellent plant in its own way, is entirely out of place in a coffee-pot.

Abyssinia seems to have been the original home of the coffee-plant, but it was known to the **Arabs** as early as the fifteenth

century and cultivated by them, **Mocha** coffee being a renowned variety. It was introduced into Europe by the Dutch from their East Indian possessions, a burgomaster of Amsterdam having carried it there from Mocha. In the eighteenth

COFFEE PLANT

century specimens of the plant were sent to the West Indies, where it flourished so abundantly that it soon became one of their staple products. Conditions in the islands suited the tree admirably, for coffee needs considerable heat and moisture for its successful cultivation, and it prefers hilly slopes to level land, and it likes a rich soil.

At present, of the West Indian Islands **Jamaica** produces the largest amount of coffee, her most celebrated plantations being on the slopes of the Blue Mountains. The coffee produced is of very excellent quality.

In **India,** the coffee plantations are situated in the south of the Deccan in the state of Mysore, and farther south still on the **Nilgiri** Hills.

Ceylon, which used to grow large quantities of coffee, has of late years devoted most of her attention to tea and rubber, and her exports of coffee have declined.

Kenya Colony lies east of Victoria Nyanza in Equatorial Africa, but two-thirds of the country consists of highlands over 5,000 feet above sea-level, and here the heat is moderated by the altitude. Interest centres in the railway which has been built from the coast to the shores of the lake. The journey takes three hours. The train starts from Mombasa and, after crossing the low-lying, hot, moist coastal belt, climbs 5,000 feet up to **Nairobi,** where on a clear day snow-capped Mount Kenia can be seen glittering in the sun. The climate here is said to be delightful, the temperature is never lower than 50° F., the average being 68° F., and the rainfall is 40 inches. Ideal conditions these for coffee, and it is here that the plantations are situated. On other slopes, too, at no great distance from the railway, there are plantations, and it is expected that coffee-growing will take an increasingly important position among the industries of British East Africa.

COFFEE FLOWER AND FRUIT

On the west and north of Victoria Nyanza lies **Uganda,** another coffee-growing country.

Farther south, to the west of Lake Nyasa, is **Nyasaland.** The coffee-tree was introduced from the Edinburgh Botanical

Gardens into the country by Scotch planters in 1876, and flourished so abundantly that the hope of the State seemed to be in its coffee plantations; to such an extent was this the case that the coffee-tree was adopted as the badge of British Central Africa, in which Protectorate Nyasaland was at that time included. Nowadays cotton and tobacco are serious rivals to coffee, though it still manages to hold its own.

Of the Malay States, **Selangor** produces most coffee; in West Africa, **Sierra Leone**; in British South America, **Guiana.** British North Borneo, too, has a certain amount of land under coffee.

The eastern slopes of the Queensland Mountains would seem a suitable locality for coffee plantations, but though a certain amount is grown it is not one of Queensland's leading products, and the same is true of Natal.

SUMMARY. We buy most of our coffee from foreign countries, chiefly from Brazil, Costa Rica, Colombia, Guatemala, and Mexico; no less than twenty-two countries contribute to our needs.

Of our own possessions, India sends us most, though we receive supplies also from Kenya Colony, the West Indies, and Aden; while smaller amounts are sent from British Guiana, Nyasaland, Malaya, and Uganda.

CACAO. 'The Emperor took no other beverage than the *chocolath*, a potation of chocolate, flavoured with vanilla and other spices, and so prepared as to be reduced to a froth of the consistency of honey, which gradually dissolved in the mouth. This beverage, if so it could be called, was served in golden goblets, with spoons of the same metal, or of tortoise-shell, finely wrought. The Emperor was exceedingly fond of it, to judge from the quantity, no less than fifty jars or pitchers, prepared for his own daily consumption. Two thousand more were allowed for that of his own household.'[1]

The emperor mentioned in the above description is the Mexican emperor, Montezuma, who was Emperor of Mexico in 1519. The *chocolath* (chocolate) is prepared from the fruit

[1] Prescott's *Conquest of Mexico.*

of the **cacao tree,** a native of **Mexico.** Its Mexican names is **cacanth.**

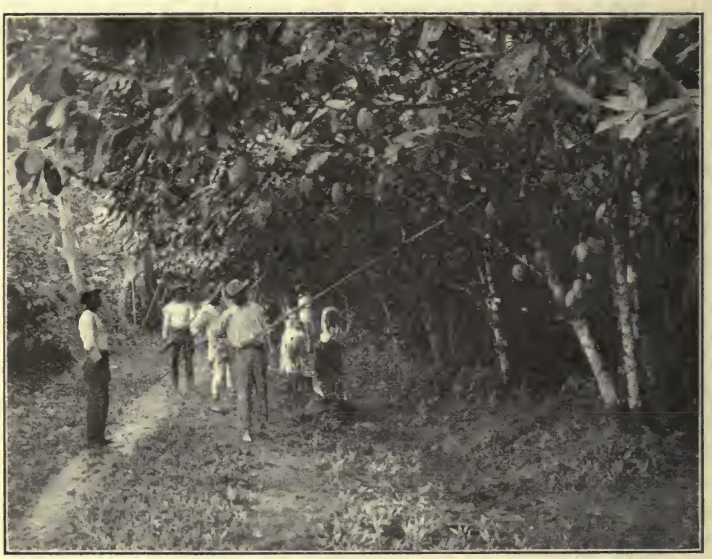
There are several varieties of the tree, but the one which produces the beverage is **cacao theobroma.** It is very delicate, and requires great heat and moisture ; it will not flourish beyond 15° north or south of the equator, and not higher than 600 feet above sea-level. It is successfully cultivated in the West Indies (especially in **Trinidad**), in **Ceylon,** and in **West Africa.** When full grown it is about the size of an apple-tree.

After the ground has been cleared of forest growth and the soil prepared, the cacao seedlings are planted, and at first, as they require shade, other crops are often grown among them. The young leaves are of a yellowish-brown colour, but later on they change to a bright green ; they are about fourteen inches long. In the third year tiny little flowers appear along the trunk and branches of the tree. These are very delicate and are quickly killed by wind, or cold, or drought. Those which survive, in three or four months produce long pods, red, yellow, purple, or green in colour and from seven to twelve inches long. Inside each of these pods are from thirty-six to forty-two red-skinned beans, clinging round a central fibre, all embedded in a white pulp.

'Next morning we are awakened by a blast from a conch. It is 6.30 a.m. and the mist still clings in the valley, the sun will not be over the hills for another hour or more, so in the cool we join the labourers on the mule track to the higher land and for a mile or more follow a stream to the heart of the estate. If it is crop time the men will carry a *soulet*, a hand of steel mounted on a long bamboo, by the sharp edges of which the pods are cut from the higher branches without injury to the tree. Men and women all carry cutlasses, the one instrument needful for all work on the estate, serving not only for reaping the lower pods, but for pruning and weeding, or cutlassing, as the process of clearing away the weed and brush is called. The pods are collected from beneath the trees and taken to a convenient heap, if possible near by a running stream where the workers can refill their

drinking cups for the midday meal. Here women sit with trays of the broad banana leaves on which the beans are placed as they extract them from the pod with the wooden spoon.'[1]

Sweating or Fermentation. After this the beans are dried on trays in the full heat of a blazing tropical sun. During this



PICKING CACAO, TRINIDAD

process their colour changes from red to a dark brown and they become softer. On many estates this drying is now done by machinery. They are then put into bags ready to be exported.

On arrival at the factory the beans are carefully sorted, and then roasted, after which the broken kernels, or nibs, are extracted. All this is done by machinery. They are next put between horizontal stone rollers which grind them to powder ; but the nibs also contain a large proportion of fatty

[1] Brandon Head, *Food of the Gods.*

matter; this mixes with the cacao powder, and there finally issues from the grinding mill a dark liquid mass. This is allowed to cool and solidify, after which it is submitted to great pressure, which causes the fat to ooze out, and a dry cake is left behind. This is again ground into powder and forms what we call **cacao** or **cocoa**.

OPENING CACAO, TRINIDAD

Chocolate is made by adding sugar and flavouring to the nibs before the first grinding. The fat is not pressed out; it is absorbed by the sugar, and the whole is ground together into a paste. When this paste is dry, it is ground again, then heated and pressed into moulds, after which it is passed through a refrigerating chamber and is put into packets ready for sale.

SUMMARY

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Tea.	Java, China, Japan (small amounts).	**India**, Ceylon.	The bulk (almost six-sevenths) of our tea is imported from British possessions, India sending nearly double the contribution of Ceylon.
Coffee.	**Brazil**, Costa Rica, Colombia, Guatemala, Mexico, and many other countries.	**India**, Kenya Colony, the West Indies, Aden; British Guiana, Nyasaland, Malaya, and Uganda.	Less than one-ninth of our imports are from British possessions, among which India is pre-eminent. During the war there was a remarkable increase from Uganda.
Cacao.	**Brazil, Ecuador,** Germany (from German West and East Africa), and many other countries.	**West Africa, West Indies,** Ceylon, and smaller amounts from other countries.	More than half our supplies come from British possessions. West Africa and the West Indies send the largest amounts.

CHAPTER X

SPICES

'Awake, O north wind; and come, thou south; blow upon my garden, that the spices thereof may flow out.'—Solomon's Song, iv. 16.

From the remotest ages poets have sung of fragrant spices, and set them among the good things of life. We read of them in the Songs of Solomon, and in the Book of Proverbs, and in many other books of ancient literature.

In the time of the Greeks and Romans they were among their most highly-prized articles of commerce. Indeed, our own word 'spices' reminds us of this fact; for it is derived from the Latin 'species', which at first meant a 'sort' or 'kind' of anything, and later came to mean produce in general,

and finally the most valuable sort of produce, viz. those aromatic and pungent vegetable substances of the east, which we now call *spices*.

Arabia was always regarded as the land of perfumes and romance, the land where the coveted spices came from; but as a matter of fact very few ever came from there, the bulk of them being products of Southern India and the islands of the east. But it was Arab merchants who brought them to Europe, and they were careful to keep the origin of their wares shrouded in mystery.

After the Crusades the people of Western Europe became eager purchasers of these eastern treasures, for they gave a flavour to their insipid salt meat in winter, and to their still more insipid salt fish in Lent, so that we are not surprised to read that the seat of honour at an English feast was by the spice box.

They were brought with other merchandise by sea from India and the east to Aden, and thence to Alexandria, which became a great collecting place for all sorts of commodities, so that, as Benjamin of Tudela, who visited it in 1172, tells us, 'it was full of bustle, and every nation had its own fonteccho (hostelry) there'.

Of all these many nations the Italians were the busiest, and the spices were brought by them to Venice, and thence sent overland to Augsburg and Nurnberg, to Bruges and Antwerp, and so to the western nations.

By this eastern trade the Venetians became enormously wealthy, and much of the beauty and glory of their city is due to the generous spending of this wealth in the building of stately palaces and churches, wherein were collected all the wonders of art and industry.

Later on this lucrative trade passed into the hands of the Portuguese, and the fortunes of Venice declined. When Vasco da Gama, in 1499, rounded the Cape of Good Hope, and visited Calicut, the first blow was struck at the Venetian trade, and we read: 'When this news reached

Venice the whole city felt it greatly and remained stupefied, and the wisest held it the worst news that had ever arrived.'

The Spaniards tried to wrest this trade from the Portuguese, but though the heroic Magellan sailed round the south of South America and westwards across the Pacific to the Philippines (where he was killed), and though his successor[1] sailed on to the Moluccas, 'where they traded on very advantageous terms with the natives, filling their holds with the spices and nutmegs for which they had journeyed so far', and finally returned home to Seville, elated with the wonders they had seen, yet the Portuguese still held their own, and it was not until the Dutch ousted them in 1521 that they finally lost their pre-eminence.

From that time onwards, however, the Dutch had this profitable trade in their hands, and they built Batavia to be a collecting centre for their goods, and prospered exceedingly. They took the most elaborate precautions to prevent other nations from sharing in their advantages. Thus, for instance, it was a crime, punishable by death, to grow cinnamon trees on private lands in Ceylon; and in certain islands of the Moluccas the clove and nutmeg trees were ruthlessly destroyed in order that Amboyna and Banda might have a monopoly of them.

Side by side with this selfish jealousy was the most utter ignorance on the part of the Home Government as to the nature of the commodities in which they traded, and an amusing story is told[2] of how the authorities in Amsterdam, unaware of the fact that both nutmegs and mace were produced by the same tree, once dispatched orders to their Colonial Governor, requesting him to reduce the number of nutmegs but to increase the number of mace-trees.

[1] On the coat-of-arms, granted him on his return by Charles V, were two cinnamon sticks, three nutmegs, and twelve cloves; also two Malay kings each holding in his left hand a spice branch (J. Jacobs, *Story of Geographical Discovery*).

[2] See *A Handbook of Tropical Gardening*, by H. F. Macmillan.

The following are some of the chief spices which we use at the present day:

CINNAMON. 'In this Iland (Ceylon) there groweth fine Sinamon . . . I was desirous to see how they gather the Sinamon, or take it from the tree it groweth on, and so much the rather, because the time that I was there was the season they gather it in, which was in the moneth of Aprill, at which time the Portugals were in Armes, and in the field, with the King of the Country; yet I to satisfy my desire, although in great danger, took a guide with me, and went into a Wood three miles from the Citie, in which wood was a great store of Sinamon trees growing together among other wild trees; and this Sinamon tree is a small tree,[1] and not very high and hath leaves like to our Bay-tree. In the moneth of March or Aprill, when the sappe goeth up to the top of the tree, then they take the Sinamon from that tree in this wise. They cut the barke off the tree round about in length from knot to knot, or from joynt to joynt, above and below, and then easily with their hands they take it away, laying it in the Sunne to drie, and in this wise it is gathered, and yet for all this the tree dyeth not, but against the next yeare it will have a new bark.'[2]

The cinnamon gardens of **Ceylon** are down in the moist sandy lowlands near **Colombo,** but the cinnamon tree (*Cinnamomum Zeylanicum*) also grows wild in abundance all over the rainy part of the island up to a height of 2,000 feet, for Ceylon is the original home of the tree, as its name indicates (*Zeylanicum*, of Ceylon), and the cinnamon produced there is superior in flavour to that produced in other countries.

The tree is an evergreen belonging to the laurel family, and in its native forests reaches a height of from forty to sixty feet, but on plantations it is pruned and kept low. Under these conditions it sends up from the root four or five long straight shoots which come to perfection in about eighteen months' time.

It has long, dark-green, shiny, leathery leaves, arranged

[1] In many places it grows to a height of sixty feet.

[2] 'Extracts of Master Caesar Frederick his eighteene yeeres Indian Observations' (*Purchas His Pilgrimes*).

on opposite sides of the stalk, and it bears a cluster of white, or pale yellow, flowers, having an extremely pleasant smell, like a mixture of roses and lilac.

Its fruit is an olive-shaped berry containing a kernel; the berry itself is soft, and insipid, and dark blue in colour. It is attached to its receptacle in the same way as an acorn is attached to its cup. In the days when there was a king of Ceylon, special fragrant candles were made for him from fat obtained from these sweet-smelling berries.

CINNAMON PLANT

It is the **bark**, however, for which the tree is specially cultivated. The shoots are cut down, stripped of their leaves, and carefully trimmed. Then at distances of about a foot, or a foot and a half, incisions are made round the stem horizontally. Next two or three slits are made lengthways from one ring to another, and the bark is then pulled off by slipping a knife under it.

These pieces of bark are bound together in bundles and left for twenty-four hours, after which they are scraped, i.e. the outer covering is removed. The bark then dries, and curls up, so that it is possible to fit the smaller quills into the larger, and finally smooth sticks are formed, about half an inch thick, and forty inches long, containing a great number of dull, light-brown layers of bark as thin as paper. After being once more dried, the sticks are made up into bales, weighing about 60 lb. each, and are ready for export.

Cinnamon, though used in medicine, is, like other spices, chiefly used to flavour food, especially chocolate.

Oil of cinnamon, which is made from the bark of the tree, is of a golden-yellow colour and is much used in perfumery.

CULTIVATION. Cinnamon can be propagated by seed, or by layers, or by cuttings. It requires a sandy soil, and abundance of heat and moisture.

SOURCES OF SUPPLY. Though the tree has been introduced into other countries, e.g. the West Indies, Senegal, and India, it is from **Ceylon** and the **Seychelles** that we obtain our chief supplies.

PEPPER (*Piper Nigrum*). 'Moreover that it may be manifest how pepper is had, it is to be understood that it groweth in a certain kingdome whereat I myselfe arrived, being called Minibar, and it is not so plentifull in any other part of the world as it is there. For the wood wherein it growes conteineth in circuit 18 dayes journey. . . . In the foresaid wood pepper is had after this maner; first it groweth in leaves like unto pot-hearbes, which they plant neere unto great trees as we do our vines, and they bring forth pepper in clusters as our vines doe yield grapes, but being ripe they are of a greene[1] colour, and are gathered as we gather grapes, and then the graines are laid in the Sunne to be dried, and being dried are put into earthen vessels: and thus is pepper made and kept.'[2]

Pepper has always been a most important article of commerce between the east and west; and as far back as the reign of Ethelred the Unready (866–71) we read that merchants, who came to trade at Billingsgate, had to pay ten pounds of pepper as tribute at Christmas and Easter.

It is interesting, too, to remember that the present Worshipful Company of Grocers was originally the Company of Pepperers, i.e. of pepper merchants, and to learn that, instead of money, tenants sometimes agreed to pay a certain amount of pepper as rent, landlords in this way making sure of a plentiful supply of their favourite condiment.

The plant from which this valuable spice is obtained is a climbing shrub with soft stems, and rather leathery leaves.

[1] They are gathered when green, but when ripe they are red.
[2] 'The journall of Frier Odoricus' (*Purchas His Pilgrimes*).

In a wild state it grows to a height of twenty or thirty feet, but when cultivated it is kept back by pruning.

It bears little flowers arranged along a stalk about three inches long in the same way as those of red currants, about twenty or thirty on each stalk, and the fruit when ripe is a small red berry about the size of a pea.

PEPPER VINE

As soon as the berries at the base of the stalk begin to turn from green to red the whole crop is gathered. It is spread out to dry in the sun, and then the berries are separated from the stalks by being rubbed by hand, after which they are winnowed, so that all leaves and twigs may be removed.

When dry the berries are black and wrinkled; they form the **black** pepper of commerce; **white** pepper is obtained by soaking the berries in water, and then removing their skins; it is not nearly so pungent as black pepper.

CULTIVATION. Pepper requires a hot climate and a rich soil, and, although it requires a fair amount of moisture, it will not thrive on swampy, undrained land. Along the **Malabar** coast of Southern India, where the best pepper in the world is grown, the cuttings for a new plantation are put into the earth just before the June rains, and as soon as they are tall enough

they are trained up the trunks of such trees as the mango or cashew-nut. In three years' time they begin to bear fruit, and they go on bearing for twelve years; then they are cut down and fresh ones planted.

SOURCES OF SUPPLY. Although Malabar pepper is the most famous and is considered the best, we import most from the **Malay Peninsula,** though **Bombay, Ceylon,** and **Kenya Colony** also send us considerable supplies. Of our tota imports more than half come from countries within the empire.

PEPPER BERRIES

GINGER (*Zingiber Officinale*). The ginger which we buy in shops is the *rhizome,* or underground stem of the plant called *Zingiber officinale.* When a new plantation is made, pieces of these rhizomes are planted in the earth, and from each joint two different kinds of stems spring up. First the leaf-stalk sprouts and grows to a height of two or three feet, and then the flower-stalk shoots up. It does not grow so tall as the leaf-stalk, rarely attaining more than a foot in height.

The flowers come out from between the scales of a little cone; their corolla is orange-yellow; they are small and soon wither. When the leaves and flowers are faded, the rhizomes are considered ready for harvesting and they are dug up. They are full of joints and knots and are very solid and tough; outside they are brown, but inside pale yellow. When all the earth has been removed, they are well washed, and the little roots are cut away, after which they are thoroughly dried in the sun.

CULTIVATION. Ginger requires a hot climate and a rich soil, and a good supply of moisture. It is considered to be a native of tropical Asia, whence it was from early times exported to Europe. In the spice trade of the Middle Ages it stood next

in importance to pepper, and in England one pound of it cost as much as a full-grown sheep.

Large quantities of it are still grown in **India,** where it is preserved in syrup, and also used as a flavouring in the celebrated Indian curries. From Asia the plant was introduced

GINGER PLANT

to the West Indies, and now **Jamaica** produces some of the most famous ginger in the world.

Sources of Supply. We buy very little ginger from foreign countries. Our chief sources of supply are **British India** (especially the Presidencies of Bombay and Madras), the **West Indies** (mainly **Jamaica**), and **Sierra Leone,** in West Africa.

NUTMEG. In Old English *nutmeg* was written *notemuge*. *Muge* was a shortened form of the French *muguette*, musk, so that nutmeg meant the musk-nut, or scented nut.

The tree (*Myristica fragrans*) is a beautiful bushy evergreen which grows to a height of thirty or forty feet. It has long, glossy, dark-green leaves, and small, pale-yellow, bell-shaped flowers.

The fruit is amber in colour, and in shape and size rather like a small round pear. The outside fleshy covering is about half an inch thick, and is tough and juicy. When ripe it splits open and shows the seed inside covered with a very beautiful lace-like substance, bright scarlet in colour. This covering is called **mace.** When it is removed, the dark-brown **seed** or **nut** itself is disclosed. It has a very hard shell marked with the lace-like impressions of the mace.

GINGER

The nuts are placed on frames and dried in the smoke of a wood fire, or in the sun. The drying takes about two months. At the end of that time the kernels rattle inside their shells. These are cracked with wooden mallets, and the **kernels** or **nutmegs** are at last ready for use.

The mace is cut into strips and dried ; during the process its colour changes from bright scarlet to pale yellow.

The chief use of nutmeg is as a spice. Its pleasant flavour not only makes food more agreeable to the taste, but also makes it more digestible. It is, however, also used in medicine, and in large quantities acts as a narcotic. From both nutmegs and mace an essential **oil** is distilled, which is largely used in perfumery, especially in making scented soaps.

CULTIVATION. The nutmeg-tree requires heat, and moisture, and a well-drained loamy soil, and the young trees require shade. The seeds are sown in nursery beds, and take about

three months to germinate, but they do not blossom until they are five or six years old. The flower of the female tree is slightly different from that of the male, and as soon as the flowers appear they are planted out; one male tree to every ten female trees. The trees are considered to be in perfection when they are about twenty years old, but they go on bearing for a hundred years. Once a plantation is

NUTMEG ESTATE

formed it needs little attention, for no weeds grow under nutmeg-trees.

In some countries the fruit is gathered by means of a hook attached to a long pole: a basket near the top of the pole catching the fruit as it falls. But more often it is allowed to fall of its own accord and is merely picked up day by day from the ground. The chief harvest is in the autumn, but there is a smaller one in the spring. Each tree produces four or five thousand nuts in a year.

Sources of Supply. In 1584 William Barrett, an Aleppo

merchant, made a list of the chief spices imported into Europe, and in his list we find the item: Nutmegs from Banda.

NUTMEG TREE AND FRUIT.

The Banda Islands are a tiny group forming part of the Moluccas. They belong to the Dutch. In them the nutmeg-tree grows wild, and there are besides extensive plantations. The nutmegs exported from these islands were formerly rubbed over with dried lime in order to kill the seed, and

thus prevent nutmeg-trees from being grown in other parts of the world. Nevertheless, the cultivation of the tree spread and they are now grown in most of the **East Indian Islands.**

In our own empire they are grown to a certain extent in India, and Ceylon, and Malay, but the **West Indies,** especially **Grenada,** have the most extensive plantations, and offer the most promising conditions for future production.

Allspice, or **Pimento,** or **Jamaica Pepper.** Just as we associate Cinnamon 'Gardens' with Ceylon, so we associate Pimento 'Walks' with **Jamaica.** The 'Walks' are on the slopes of the limestone mountains on the north side of the island. They occur up to a height of 1,500 or 2,000 feet.

The word *Pimento* is a form of *Pimienta,* the Spanish for pepper, and when allspice was first imported into Europe it was called Pimienta. Afterwards it was called **Allspice,** because it was supposed to combine the flavours of all the spices, notably of cloves, cinnamon, pepper, and juniper.

The pimento-tree is a slender evergreen belonging to the myrtle family; it grows about 30 feet high. It has a smooth greyish bark, which it sheds every year, and its long dark-green leaves resemble those of the myrtle. Its flowers are white with four rather thick, rounded petals and very numerous stamens. The fruit is a little berry about the size of a pea; it contains two seeds. The berries are gathered while they are green, because when they are ripe the inside pulp becomes moist and sticky, and it is then difficult to dry them properly.

Men go up into the trees and break off the twigs containing the fruit, and throw them down to women and children below, who pick off the berries and spread them out in the sun to dry. In a few days they change in colour from green to dark brown, and then they are ready for packing.

The harvest, called the 'breaking', is in July and August, and in good years the yield from a 'Walk' is enormous, but the crop varies very considerably; and there are often bad years.

Like other spices, allspice is used in medicine, but its chief use is as a condiment. It is interesting to read that Russia in former times used to buy enormous quantities of allspice from Jamaica to flavour her black rye bread, but that during one of her wars she found that she could get a similar flavour from another plant growing in her own country, and she bought no more allspice from Jamaica.

CULTIVATION. Allspice requires heat, but not too much moisture, and it likes a well-drained limestone, or loamy soil, and where these conditions obtain it will grow well. People used to imagine that the seeds would not germinate if sown in the ordinary manner, and that a pimento plantation must spring up of its own accord; but nowadays it is found that, when the seeds are properly washed and dried, they grow extremely well when planted in the ordinary manner.

The trees begin to yield when they are about seven years old, but they are not in perfection until they have reached their twentieth year.

SOURCES OF SUPPLY. The pimento is produced in other tropical countries, but **Jamaica** is the only one which exports it in any considerable quantity.

CLOVES. Our word *clove* is derived from the Spanish *clavo*, which means a *nail*. The Spaniards and Portuguese gave the bud this name because of its likeness to a nail in shape.

The clove-tree (*Eugenia caryophyllata*), like the pimento, belongs to the myrtle family, and in many respects these two beautiful trees resemble one another. They both grow to about the same height, thirty or forty feet, they are both evergreen, and have a pale, smooth, greyish bark, and long dark-green, shining leaves; but the clove-tree is rather conical in shape, its lower branches being much longer than its upper ones. The bunches of flowers in both trees consist of several stalks, with blossoms, arranged in sets of three, at the end of each stalk.

The **calyx** of the clove-tree flower is about half an inch long and is very solid; it gradually changes from green to bright

red. Its upper edges are cut into four short teeth, and it holds a small, four-petalled, pale-yellow flower, which in the bud is a tiny yellow ball, for the petals lap over one another and enclose the rest of the flower. The fruit is like a small purple plum, but the seed fills up all the interior, and the outer covering is thin.

When the calyx is red, and before the petals have opened, the crop is harvested. In Zanzibar each clove is picked by hand, movable stages being erected to enable the gatherers to reach the upper branches, but the more usual method is to shake, or beat, the trees, when the cloves fall readily to the ground. They are spread out in the sun to dry, and during the process of drying change from bright red to dark brown.

CLOVE PLANT

Their pleasant flavour has always caused them to be used in large quantities in cookery, and their popularity is still very great. **Oil of Cloves** is a pale yellow oil used in soap-making and perfumery.

Sources of Supply. To the east of Celebes, in latitude 0.28° N., lie five little islets, which in former days were known as the Moluccas or Clove Islands; they are regarded as the original home of the clove-tree, but, when the Dutch took the islands from the Portuguese, they compelled the inhabitants to destroy their trees, so that the Dutch plantations in Amboyna and Banda might have a monopoly of the trade in cloves. Nevertheless, the cultivation of the tree spread, and it now flourishes in most of the **East Indian Islands.**

In 1770 the French introduced the clove-tree into their **Island of Réunion,** and from there its cultivation spread to

Zanzibar and **Pemba,** where it now forms the chief article of commerce, the crop in a single year sometimes reaching as much as ten and a half million pounds. Indeed, these two islands now produce the largest part of the world's supply of cloves.

Besides Zanzibar and Pemba, in our empire, **Penang,** India, Ceylon, and the West Indies export cloves.

SUMMARY. Of **cinnamon, allspice, cloves,** and **ginger** our supplies are practically all derived from empire sources, while of **pepper** more than half is British; and though **nutmegs** are at present mainly imported from foreign countries, **Grenada** affords a promising source of future supplies.

Not only so, but of **cinnamon, cloves,** and **allspice,** the empire is the chief source of supply for the whole world.

Spices

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Cinnamon.		**Ceylon,** Seychelles.	Practically all our supplies come from British Possessions.
Pepper.	Java, Siam.	**Malay Peninsula,** British India, Ceylon, Kenya Colony.	Of our imports more than half come from British Possessions.
Ginger.	Japan.	**British India,** West Indies, Sierra Leone.	Our imports from foreign countries are very slight.
Nutmeg.	East Indies.	Grenada.	
Allspice.		**Jamaica.**	Practically all our supplies are derived from Jamaica.
Cloves.		**Zanzibar** and **Pemba,** Penang, India, Ceylon, the West Indies.	The largest part of the world's supply comes from Zanzibar and Pemba.

CHAPTER XI

OIL-SEEDS AND OILS

An enormous and ever-increasing quantity of oil-seeds and oils are imported into this country for the manufacture of margarine (and various nut-butters), soap, candles, lubricants, and many other substances. The following are some of the most important oil-yielding plants:

THE AFRICAN OIL PALM. 'They have three kinds of trees, as the Palme-trees, whereof some are females and beare Grapes as bigge as Plummes of an Orange colour, at the one end being somewhat blackish: those Grapes they peele to the stones, and thereof they make Oile, which they call **Palme-Oile,** which is verie delicate and good, which they use to dresse their meate withall, and make good sauce for their fish, the thickest of this Oile they use to anoint their bodies withall, to make them cleane, and the women use it to frizell their haire, the veines are as great as acornes, and as hard as a stone, at the end thereof having three round holes, they beat them in pieces and within find certain Nuts, like little earthen pellets, much like hazell-nuts, but when you eat them, they taste of wood and are verie drie.'[1]

The tree from which these 'Grapes' are obtained is the **African Oil Palm.** Its botanical name is *Elaeis Guineenis*, i. e. *Guinea Olive-tree.* When full grown it attains a height of sixty feet; and, like all palms, its trunk is marked with the scars of fallen leaves, but, in the days of its youth, it is a little forest in itself, for the bases of the dead leaves do not fall off, they only bend back, and the spaces between them and the trunk form receptacles for rain-water, and all sorts of bits of decaying vegetation, which make a fertile soil for any chance seeds or roots that may get carried thither. These gradually sprout and grow, and soon all up the trunk are to be seen ferns, and creepers, and plants of all sorts. When the tree

[1] 'A description and historicall declaration of the golden Kingdome of Guinea . . . written by one that hath oftentimes beene there. A.D. 1600.' (*Purchas His Pilgrimes.*)

is about twenty feet in height these leaf bases gradually fall off, and with them the vegetation which they have supported, and the trunk emerges clean and shapely.

At its top it has a crown of enormous pinnate-shaped leaves, eight, twelve, or even fourteen feet long, the leaflets themselves being often more than a foot in length.

Mr. Farquhar, in his most interesting account of the Oil Palm,[1] describes how it sends forth a long green spike, which shoots out upwards above the dense mass of forest growth to the light and air, and having won breathing space for itself unfolds its great green leaves.

When a little tree of about three years old it begins to bear male flowers, and two or three years later female ones appear. These are arranged along the flower-stalks, which themselves grow out from a main stalk (just like a bunch of red currants).

The main stalk sprouts at the top of the trees between the trunk and the bases of the leaves, and when fully developed is about seventeen inches long. The flower-stalks are at first encased in a green sheath. This opens, and the flowers on each side of the stalks blossom; they are very numerous. In a full-grown tree there are as many as 240 stalks, and arranged along each of these about eight or ten flowers, so that each spike bears altogether about 2,000 flowers. Out of these 600 or so develop into complete fruits, but the remaining ones, though without kernels, are very rich in oil. A good bunch of fruit will weigh as much as 31 lb., and a tree bears on an average five bunches in a year.

In a forest, of course, there are trees of all ages and sizes, and in the small ones it is easy to see when the fruit is ripe, but in the very tall ones this is difficult. The native collector visits them from time to time, and instead of examining the trees he observes carefully the ground in which they grow, for parrots, and monkeys, and rats, and mice like the fruits, but they do not eat the whole of them, so as soon as he finds

[1] J. H. J. Farquhar, *The Oil Palm and its Varieties.*

half-eaten fruits lying about, he knows that at the top of the tree the great golden bunches are ready to be cut.

He climbs the tree with the help of a rope round his foot, much in the same way as a West Indian climbs his coco-nut

TREE OF THE OIL PALM

trees, and with a great knife or chisel cuts off the bunches of fruit.

The next operation is to extract the oil. The bunches are piled up into heaps, and covered with leaves until the fruits can be picked off easily from the stalks. They are then put into a great iron cauldron with some water and brought to

the boil. As soon as they are soft, they are shovelled out into round wooden tubs, and pounded with mortars until the pulp is separated from the stones. The whole oily mass is then emptied on to long narrow sloping trays, and the 'stones' are picked out, and thrown into a tub of water.

Then the women with their hands squeeze out the oil from the pulp, and it collects in the lower end of the tray. The pulp which remains over is thrown away, and the oil is

FRUIT OF THE OIL PALM

poured into kerosene tins. Each of these holds about five gallons, and two of them can be carried by a man on his head.

Through the hot forest they trudge with these heavy loads to the nearest market, whence the oil is sent down in canoes to the various factories along the coast, and from there exported.

The 'stones' or 'nuts', after being dried, are cracked between two flat stones, and the kernels are picked out by hand. These are exported as they are, and the oil is expressed from them in the country which imports them.

Uses of the Oil Palm. In its native country almost every part of the tree serves some useful purpose ; the great leaves, for instance, are used for thatch, and brooms are made of the midrib of the leaflets.

To the native mind, however, its most valuable product, after **oil,** is the **wine** which it yields. There are various methods of collecting this ; one is to make a round hole in the flowering stalk, and insert a narrow-necked bottle into it to catch the juice as it flows out. Unfortunately this collecting of wine is bad for the trees, and where the practice is in vogue they sooner or later dwindle and die.

Palm oil, i.e. the oil made from the pulp of the **fruit,** is reddish yellow in colour, and is used chiefly in the manufacture of **soap** and **candles** ; as a **lubricant** for the axles of railway engines, and in the **tinplate** industry.

Palm-kernel oil, i.e. the oil expressed from the **kernels** of the nuts, is white in colour, and is increasingly used for making **margarine** [1] and various other edible butters and fats. The ' cake ', which is left over after the oil is extracted, is very rich in fat, and is a valuable food for animals.

Climate and Soil. The oil palm, unlike the coco-nut, does not like the sandy shore of the sea ; it likes a rich moist soil, and in West Africa the great oil forests do not begin till two or three miles inland.

With regard to climate, it will not grow vigorously with less than seventy inches of rain in the year, and an average of between 70° and 80° of heat.

In West Africa, from Sierra Leone to French Congo, not only is it hot and rainy, but there is very little difference between summer and winter, and the rainfall occurs all the year round, though it is heaviest in spring and autumn.

' Dayes and Nights are of one length or else there is little

[1] Margarine (from the Latin *margarita*, a pearl) was a name originally given to ' a peculiar pearl-like substance extracted from some vegetable oils and also from the fat of some animals '. The familiar compound of the present day consists of a mixture of fats (animal or vegetable), oils (such as palm kernel or coco-nut), water, milk, and salt.

difference: for the Sunne riseth and goeth downe there commonly at sixe of the clocke, but it is risen at least halfe an houre above the Horizon before it sheweth itself so that you shall seldom see it cleerely rise or goe downe.

'They shun the raine and esteeme it to be very ill and unwholesome to fall upon their naked bodies, which they do not without great reason, for wee find ourselves to bee much troubled therewith when we travell. . . .

'Specially the Raine under the Equinoctiall Line is so unwholesome and rotten that if a man hath been in the Raine and is thorow wet, and so lieth downe to sleepe in his cabin, in his wet clothes, without putting them off, he is in danger to get some sicknesse for it breedeth fevers. . . . And they find no less unwholesomenesse therein, for when it begins to rain they get them out of the way and if any drops fall upon their naked bodies they shiver and shake as if they had a Fever, and cast their Armes over their shoulders to keep the Raine from them; which they do not because the water is cold, for oftentimes it is so warm as if it were sodden: but because of the unwholesomenesse for their bodies, which they find thereby. And when they have trodden in the daytime in the water with their feet, at night they make a fire, and lie with the soles of their feet against it, which they doe to draw the moysture of the water, which is gotten into their bodies, out againe at their feet: then they anoint their bodies with Palme Oyle, which they also use for a beautifying to make their bodies shine, and that they doe to shunne the Raine water (which) within those Countreys (as many men write) is very unwholesome and thereof many dangerous diseases are engendered.'[1]

Sources of Supply. Though the oil palm grows to a certain extent in other parts of the world where the climate and soil are suitable (as, for instance, Central Africa, and the West Indies, and Guiana), yet the amount of oil at present produced in those places is so small compared with the output from West Africa as to be entirely negligible.

Unlike rubber and copra, palm oil is not yet a plantation product; the great forests stand as they have always stood, and the methods of collecting and preparing oil to-day differ but little from those in vogue in the remote past.

[1] 'Description of Guinea, A.D. 1600.'

Efforts are now being made, however, to employ machinery for cracking the nuts and picking out the kernels in place of the slow tedious methods now in use, and doubtless other similar improvements will follow, for the demand for palm oil continually increases.

The two great bays in the Gulf of Guinea are the Bights of Benin and Biafra. The rivers which flow into these bights flow for the most part through palm-oil forests, and have at their mouths palm-oil towns. They are separated by the mouths of the Niger, whose delta alone covers 14,000 square miles of alluvial forest and jungle. The arms of the delta have long been known as the Oil Rivers. They include such names as the Brass River, and the Bonny, which seem indeed to reek of oil, as does the Old Calabar farther to the east.

The most important British part of this eight hundred miles of coast is now called **Southern Nigeria. Lagos** in the west, at the terminus of the railway to Kano, is the chief sea-port for the whole district, and from it enormous quantities of oil are exported.

Other oil-producing British colonies of West Africa are Sierra Leone, the Gold Coast, and Gambia, but the bulk of our oil imports come from Southern Nigeria.

Before the war practically **all** the palm **kernels** were exported to **Germany,** and we bought a certain amount of palm-kernel oil from her, but in 1917 over 200,000 tons of kernels were imported by us from our **West African Colonies,** and also about a fourth of this amount from foreign countries, chiefly from the Belgian Congo.

COCO-NUT PALM (*Cocos nucifera*). Along the sandy shores of tropical lands, their ruddy roots and brown trunks contrasting with the deep blue of the encircling ocean, stand groves of tall coco-nut palms. They grow to a height of sixty or eighty feet. The trunk is not very thick; in a full-grown tree its diameter measures only about eighteen inches.

It is bare of leaves, but is scarred all up its height with rings marking the places where the leaves have fallen off, for the

tree grows from its summit and sends out no branches. At its top is a crown of from twenty to thirty leaves, the new pale green ones in the middle and the old yellow ones outside.

These leaves are like enormous green feathers, with a great midrib, eighteen feet long, and leaflets, each about three feet in length. The midrib is so strong that the natives of the countries where it grows often use it as an oar for their boats. *Pinna* is the Latin for a feather, and so these coco-nut palms are said to be pinnate-leaved palms. Each tree produces about twelve leaves in a year.

The flowers grow along a stalk in the same way as currants grow, and there are several stalks on one stem. The stem is enclosed in a sheath, or spathe, like that of an arum lily. The male flowers are yellowish and the female ones greenish. They both occur on the same stalk. As about twenty nuts are produced inside each spathe, and the tree sends out about twelve spathes during the year, the average yearly crop of a tree is 200 nuts. They are not all ripe at the same time.

Before they have been stripped of their outer coating of coir the nuts are about the size of an ordinary football, and weigh about five or six pounds. The lower part of a nut has ' eyes ', and looks rather like a mask, hence the Portuguese gave it the name ' coco ', which in their language means a mask ; the tree they called by another name.

Coco-nut palms which grow by the sea-shore often bend over towards the sea, and so nuts often fall into the water. Their outer covering of fibre makes them light in proportion to their size, and so they are carried along by ocean currents until they reach another shore. Sometimes they are washed up on to a little barren island and are the first plants to sprout and grow there.

Nowadays, however, coco-nut trees are often cultivated and grown in plantations. It is found that although they like sea air they will thrive a considerable distance away from the sea. The young plants are generally reared from seed

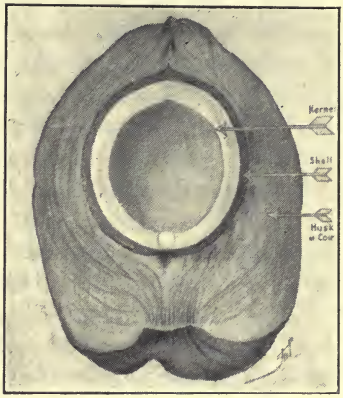
in nurseries, and when they are six months old are planted out to form the future plantation. Holes are dug about thirty feet apart each way, and into these the young plants are put, so that each acre grows about forty-eight trees.

COCO-NUT TREE

In the nurseries the nuts are laid in the earth slantways with the stalk ends raised, so that water may not collect in the 'eyes', and rot them. Coco-nut palms never grow straight up from the root; the lower part of their trunks is always curved. When the plants are seven years old they begin to bear fruit, and when they are ten years old they are considered to be in full bearing, and they continue to bear for

eighty or one hundred years. In some countries, e.g. the **Malay Peninsula**, the natives cut notches in the trunk as they climb up to gather the nuts, but in the **West Indies** they use a rope. By the first method a man can gather about five hundred nuts a day, by the second a thousand.

After the nuts are gathered, the next operation is to remove the outer covering of fibre, which is usually about two or three inches thick. This is done by striking the nut sharply on an iron-pointed stake set up in the ground. The fibre is then torn off by hand. When the fibre has been removed, the nut is as we see it in greengrocers' shops.



SECTION OF COCO-NUT

Copra. To obtain copra, as the **white dried flesh** is called, the shell must be removed. This is done about three weeks after the nuts have been gathered. They are cleft in two with a hatchet, and, after being exposed to the sun for a little while, the copra is taken out.

It is then either dried in the sun, or in a drying-house by means of air artificially heated.

Coco-nut Oil. To obtain the oil from the copra various methods are in use, but in all the most modern ones the copra is broken up and ground to a meal, then heated and heavily pressed. The oil which oozes out is white in colour, and in temperate climates it is solid ; in the hot tropics it is liquid. After it has been purified and refined it is in all respects equal to oil of almonds, and is used for a great variety of purposes.

In India, where soap until recently was an unknown luxury, the natives used it to anoint their bodies ; it produces a fine gloss. They also use it for cooking, and before the introduction of kerosene they used it as a lamp oil. Their lamps were of

simple construction. They consisted of half a tumbler of water with oil floating on the top as far as the brim. Two lighted sticks served as wicks.

The chief use of coco-nut oil to us is for making **Margarine** (and various other butters and fats), **Soap,** and **Candles.**

Poonac. All animals are fond of coco-nut kernels, and, nowadays, after the oil has been extracted from the copra, the residue is ground up into **meal** for feeding cattle ; it is called poonac.

Coir. The husks and fibre in which the nut is embedded used to be steeped in water in pits for six months, or even a year, and then beaten with a stick to separate the fibres from one another. Nowadays, the same process of wetting and beating is followed, but on most plantations machinery is employed and the methods are more expeditious.

The **Fibre** is called **Coir.** It is very strong, and is twisted into ropes, woven into matting for floor coverings, and used as a substitute for horsehair. Door-mats are made of it and ships' fenders, and various kinds of brushes and brooms.

Sources of Supply. Coco-nut palms require sunshine and fresh sea-breezes, and though in some cases they thrive at a considerable distance away from the sea, yet their natural home is the low-lying sandy shore of tropical islands, where their roots can push out to the salt water, and their great leaves can sway in the health-giving breeze. The soil of volcanic and of coral islands seems specially suited to them, though they will grow well in other soils.

Within the empire **Ceylon** stands first as a producer of coco-nuts. Millions of coco-nut palms are cultivated in the lowlands, especially on the east and south-west coasts, and large quantities of **coco-nuts, desiccated coco-nut, coir, copra, coco-nut oil,** and **poonac** are exported.

Many other British countries, however, grow coco-nuts, and our imports of copra come not only from **Ceylon** [1] but also

[1] The imports vary in amount from year to year. This is the order of importance for 1915.

from **Malaya** and **Australia**, as well as from **India, New Zealand,** the **West Indies** and **Mauritius,** from **Fiji** and other islands in the Pacific, and from Kenya Colony, Zanzibar, and the Gold Coast, in Africa.

CASTOR-OIL PLANT (*Ricinus communis*). In tropical climates if left to itself it attains a height of forty feet, but in more temperate lands it becomes a bush, while in England it has to be raised from seed every year, and never grows more than four or five feet high.

It has large smooth leaves cut into seven or more segments. The flowers occur on a thick spike, the male ones at the base and the female ones at the top. They have no petals, but the stigmas of the female ones are long and red in colour, and they give a general effect of redness to the whole spike. The seeds are contained in a three-celled spiny capsule ; they are nearly half an inch long, of a pinkish-grey colour, dotted with brown.

To obtain the **oil** the **seeds** are put under a powerful hydraulic press, and the whitish oily liquid which oozes out is known as cold drawn castor oil. It is further purified by being mixed with water, then boiled and skimmed. The pressed seeds which remain are sometimes heated and then pressed a second time, but they yield an inferior oil.

Castor oil has many valuable qualities. In **India** and other parts of the tropics it is used as a **lamp oil**, and is said to give a whiter light than petroleum or any other mineral or vegetable oil, moreover it makes scarcely any soot.

It is excellent, too, as a **lubricant** for machinery of all kinds, but it is specially valuable for use in **air-craft** as it does not freeze until the thermometer is at 0° F., then it slowly congeals to a yellow solid. It is also used for making **soap** and **candles** and for **dressing leather.**

There are two kinds of seeds, large and small ; lamp oil and lubricants are usually made from the large kind, **medicinal oil** from the small variety.

The cake, which remains after the oil has been extracted,

forms a valuable manure, and the stems and husks make excellent fuel ; it is often used in sugar-cane factories.

SOURCES OF SUPPLY. The plant is supposed by some to be a native of India, others maintain that Africa is its original home. However that may be, it is found growing wild in the forests and jungles of **India**, and it is from there that we receive our chief supplies. In 1917 we imported over £1,000,000 worth. The seeds are crushed at **Hull,** but there is a growing tendency to crush the seeds in the mills of Bombay, and to export the oil instead of the seeds.

In the West Indies and Kenya Colony the plant grows wild, and these countries and Rhodesia are probable sources of future supply.

COLZA OIL (from the Dutch *Koolzaad, cabbage-seed*) is made from the seeds of two species of **rape ;** they are nearly allied to the turnip, and all three species belong to the cabbage tribe. In the east of England a good many are grown as food for sheep, and some for their seeds, but most of our seeds we import from **India.** Before the war Russia sent us large supplies, and China and the Argentine a considerable amount.

The oil is used for burning in lamps, lubricating machinery, and for many other purposes.

CASHEW NUTS (*Anacardium occidentale*). The oil from these is now used in making Cashew **Nut Butter** and for other purposes. The peculiarity of the tree is that its flower-stalk is enlarged to the size and shape of a small pear ; it is of various colours—white or yellow or red. Beyond it occurs the ash-coloured, kidney-shaped fruit, which consists of a hard shell enclosing a pleasant-tasting kernel. When pressed the **kernels** yield a yellow **oil** equal in value to almond oil, and exceedingly nutritious.

Between the outer and inner layers of the shell there is a black oil which is used by the Andamans to colour and preserve their nets ; it is very astringent and takes the skin off the lips of any one who tries to crack the nut with his teeth. The bark of the tree is also used for tanning.

SOURCES OF SUPPLY. The Cashew tree grows wild in the **West Indies,** and in the coastal forests of **India,** but in India the kernels are so extensively eaten that few are left over for export.

Cotton Seed. **British India** and **Egypt** send us our chief supplies of cotton seed, though we also buy considerable quantities from Uganda, Kenya Colony, and Nigeria. Of foreign countries Brazil and Peru send us most, but our imports are mainly from British countries. **Cotton-seed oil** comes from the **United States.**

THE GROUND-NUT (*Arachis hypogoea*). This is a little leguminous plant which grows about a foot high. From its root it sends out branches which rise only a little way above the ground. The leaves are almost square in shape with two pairs of opposite leaflets, and at the junction of the leaf-stalk and stem of the lower branches bright yellow flowers occur resembling those of a pea, but each having a very long calyx.

When the petals fall and the pods begin to form, the part of the flower just under the seed-vessel quickly grows into a thick stalk about an inch and a half in length; this stalk pushes the pod underground and here the peas or seeds ripen. The pods are of a pale straw colour and their surface is dry and wrinkled. They each contain two reddish-brown nuts or peas.

Sir George Watt[1] says that in India 'this curious plant often attracts to itself a number of red ants which in gardens in Bengal seem regularly to soften and pulverize the soil so as to facilitate the movement of the pod'.

The nuts are said to be even more nutritious than lentils, and in America (where they are called **pea-nuts**) they are largely used as an article of food. They are sold roasted at street corners in New York as chestnuts are sold in London. Fried in butter, too, and sprinkled with cayenne, they are said to be as good as salted almonds.

[1] *Dictionary of Economic Products of India.*

It is, however, for their *oil* that they are chiefly valued. It is of a pale yellow colour and in all respects resembles olive oil. The trade in ground-nut oil is comparatively recent. In the 'fifties a merchant of Marseilles made experiments and

GROUND-NUT

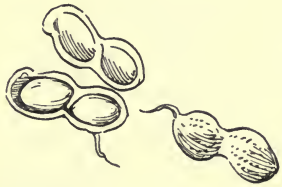
found that it could be used instead of olive oil in the manufacture of **Soap**. From that time onwards increasing quantities were brought from **India** and **West Africa** to be used in the great soap factories of Marseilles.

We, in England, have hitherto not set much value on ground-nuts, and our importations of them have been small.

Now, however, we are importing considerable quantities, and doubtless in the future these will be increased.

Not only can the oil be used in the manufacture of soap; refined and purified it can be used as **salad oil,** and **Margarine** can be made from it. After the oil has been expressed, the **residue** forms a valuable **feeding-cake** for cattle.

Sources of Supply. South America is regarded as the native home of the ground-nut, and it was not known in the Old World before the time of Columbus, but now it is cultivated in all hot countries, though **India** (chiefly South India and



GROUND-NUT

Flower. Fruit.

Bombay) and **West Africa** yield the largest supplies. From India the nuts are exported in their shells.

In West Africa, **Gambia, Northern Nigeria,** the **Gold Coast,** and **Sierra Leone** all produce ground-nuts. They are exported stripped of their shells.

Not only do the plants require but little care in cultivation and yield a quick return, but they enrich the soil for other plants, and are therefore often grown as catch crops among young coco-nut palms, and they often follow grain and cotton in the rotation of crops. In the Sudan, for instance, where irrigation is necessary and intensive cultivation is practised, ground-nuts are considered a valuable crop for restoring fertility to the soil after other crops have exhausted it.

For these and other reasons the **Sudan, Malaya, Kenya Colony, Uganda, Natal,** and many other places are paying

increasing attention to the cultivation of ground-nuts, and our supply is practically unlimited.

SESAME (*Sesamum Indicum*). This is an annual which grows about four feet high. It bears bell-shaped pinkish flowers, similar to those of the campanula. These flowers occur singly at the junction of the leaf-stalk and stem of the plant. The tiny seeds (about one-fifth of an inch long) are contained in a pale green leathery capsule about one and a half inches long. They are very numerous.

SESAME PLANT

They are chiefly valuable for the **oil** which is expressed from them. It is yellow in colour, and in many respects resembles ground-nut oil and olive oil. It is used in India, as ground-nut oil is, for cooking, for anointing the body, as a lamp oil, and for other purposes. In Europe it is chiefly used for making **Soap**, also, the purer and better kinds, for making **Margarine**, and **Vegetable Butters.** When the oil has been expressed, the **residue** is used as **food for cattle.**

Sesame oil has one curious property possessed by no other oil. If a mixture of sulphuric and nitric acid be shaken up with it, it turns green, so that when used in the manufacture of margarine its presence can always be detected and the margarine cannot then be sold as ordinary butter.

SOURCES OF SUPPLY. It is grown all over **India**, and in **Egypt, Kenya Colony, Uganda,** and **West Africa.** As in the case of ground-nut oil and many others, we have hitherto neglected it and imported only small quantities, but in the future

probably we shall greatly increase our supplies. Our imports at present (1917) come mainly from **British India**, though Nigeria has supplied us with a certain amount.

Of foreign countries China sends the largest quantity.

OLIVES, the fruit of the *Olea europaea*. The olive is a beautiful evergreen tree which usually grows to about twenty or thirty feet high, though some trees are very much taller than this. It grows very slowly, and lives to a great age. It has a smooth pale-grey bark, and small, oval, leathery leaves, covered with tiny hairs ; on the top side the leaves are of a greenish-grey colour, but underneath they are silvery white. The flowers are pure white set in a calyx of pale green, and the fruits, or olives, when ripe are rather like small long purple plums.

SEED POD, SESAME

Asia Minor and **Syria** are considered to be the original home of the olive-tree, and in these countries great woods of the wild tree still abound. But from very early days olives have been cultivated in all Mediterranean countries, and in Italy, and France, and Spain, whole districts several miles in extent are planted with them, while in Greece the tree was considered to be under the special protection of the goddess Athene.

According to the old story, Neptune and Athene both desired the possession of Athens, and the gods decided that whichever produced a gift the most useful to man should have his desire. Neptune thereupon struck the ground with his trident, and a horse appeared ; but Athene planted the olive, and the gods gave her the city, rightly judging that hers was the more valuable gift. An olive branch was regarded as a symbol of peace, and a crown of wild olive was considered the highest reward of bravery.

Unripe green olives are pickled and eaten either before meals or as dessert. The wood of the tree takes a high polish and makes beautiful furniture. But it is for its **oil** that the

tree is most valued. To obtain olive oil, or, as it is often called, salad oil, or Lucca oil, the **fruit** is crushed. The oil from the first crushings is the best; the inferior kinds pressed from the pulp after it has been steeped in water are only fit for soap-making.

Italy, France, and **Spain** at present supply us with all the oil we use, but there are districts in Australia in which the tree thrives well.

In **South Australia,** the cultivation of olives and the extraction of oil are well-established industries, and there are large tracts of country with a light rainfall and poor soil, on which thousands more trees might be grown with advantage. The **Darling Downs** in **Queensland** seem particularly suited to the cultivation of olive-trees, and many are already doing well here, though there are other parts of the State with a similar soil and climate in which the trees would certainly thrive. One writer gives it as his opinion that Queensland is destined some day to be 'one of the largest producers of olives on earth'.

Not only is the oil very valuable, but the trees themselves provide a much-needed shelter for cattle in those open downs of Australia, where the rainfall is too scanty, and the soil too poor, for other trees to flourish.

SUMMARY. Within the empire **India** and **West Africa** stand out pre-eminently as exporters of oil-seeds and oil.

The value of the **Indian** export alone is estimated at £17,000,000. We have long been accustomed to buy from her such well-known seeds as **Linseed, Castor Seed, Cotton Seed,** and **Rape Seed**, but there are many others such as **Sesame, Mowra,** and **Poppy,** which, together with **Ground-nuts**, we shall in the future import from her in increasing quantities.

West Africa is first and foremost the exporter of **Palm Oil** and **Palm Kernels** and **Ground-nuts.** Palm oil we have always bought from her, but palm kernels and ground-nuts we have hitherto neglected. In the future these, with **Sesame Seeds** and **Shea-nuts,** will be among our most valuable imports.

Ceylon, Malaya, Australia, India, and many other British countries already supply us with large quantities of **Copra,**

OLIVE-TREE AND FRUIT

and other products of the **coco-nut**, and these supplies will in the future be augmented to meet the ever-increasing demand.

Canada exports large quantities of **Flax Seed,** and **Egypt Cotton Seed,** while many other countries are beginning to export these and other valuable oil-seeds and oils, among which **Australian Olive Oil** is bound to take a prominent place.

SUMMARY : **Oil-seeds and Oils**

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Palm oil.	French and Portuguese West Africa, Liberia. Before the war German West Africa ; during the war Belgian Congo.	**Southern Nigeria,** Northern Nigeria, Gold Coast, Sierra Leone	Though we import palm oil from foreign countries, the amount is negligible compared with that from British possessions, and the bulk of this comes from Southern Nigeria.
Palm kernels, for expressing oil.	Belgian Congo, and other countries.	**Southern Nigeria,** Northern Nigeria, Sierra Leone.	Before the war the kernels were sent to Germany and we bought a certain amount of oil from her, but in 1917 more than 200,000 tons of kernels were imported by us from our West African colonies, and about a fourth of this from foreign countries.
Copra, for expressing oil.	Philippines, Dutch East Indies.	**Ceylon,** Malaya, Australia, India, New Zealand, West Indies, Mauritius, Fiji, Kenya Colony, Gold Coast, Zanzibar.	The foreign imports are small compared with those from British countries.
Flax-seed, or linseed, for expressing oil.	**The Argentine** The Netherlands, China.	**India,** Canada	In 1917 the bulk of our supplies came from India, though we bought large quantities from the Argentine. Before the war Canada sent us more than the Argentins.

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Castor seeds, for expressing oil.	Brazil.	**India.** Probable future sources: West Indies, Kenya Colony, Rhodesia.	Other sources of supply are at present unimportant compared with India.
Cotton seed, for expressing oil.	Brazil, Peru.	**India, Egypt,** Uganda, Kenya Colony, Nigeria.	Most of our imports of seed are from British countries, but the **oil** comes from the United States.
Cotton-seed oil.	The United States.		
Rape seeds, for Colza oil.	Russia, China, the Argentine.	**India.**	During the war supplies from other countries declined, and in 1917 practically **all** came from India.
Ground-nuts, for expressing oil.	French West Africa, Portuguese West Africa.	**Gambia, Nigeria, Sierra Leone, India,** Kenya Colony, Hong Kong.	More than half our imports come from British countries, and of these West Africa and India send us the largest supplies.
Sesame seeds, for expressing oil.	China.	**India,** Nigeria.	
Olive oil.	Italy, Spain, France.	Probable sources of future supply: Victoria, Queensland.	
Shea nuts, for expressing oil.		Probable sources of future supply: Nigeria, Ashanti.	
Poppy seeds and Mowra seeds, for oil.		Probable source of future supply: India.	
Cashew nuts, for oil.		The West Indies.	
Soya beans, for oil.	Russia, China, Japan.		

CHAPTER XII

DRUGS AND TOBACCO

'It may truly be said of fantastical physitions, who when they have found an approved medicine and perfect remedy near home against any disease, yet not contented with that, they will seek for a new farther off, and by that means many times hurte more than they helpe.'—John Gerard (1545–1607), gardener to Lord Burleigh.

The Dutch word *droog* means 'dry', and the plural *droogen* was used in the special sense of 'dried roots', and later on was extended to mean any substance, vegetable or mineral, which was used in the preparation of medicines. From the Dutch *droogen* the French word for drugs was derived, *drogue*, and from the French, our own word 'drug'.

Many of the best-known spices in addition to their pleasant flavours possess also medicinal properties, and spices and drugs are often therefore classed together.

'In days gone by, England grew her own medicinal herbs. Then Germany and Austria gradually undersold the home-grown plants, and English people forgot the art of growing herbs, and forgot their value when they saw the plants in hedge-rows and woods.

During recent years the acreage devoted to drug cultivation in this country has become more and more restricted by competition with foreign products, and in consequence British-grown drugs have been steadily ousted from the market. In 1913 we imported over £71,000 worth of varieties of vegetable drugs which we are able to grow or collect here.'[1]

One of the most important British plants which yield valuable drugs is *Atropa belladonna* or the **deadly nightshade,** a bushy herbaceous plant, which grows from two to four feet high. It bears large, bell-shaped, purplish flowers, and its fruit when ripe is like a small black juicy cherry, intensely

[1] M. Grieve, F.R.H.S., Principal of Whin's Vegetable Drug Farm, Chalfont St. Peter.

sweet, and very poisonous. 'Banish, therefore, these pernicious plants from your gardens', says Gerarde, 'and from all places near to your homes where children do resort.'

This deadly character of belladonna is due to the presence of an alkaloid called **atropine**, one-tenth of a grain of which swallowed by a man has been known to occasion symptoms of poisoning; it is contained in all parts of the plant, but is especially abundant in the thick fleshy roots.

Atropa, the name of the genus to which belladonna belongs, is derived from the Greek *Atropos*, the mighty goddess, who with 'the abhorred shears' cuts the 'thin spun thread' of human life.

Atropine possesses the valuable power of dilating the pupil of the eye, and is, therefore, of great service to oculists in their work. The tiny disks which they use for this purpose are made of gelatine with $\frac{1}{5000}$ of a grain of atropine in each, the entire disk weighing only one-fiftieth of a grain. Italian ladies used to consider this enlargement of the pupil an addition to their charms, hence the name *belladonna* which in Italian means *beautiful lady*.

The various preparations of belladonna serve many useful purposes; they lessen pain, for instance, in cases of neuralgia, and rheumatism, and sciatica, and for this and many other reasons the plant is considered a very valuable one.

It is not very common in England, though in our southern counties it is found often growing in the shade of trees on the slopes of chalky hills, and its cultivation under favourable circumstances yields excellent results. There seems no reason, therefore, why we should be dependent on foreign sources of supply for a commodity of such vital importance to us, and it is gratifying to learn that a beginning has been made in the work of rendering us self-supporting in this respect.

'Before the war the bulk of the world's supply of belladonna was derived from plants growing wild on waste stony places in Southern Europe, comparatively little belladonna having hitherto been grown in England. The industry was

an important one in Croatia and Slavonia in South Hungary, the chief centre for foreign belladonna. . . . In August 1916 the drug atropine derived from the plant had risen from 10*s*. 6*d*. per ounce before the war to £7 per ounce.'[1]

Another important British drug is derived from **Foxgloves,** and there are very many other drug-producing plants. Mrs. Grieve in her catalogue gives more than 600 which can be grown in the British Isles.

Of other drugs which are not suitable to our climate, **quinine, opium, eucalyptus,** and **camphor** are among the most important.

QUININE. 'This medicine, the most precious of all those known in the art of healing, is one of the greatest conquests made by man over the vegetable kingdom. The treasures which Peru yields, and which the Spaniards sought and dug out of the bowels of the earth, are not to be compared in utility with the bark of the quinaquina trees which they for a long time ignored.'—*Dictionnaire des Sciences Medicales.*

Quinaquina (bark of bark) is the name given by the Indians of Peru to the trees which we call **Chinchona** trees; our word **quinine** is derived from it. Quinine is a white substance, very bitter and without smell. It is obtained by a complicated process from the powdered bark of various species of chinchona trees. Its uses are many and various, but it is valued most of all for its healing virtues in cases of fever and malarial affections of all kinds. In these illnesses it is without a rival in efficacy.

Chinchona Trees. Twenty-four miles to the south-east of Madrid 'on a breezy hill' stand the ruins of the old castle of Chinchon, 'with the little town nestling at its feet.'

Hither came in 1621 the young and beautiful bride of the Count of Chinchon. She was twenty years old, and eight years later she accompanied her husband to Lima in Peru, of which country he had been made viceroy. But the climate was unhealthy, and in 1638 the countess was stricken with fever and lay in a dangerous condition in the palace at Lima.

[1] M. Grieve.

At Loxa, in Ecuador, grew some quinaquina trees, the bark of which was said to possess marvellous powers of healing, and the Governor of Loxa, hearing of the countess's illness, sent a parcel of this bark to her. Its effect was magical; the fever left her.

In 1640 she returned to Spain, bringing with her quantities of quinaquina bark; its virtues were quickly recognized by the Jesuits, and from them the knowledge of its usefulness spread among Roman Catholics, especially in Spain and Italy, but for a long time the Protestants and orthodox physicians refused to have anything to do with it. However, in course of time this prejudice was overcome, and there arose a great and increasing demand for it. In 1679 Robert Talbot, an English physician, cured Charles II of a fever by its use, and from him Louis XIV purchased the secret. The price he paid was 2,000 louis d'or (£2,000), a large pension, and a title.

The Swedish botanist Linnaeus (1738–83) called the quinaquina trees *Chinchona* trees, in honour of the countess who introduced the bark into Europe.

It was from the forest of Loxa that the bark was exported, and the native collectors thought of nothing but their own immediate profit, and paid no heed to the havoc they wrought in making their collections, so that, wherever they went, the trees were destroyed, and a desert was left behind them. The bark in consequence grew rarer, and the price increased. In England it cost 10*s*. an ounce, and in India, where its need was most urgent, 20*s*.

It was to remedy this state of things that in 1860 Sir Clements Markham set out to Peru, with the object of collecting Chinchona plants and seeds, and establishing plantations in India. It was an extremely difficult enterprise.

All along the eastern slopes of the Andes from 20° S. to 10° N. (i.e. from the south of Bolivia to the north of Ecuador) are sub-tropical forests, and in these forests grew the Chinchona trees. There are many varieties, but they all need

a mild and equable climate, such as that suitable for coffee and cacao trees, i.e. between 60° F. and 65° F. mean temperature.

'When in good soil and under favourable conditions they become great forest trees; on higher elevations, and when crowded or growing on rocky ground, they frequently run up to a great height without a branch, and at the upper limit of their zone they become mere shrubs.' They are evergreen trees with bright green, shiny, laurel-like leaves; but the leaves have crimson veins. They bear large clusters of fragrant flowers, rather like lilac, but generally roseate in colour.

It was resolved to form three separate expeditions to the Chinchona forests, the most difficult one to the Caravaya region of Peru being undertaken by Sir Clements himself.

He tells how they started from Islay, on the coast of Peru, and then journeyed across the Andes to the eastern side of Lake Titicaca. Their road lay across desolate plains, and across snow-capped mountains, and down steep ravines, but at last, after travelling for six weeks, they came upon their first clump of Chinchona trees at an altitude of 5,400 feet.

'I entered the Chinchona forests, travelling on foot, with Weir the gardener and four young Indians carrying the food in leather bags. All were faithful, active, steady young fellows and good comrades, except one, who deserted with a bag of toasted bread. Soon we came to the coca plantations, then the volume of the rivers increased and they were difficult to ford. At length we came upon the first Chinchona plant, only a shrub at this elevation, 5,400 feet. It was on a grassy slope, growing with other beautiful flowering shrubs. . . . It was a great event. I gazed with feelings of delight at the panicles of exquisite roseate flowers and the rich glossy leaves with crimson veins of my first Chinchona. Pressing onwards for several days, and always descending, we reached the forests in the valley of the river Tambopata.'[1]

They spent a fortnight in gathering plants, cutting their way through dense forests, where no European had ever been

[1] *Chinchona*, by Sir Clements Markham.

before, and where no roads of any kind existed, and where creepers and tangled undergrowth tripped them up at every step. Often their route lay along the edge of forest-clad precipices which overhung foaming dashing torrents hundreds of feet below. But after all their labours in these pathless wilds worse troubles awaited them.

In describing their journey Sir Clements says: 'At Accokunka I met a red-faced man, about 50 years of age.' It was this red-faced man who stirred up strife and was the cause of all their difficulties.

There was no law in Bolivia against collecting Chinchona plants, and, moreover, the explorers had received special permission to make their collections, yet now orders came to arrest them, and it was only by using the utmost precaution and by dint of the most strenuous endeavours that they managed to reach the coast by another route. But they had their plants safe. They were carefully packed in specially made cases and conveyed across the Isthmus of Panama. During the night, while the cases containing the plants were awaiting shipment, an attempt was made to kill them by pouring boiling water upon them.

They reached Southampton in a flourishing condition, but, sad to say, after all this care, and toil and danger the heat of the Red Sea in summer proved too much for them, and they died on their way to India. However, the seeds survived, and these and other seeds and plants from the other regions explored were safely landed in India. Plantations were formed on the **Nilgiri Hills,** where 'the warmth is not heat, and the coolness is not cold', and from here other districts received seeds and plants, so that now there are flourishing plantations in **Sikkim,** and **Burmah,** and **Ceylon**, as well as in Southern India.

The tree is also cultivated in Jamaica and South Africa.

The result of these enterprises is that whereas in India quinine used to be sold at 20*s*. an ounce, and was, therefore, quite beyond the means of the poor fever-stricken native, now

it can be purchased in halfpenny packets and the poorest can get cured of his disease.

In England the price has gone down from 10*s.* to 1*s.* an ounce. Yet this boon was not conferred on humanity without sacrifice. Two of the explorers were crippled and disabled as a consequence of the paralysis which followed the fevers they contracted in the forests, and one poor Indian who helped to collect seeds was thrown into prison, where he was beaten and starved to death.

SOURCES OF SUPPLY. Before the war, however, in spite of these sacrifices, we imported practically all our quinine from foreign countries, mainly from the *Netherlands* (there are flourishing plantations in *Java*) and *Germany*. During the war our supplies came almost entirely from the Netherlands.

OIL OF EUCALYPTUS. This is a very valuable antiseptic drug, obtained from the leaves of the **Eucalyptus globulus,** or **Australian Blue Gum.** This is one of the largest known trees, sometimes attaining a height of over 400 feet. It has a smooth greyish trunk, the outer layers of which easily peel off. Its leaves are of a dull grey-green colour, long and narrow, tough and leathery. They contain numerous oil-glands, which help them to resist the heat, and which emit the well-known peculiar odour of the Australian Bush.

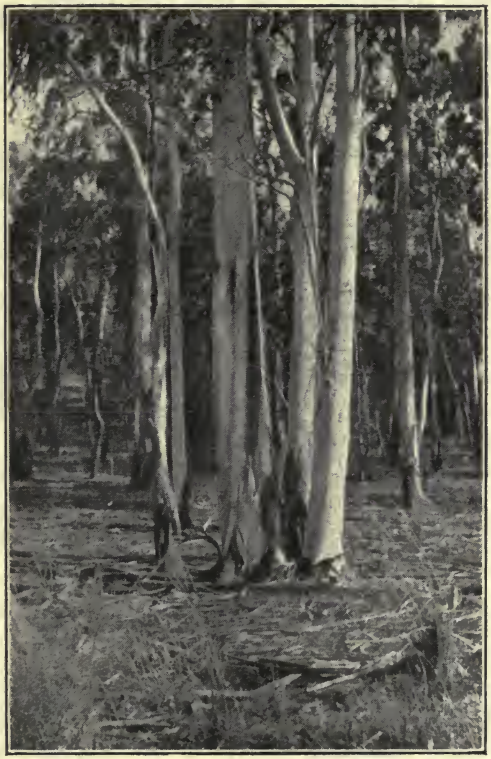
The flowers are large with very many stamens arranged in rows around the edge of the calyx. The cream-coloured filaments are long and delicate, with small yellow anthers at their extremities. There are no petals. The upper part of the bud consists of a thick knotty green lid, which drops off when the flower opens. It is this lid which gives the tree its name *eucalyptus*, well covered.

The fruit is rather like a button in shape, hence the name *globulus*, which means a little button.

'The fever-destroying tree' is another name by which it is known, because when planted in malarial districts it makes them less unhealthy. Its enormous roots suck up huge

quantities of moisture and so drain the land, and its leaves exude antiseptic odours.

To a French botanist belongs the honour of having discovered the eucalyptus tree. While on a voyage of exploration he



EUCALYPTUS FOREST

came upon vast forests of *Eucalyptus globulus* in Southern Tasmania. In 1792 seeds were first sent to Europe.

In favourable situations its growth is extraordinarily rapid, and in Southern Europe it flourishes abundantly, but it is very sensitive to frost, and hence Cornwall and the

south-west of Ireland are the only places in the British Isles where it will grow out of doors without shelter.

OPIUM. Latin *Opium*, from Greek *opos*, vegetable juice.

> Corn poppies, that in crimson dwell,
> Called Headaches, from their sickly smell.
>
> JOHN CLARE (1793–1864).

This quotation refers to the common red poppies which blossom in our cornfields, but opium is the dried juice of the **White Poppy,** *Papaver somniferum.*

Incisions are made at sunset in the unripe capsules,[1] or seed-vessels, of the poppies, and by morning the milky juice has hardened into a kind of brown gum. This gum is the opium of commerce; it has an earthy, drowsy smell, and a bitter taste.

Opium is one of the most precious of all drugs, for it contains an element which induces sleep and relieves pain. Morpheus was the Son of Sleep and the God of Dreams, and the element in opium which produces sleep and insensibility to pain is therefore called **morphia,** or morphine. Though a very valuable medicine, opium is very harmful if used intemperately.

The white poppy is cultivated in England chiefly in Lincolnshire, and is found growing wild in various other places in England, but its narcotic[2] properties are not so strong as when grown in warmer climates, and most of our opium is therefore imported.

In India the white poppy is extensively cultivated in the **Ganges Valley,** and on the **Malwa Plateau. Ghazipur** and **Patna** are the collecting centres in the Ganges Valley, and **Calcutta** the port of shipment. The produce of the Malwa Plateau is exported from **Bombay.** Unfortunately most of this opium is sent to China, where large numbers of the population are addicted to the vice of opium smoking.

All parts of the poppy, except the seeds, contain a certain

[1] Capsules: Latin *capsula*, a little box or chest.
[2] Narcotic: Greek *narkotikos*, from *narkoun*, to benumb.

amount of narcotic juice, and poppy heads, or poppy capsules, are often used in fomentations to allay pain. The seeds yield an oil resembling olive oil, and are often used to adulterate it.

SOURCES OF SUPPLY. Before the war we obtained most of our supplies from Asiatic Turkey, **Smyrna** being the port of shipment; very considerable quantities, too, came from Turkey in Europe and from Persia, while a small amount came from India. During the last four years the Turkish supplies have fallen off and those from **India** have enormously increased.

CAMPHOR. Latin *Camphora*, from Arabic *kafur*. Camphor is a white, translucent substance obtained from the wood of the *Cinnamomum camphor*, or *Camphor Laurel*. It has a pungent aromatic odour and has many and various uses. Though insoluble in water it is soluble in milk.

The camphor laurel grows to about thirty feet high, and has glossy, evergreen, oval-shaped leaves, and long spreading branches. It bears little clusters of tiny yellowish flowers. The wood of the tree is cut up into chips, and exposed to the steam of boiling water. The camphor vapour rises from the wood, and is then condensed. This is the crude camphor, which is exported, and which after its arrival in this country has to be refined or purified.

Formosa sends us most of our camphor at present, but the camphor tree has been successfully introduced into the Cape of Good Hope and Jamaica, as well as into other countries, and there seems no reason why we should not be able to supply our own needs from trees grown in our own dominions.

SUMMARY. Most of our Peruvian bark and **quinine** comes from **Java** and the **Netherlands,** and our **opium** from **Turkey,** very small amounts of these being imported from India.

With these two exceptions most of the other drugs given in the *Annual Statement of Trade* are unenumerated, only the total value of the imports being given.

The foreign countries which sent us the largest supplies

before the war were **Germany** and the **United States,** but many other countries also contributed to our needs, in all about twenty-three.

Of British countries **India** and **Ceylon** stood first, each sending about the same amount, while Australia and the Cape of Good Hope and the West Indies sent smaller quantities. The **total** value of the imports was over **£1,000,000,** of which only **£213,000** came from **British Possessions.**

During the war our imports from **British** sources **trebled,** and of this increase **India** bears the largest share, while at home we have made a beginning in growing drug-plants such as belladonna and foxglove, for which our climate is suitable.

TOBACCO (*Nicotiana tabacum*). 'A custom loathesome to the eye, hateful to the nose, harmful to the brain, dangerous to the lungs, and in the black stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless.' Thus wrote King James, and in his dislike of the practice of smoking he was not alone, many other rulers doing their utmost, by scathing abuse and barbarous punishments, to suppress the objectionable habit, but all in vain. In spite of every discouragement the habit of smoking spread, until now it is almost universal.

The word 'tobacco' is derived from *tabaco*, which was the name for the pipe or tube in which the natives smoked the dried leaves of the tobacco plant, and which the Spaniards mistook for the name of the plant itself.

Tobacco was introduced into this country by Sir John Hawkins, though it was Sir Walter Raleigh who did most to popularize it, by encouraging the cultivation of the plant in his colony of Virginia; we read of him that he 'tooke a pipe of tobacco a little before he went to the scaffolde'.

Jean Nicot (1530–1600), while French ambassador at Lisbon, sent to his native country some tobacco plants which had lately arrived from Florida, and later on botanists, in his honour, gave the name *Nicotiana* to the genus of which the American plant is a species.

Nicotiana tabacum is a fine handsome plant with great, broad leaves, covered with tiny little hairs. It grows about six feet high, and has beautiful pink flowers. This is the kind which is most extensively grown. It is often called the American tobacco plant, for not only is it a native of America, but the States, especially Kentucky, Virginia, and Carolina, produce more than half the tobacco crops of the world.[1] Though grown chiefly in tropical or sub-tropical climates it does well in temperate ones, provided it can be protected from frost, to which it is peculiarly sensitive.

With regard to soils, it seems to prefer a light sandy loam or alluvial soil, though heavy clay produces good crops. The quality of the leaf varies greatly according to the soil and climate in which it is grown; heavy soils produce strong tobaccos and light ones mild.

The seeds of the plant are very small, about 100,000 to the ounce, and when sown they are mixed with sand or wood-ashes, so that they may be evenly distributed. When the flower begins to shoot, the top is nipped off, in order that all the strength may go to the leaves. These are gathered as they are ripe, and either dried in the sun or in drying sheds, then piled in heaps, and left for a week or two to ferment, after which they are sorted out according to size, pressed down into barrels, and packed for export.

The tobacco grown in **Cuba** has a pleasant aromatic smell, which has caused the Havana cigars manufactured from it to have a world-wide reputation. A good deal of 'Cuban' tobacco is, however, imported from the Philippines and made into cigars in Havana.

Besides *Nicotiana tabacum* there are many other species of the tobacco plant, two of the best known being *Nicotiana rustica* and *Nicotiana persica*. The first grows to about four feet in height, and bears greenish-coloured flowers.

[1] Next in order of importance comes India (where large quantities are grown), and then Russia, Austria-Hungary, the Dutch East Indies, and Japan. It is also largely grown in Italy, France, and Germany.

It is the kind which is cultivated in **Turkey** and **Syria** from which the famous *Latakia* tobacco is made. Its peculiar flavour is due to the fact that the leaves are fumigated for four or five months, so that the natural flavour is disguised. *Nicotiana persica* grows in Persia and produces the mild Shiraz tobacco. It is a small plant with a pretty white flower. The one which grows in our gardens is *Nicotiana finis*.

In the Empire, though **India** (Bombay, Madras, and the Punjab) is the chief tobacco-growing country, our imports from her used to be small, as the native method of curing does not suit our tastes. There are, however, some European factories, and our Indian imports have increased during the last few years.

Nyasaland grows good tobacco, especially in the Shiré Highlands, and our imports from Nyasaland used to be greater than from any other British country, but recently North Borneo has come to the front, and in 1917 our imports from these two countries were almost equal in amount.

Rhodesia, too, has a soil and climate very suitable for tobacco, and our imports from here used to be considerable, but of late years maize has to a certain extent ousted tobacco.

In the Union of South Africa tobacco is grown (especially in the rich limestone district of Oudtshorn) and in the Transvaal as well as in Natal, and there seems no reason why the quantity grown should not be much greater than it is, but at present our imports from these countries are small.

Cyprus has a suitable soil and climate, and our imports from here show a considerable increase. The difficulty against which growers have to contend is the lack of care and diligence on the part of the labourers.

In the West Indies, especially in Jamaica, the production of tobacco is increasing.

Summary. In 1913 our imports of unmanufactured tobacco amounted to 162 million pounds, of which 2 million were from British countries. In 1917 our imports had fallen

to 46 million pounds, of which 3 million were from British countries.

Our chief foreign source of supply is **America,** and before the war we also bought a considerable amount from Turkey and the Netherlands, and smaller quantities from many other countries, including Germany and Portuguese East Africa.[1]

Of British countries **Nyasaland** and **North Borneo** send us most, though we also import from India, Cyprus, Egypt,

FIELD OF TOBACCO, SOUTH AFRICA

Rhodesia, Canada, the West Indies, and the Union of South Africa.[2]

Foreign **cigars** we buy mainly from **Cuba,** the Netherlands, and the Philippines ; British from **India,** the Channel Islands, and the West Indies.

British **cigarettes** come from **Canada** and **Egypt,**[3] foreign ones from the United States.

[1] America 142 million pounds; Turkey, 6; the Netherlands, 6; Germany, 2; P E. Africa, 1. (1913.)

[2] This is the order for 1917.

[3] Much of the tobacco from which they are made is imported from Greece.

APPENDIX I

IMPORTS OF WHEAT

	1913	1914	1915	1916	1917
	cwt.	cwt.	cwt.	cwt.	cwt.
Russia . .	5,011,100	7,234,827	796,300	12,500	111,406
Germany . .	447,600	977,500	—	—	—
Netherlands . .	1,600	1,600	—	—	—
Belgium . .	—	10,800	—	—	—
Bulgaria . .	—	192,500	—	—	—
Rumania . .	38,600	343,500	—	—	—
Turkey, European .	35,700	26,500	—	—	—
,, Asiatic .	5,300	12,800	26,000	—	—
Persia . . .	10,000	52,000	149,100	—	—
United States of America . .	34,037,944	34,220,166	41,649,000	64,544,100	64,208,300
Chile . . .	765,100	50,700	—	116,900	500
Uruguay . .	—	17,800	6,700	—	—
Argentine Republic	14,756,200	6,497,760	12,156,000	4,495,700	6,760,600
Other Foreign Countries . .	2,100	200	600	600	10,200
Total from Foreign Countries . .	55,141,244	49,638,653	54,783,700	69,169,600	61,031,606
British India .	18,766,100	10,708,900	13,956,500	5,611,900	2,744,700
Australia . .	10,126,658	12,113,400	180,300	3,699,620	9,243,700
New Zealand .	56,200	8,500	—	30,500	3,500
Canada . .	21,787,900	31,457,090	19,725,300	21,551,000	18,408,300
Other British Possessions . .	—	200	22,100	7,500	3,800
Total from British Possessions .	50,736,858	54,288,090	33,884,200	30,900,520	30,404,000
Total . .	105,878,102	103,926,743	88,667,900	100,070,320	91,435,006

IMPORTS OF MAIZE

	1913	1914	1915	1916	1917
	cwt.	cwt.	cwt.	cwt.	cwt.
Russia . . .	1,684,100	811,900	1,000	—	—
Bulgaria . .	259,200	—	—	—	—
Rumania . .	1,002,300	7,004,641	—	—	—
Turkey, European .	31,200	26,800	—	—	—
,, Asiatic .	8,200	135,200	—	—	—
Egypt . . .	100	28,800	—	—	—
United States of America . .	6,879,300	232,925	1,695,300	6,991,800	10,670,300
Brazil . . .	4,800	142,100	—	34,900	295,618
Uruguay . .	19,600	56,900	12,900	200	—
Argentine Republic	38,854,073	28,642,884	44,152,400	20,843,700	9,578,200
Other Foreign Countries . .	81,480	294,640	285,200	373,210	129,960
Total from Foreign Countries . .	48,565,153	37,635,990	46,146,800	28,243,810	20,674,018
Egypt . . .	—	—	15,200	1,161,300	600
British West Africa	179,300	49,700	22,500	18,900	7,500
British South Africa	34,700	1,317,800	2,173,500	2,490,600	2,679,000
Canada . .	211,500	—	148,000	2,174,000	1,635,700
Other British Possessions . .	45,400	21,957	9,600	16,200	11,600
Total from British Possessions .	589,800	1,404,757	2,434,500	5,915,400	4,334,900
Total . .	49,154,953	39,040,747	48,581,300	34,159,210	25,008,918

IMPORTS OF BEEF

	1913	1914	1915	1916	1917
	cwt.	cwt.	cwt.	cwt.	cwt.
Chilled :					
United States of America . .	—	2,079	608,908	388,611	335,803
Uruguay . .	31,982	160,412	289,113	166,944	58,891
Argentine Republic .	5,216,022	4,649,718	1,702,186	1,275,647	1,073,102
Other Foreign Countries . . .	—	—	18,339	30,511	23,939
Total from Foreign Countries . .	5,248,004	4,812,209	2,618,546	1,861,713	1,491,735
Total from British Possessions . .	—	—	—	6,204	3,340
Frozen :					
United States of America . .	1,462	85,510	392,443	541,596	602,323
Uruguay . .	397,378	569,367	74,500	34,972	171,912
Argentine Republic .	1,955,853	1,343,408	3,394,275	2,762,031	1,598,030
Other Foreign Countries . . .	—	—	29,303	44,822	55,011
Total from Foreign Countries . .	2,354,693	1,998,285	3.890.521	3,383,421	2,427,276
Australia . .	1,347,464	1,551,001	1,236,938	765,493	1,107,704
New Zealand . .	244,168	476,680	735,226	875,086	760,094
Canada . . .	6,555	8	71,880	121,191	286,510
Other British Possessions . .	—	1,132	46,483	38,865	45,061
Total from British Possessions . .	1,598,187	2,028,821	2,090,527	1,800,635	2,199,369
Total . .	3,952,880	4,027,106	5,981,048	5,184,056	4,626,645

IMPORTS OF SUGAR (UNREFINED)

	1913	1914	1915	1916	1917
	cwt.	cwt.	cwt.	cwt.	cwt.
Beetroot :					
Denmark (including Faroe Islands)	628,996	400,232	—	—	—
Germany	9,428,937	3,039,063	—	—	—
Netherlands	217,687	114,494	2	—	36,294
Belgium	49,323	—	—	—	—
Austria-Hungary	3,217,169	1,303,429	—	—	—
Total	13,542,112	4,857,218	2	—	36,294
Cane, and other Sorts :					
Danish West India Islands	4,836	3,018	—	—	—
Germany	11,583	30,727	—	—	—
Netherlands	6,467	12,551	—	—	13
Java	1,979	5,827,655	5,871,923	5,633,526	5,414,046
Dutch Guiana	92,120	85,760	31,920	49,318	50,365
France	358	2,293	—	—	—
Portugal	94,077	—	3	—	—
Portuguese East Africa	203,594	337,211	274,257	11,254	15,607
Egypt	—	10,528	—	—	—
China	—	3,870	—	—	—
United States of America	61,441	387,826	1	7,247	2
Philippine Islands and Guam	—	54,400	120,769	1,344,485	129,303
Cuba	4,484,546	5,237,335	7,194,922	11,089,053	13,987,047
San Domingo	188,249	349,315	5,600	72	—
Mexico	82,685	109,527	2,261	—	—
Guatemala	61,705	22,116	1,317	—	—
San Salvador	5,176	5,711	1,109	—	—
Costa Rica	—	—	21,873	13,686	26,013
Colombia	—	2,883	19	—	—
Venezuela	6,169	48,670	53,614	19,154	—
Peru	549,735	930,855	628,809	1,112,262	1,017,867
Brazil	102,655	399,141	465,621	183,916	470,046
Uruguay	—	4,230	—	—	—
Argentine Republic	—	518,543	287,089	—	—
Other Foreign Countries	217	272	4,887	5,094	990
Total from Foreign Countries	5,957,592	14,384,437	14,965,994	19,469,067	21,111,299

IMPORTS OF SUGAR (UNREFINED) (*continued*).

	1913	1914	1915	1916	1917
	cwt.	cwt.	cwt.	cwt.	cwt.
Cane, and other Sorts (*continued*).					
Union of South Africa . .	578	900	8	1,483	—
Mauritius and Dependencies . .	401,500	979,507	2,221,624	1,612,576	625,351
British India . .	77,005	200,349	17,327	944	2
Straits Settlements and Dependencies (including Labuan) . .	—	9,949	—	—	—
Hong Kong . .	—	3,007	—	—	—
Australia . .	—	150,215	4,893	—	—
Canada . . .	794	133	—	137	—
British West India Islands . .	587,273	624,755	1,477,826	1,194,798	1,869,910
British Guiana .	367,439	772,533	849,826	180,383	717,931
Total from British Possessions	1,434,589	2,741,348	4,571,504	2,990,321	3,213,194
Total . .	7,392,181	17,125,785	19,537,498	22,459,388	24,324,493
	£	£	£	£	£
Sugar, total value of :					
Foreign Countries .	22,135,688	28,993,273	25,275,178	32,340,337	30,002,317
British Possessions .	930,933	3,124,897	6,536,982	5,027,338	6,707,279
Total value .	23,066,621	32,118,170	31,812,160	37,367,675	36,709,596

PART II

RAW MATERIALS AND THE PRODUCE OF MINES

CHAPTER XIII

FIBRES

COTTON. The cotton plant belongs to the genus *Gossypium* of the Order *Malvaceae*. There are several varieties, both wild and cultivated, growing in different parts of the world.[1] One of the most valuable is a variety of the *Gossypium Barbadense*, known as **Sea Island Cotton.**

The plant if left to itself grows to a height of from six to twelve feet, sometimes shooting straight up and bearing its flowers at the top of its stem, as hollyhocks do, and sometimes sending out many branches sideways, which in their turn bear flowers and send out other branches, so that the final shape of the plant is that of a pyramid. This pyramidal plant does not grow so tall as the simpler kind (four feet is the usual height), and, for this and other reasons, is considered to be the most desirable form to cultivate.

The leaves are large and either three- or five-lobed. The flowers occur singly in between the stem and the base of the leaf-stalk. They resemble those of the hollyhock and mallow, having five overlapping petals which are usually sulphur yellow in colour with a blotch of purple at the base.

The small *calyx* is completely hidden by three large tooth-edged bracts which are at first dark-green, but afterwards change to brown. The *stamens* are very numerous, and are joined together to form a tube, which is joined on to the base of the petals. The tube is dotted all over with slender filaments

[1] Between 40° N. and 30° S. of the Equator.

which support the yellow anthers. The *style* has a three- or five-lobed stigma which passes from the seed-vessel through, and some distance beyond, the staminal tube.

The **fruit** consists of a green *capsule* or *boll* containing numerous dark-brown seeds, each covered with long, white,

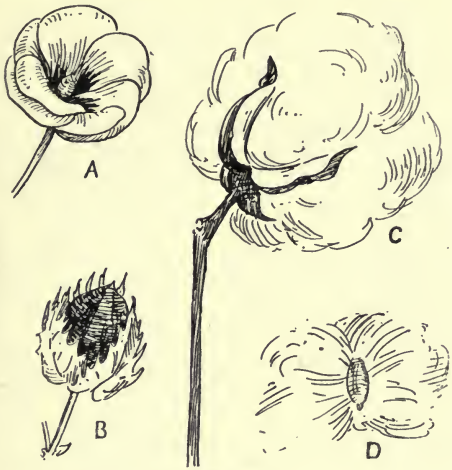
COTTON PLANT

flattened, and twisted hairs. The capsule is surrounded at the base by the three tooth-edged bracts. When the fruit is ripe the capsule bursts open and discloses a mass of white fluffy material. This is the **cotton** of commerce, and it consists of the innumerable hairs covering the seeds, which are themselves entirely hidden from view.

These hairs or fibres vary very considerably in length and thickness: one and three-quarter to two inches is the usual

length of Sea Island cotton; their thickness varies from $\frac{1}{600}$ to $\frac{1}{2000}$ of an inch. Cotton in which the fibres measure less than one and one-eighth inches is said to be *short-stapled*, that in which they measure more than this, *long-stapled*.

CULTIVATION. The cotton plant grows best on rich well-drained soils, though it often does fairly well on thin poor soils. Whilst forming its stems and leaves and flowers it requires plenty of moisture; a hot steamy atmosphere and frequent



COTTON

A, flower. B, boll. C, open boll. D, seed with cotton attached.

showers suit it admirably; but while the seeds are ripening it requires dry sunny weather with little or no rain.

In different parts of the world therefore the time of sowing the seed varies. In **St. Vincent,** for instance, June or July is considered a favourable time; in **Barbados** May or June; and in the **United States,** March.

When the ground is in a suitably moist condition shallow holes are made, and four seeds are put into each hole, and covered with earth to the depth of about an inch. The holes should be about twenty inches apart, and the rows four or

five feet wide. The young shoots usually appear in about eight days, and are thinned out until only one is left in each hole.

Three or four months later the flowers begin to appear, and in the hot sunshine bees, and wasps, and humming-birds are seen buzzing over the plantations, carrying the yellow pollen from one flower to another. Later on the flowers wither and the capsules burst open, and then the cotton has to be picked.

Picking. This is a wearisome and toilsome operation, and at present is almost entirely done by hand, as no satisfactory picking-machine has yet been invented.

'The picking season is the busy time on a cotton plantation. All hands are requisitioned, as the quality and cleanliness depend, to a large degree, upon its being quickly gathered after the bolls have opened. Should it be left long on the plant after opening, it is liable to be injured by the heat of the sun, which overdries it; or again by the winds which load it with sand, or dust, and dirt of various kinds. The cotton fields are so arranged that a section can be given to each picker, who, provided with a bag tied round his body, and a sheet or large basket, which he leaves at the end of his section, passes rapidly between the rows, using both hands, picking the open bolls on each side, until he gets to the end, when he empties the contents of his bag upon his sheet, and recommences his work.

'Picking is an operation requiring considerable skill and expertness. The picker has to seize at the first effort the whole of the contents of each boll, and bring it away in his fingers, taking care not to bring away any of the boll-leaf, or petals, which it is difficult to remove subsequently, and which seriously deteriorate its quality.

'The average amount picked by each labourer in an ordinary field is about one hundred pounds of seed-cotton each day. The pickers go to the field with the opening of the day and work with little intermission till darkness closes.'[1]

In the West Indies the method is slightly different. The writer of *Cotton Cultivation in the West Indies* says:

'The pickers should be trained to hold the boll firmly with the left hand, with two fingers and the thumb inserted from

[1] Richard Marsden, *Cotton Spinning.*

below between its segments. They should remove the seed-cotton with the right hand in one pull; if they take two pulls they will take much longer to pick the cotton.'

The wages of course vary in different parts of the world. In the West Indies they receive from $\frac{1}{4}d.$ to $\frac{1}{2}d.$ for every pound of seed-cotton they pick.

GINNING. The cotton which is brought in from the plantations is known as seed-cotton, and the first process after

COTTON GINNING

harvesting is to **remove the seed from the lint.** Before the invention of machinery this was done slowly by hand; it has been calculated that it took one person two years to produce one bale (500 lb.) of cotton, whereas now one machine turns out from three to fifteen bales in a day.

Eli Whitney's Saw Gin was invented in 1793; it consists of a number of circular saws, which, as they revolve, tear the lint from the seeds.

There are now many other kinds of cotton gins, but the

object of all is the same, namely, to get rid of the seeds with as little injury to the lint as possible.

Baling. When the seeds have been removed, the cotton is pressed together and formed into great **bales,** or bundles. These generally weigh **500 lb. each,** but Indian bales weigh only 400 lb. The Indian ones are bound up in black hemp, and are secured by iron bands.

Carding. When the bales arrive at the factories the cotton undergoes various processes, all with the object of removing extraneous matter and separating the fibres from one another. At last, having been reduced to a **long sheet** or **lap** of uniform thickness, it is ready for carding.

The word **Card,** used in this sense, comes from the Latin *carduus*, a *thistle*, and a card was an instrument for combing wool or flax, or for cleaning and smoothing the hair of animals; it was usually made by inserting bent teeth of wire in a thick piece of leather, fastened to a piece of wood.

The modern carding machine is more complicated, but the principle is the same. Instead of a thick piece of leather studded with teeth, there are several rollers covered with sharp little steel teeth, and the 'lap' after having passed under these rollers emerges in the form of a soft untwisted rope called the **Sliver.**

The 'sliver' is still further straightened and lengthened, until at last it is no thicker than a thread, and then it has to be twisted or spun.

Spinning. A spinning machine consists of a number of spindles which revolve rapidly and **spin** or **twist** the thread. This is then wound on to bobbins, or reels, and either forms the yarn for weaving, or, after being subjected to other processes, appears as our sewing cotton.

Weaving. Weaving is doing by machinery on a large scale what we do by hand on a small scale when we darn. The first process consists of putting the **long** strong threads (called the **Warp**) in position on a roller at the back of the loom or frame. These threads must be as long as the piece of cloth

to be woven. The ends of these threads pass through steel eyes which can be raised or lowered in sets. All the even threads form one set; the odd ones another.

The **Weft** or **Woof** is the yarn wound on to a shuttle (corresponding to the needle in darning). When one set of warp threads is raised, the shuttle passes between them and those which remain unraised. Then the process is reversed; the unraised ones are raised, and the others lowered, and the shuttle passes back.

After each journey of the shuttle from side to side, an instrument pushes the weft up close against the preceding weft.

CENTRES OF MANUFACTURE. In England the **South Lancashire** and Cheshire coalfield on the western side of the Pennines is the chief seat of the cotton manufacture.

The abundance of coal and water, the dampness of the atmosphere, and the nearness to the sources of supply in the New World, were some of the advantages which told in favour of this locality in the past, and they are advantages which still exist, though the raw cotton used does not at present all come from the west.

Manchester, with nearly one million inhabitants, is the centre of this district, and **Liverpool,** on the coast, the most important town, both for the import of the raw material and the export of manufactured goods, though ocean steamers can now come by the Ship Canal right up to Manchester itself.

SPINNING is carried on chiefly in the **South,** at **Oldham, Bolton, Ashton,** and **Rochdale**; WEAVING in the **North,** at **Blackburn, Burnley, Preston,** and **Bury.**

Cotton goods, chiefly **hosiery** and **lace curtains,** are also manufactured at **Nottingham** on the York, Derby, and Nottingham coalfield. As the threads used in these articles are necessarily very strong, the dry atmosphere is not a disadvantage; they are not liable to become brittle and snap as fine threads do.

In Scotland **Spinning** is carried on in the west at **Glasgow** and **Paisley,** on the Clyde coalfield.

The **different kinds** of cotton are many and various. Some of them are as follows: calico, muslin, dimity, corduroy, gauze, nainsook, ticking, madapolam, flanelette, fustian, chintz, cretonne, sateen, grenadine, zephyr, silesia, tape, lamp-wicks, piqué, jean, mull, lace, lace curtains, and many others.

Cottons have many valuable qualities. In the first place they are cheap, and are therefore procurable by the poorest classes of the populations of all the world. Besides this they lend themselves to various methods of treatment, so that they can be manufactured into cloth of an almost infinite variety of texture and colour, and, in consequence, are increasingly popular among the more well-to-do classes in our own and other countries.

As a result of this **the demand for raw cotton continually increases.**

Our average **annual import** of **raw cotton** is **two thousand two hundred and ninety million pounds,**[1] and 'there is no industry in Great Britain, except agriculture, which affords so much employment, directly or indirectly, for the masses of the people, as the manipulation of cotton, or which is of more importance to the whole mercantile and industrial system of England'.[2]

Sources of Supply. The modern system of cotton manufactures dates from the middle of the eighteenth century, and was largely the result of the series of wonderful inventions which took place at that time.[3]

In early days Lancashire manufacturers bought their raw cotton from the **West Indies** (as late as 1790 only 300 bales were bought from the United States), but conditions rapidly changed, and later on the **States** became the chief source of our supplies.

[1] Calculated on the five years, 1909 to 1913.

[2] R. J. Peake, *Common Commodities of Commerce.*

[3] For instance: 1769, Arkwright's machine for spinning by rollers; 1770, Hargreave's spinning jenny; 1779, Crompton's Mule; 1785, Watt's steam engine applied to cotton manufacture.

Since 1901, however, owing mainly to the energy and enterprise of the *British Cotton Growing Association* and similar organizations, efforts have been made to increase the production of cotton within the **empire.**

The chief empire producing countries are :-

India. From prehistoric times the cotton plant has been grown in India, and the fibre woven, and dyed, and worn by the people of India. After the Crusades had opened up trade between Europe and the East, **calico** (from **Calicut**) was one of the materials brought to Europe from India. Later on, other cotton materials were exported, and this trade grew and flourished down to modern times, so that hand-made Indian cottons formed a very important source of wealth to the various East Indian Companies.

When we began to manufacture cotton by machinery this export declined, and it became the custom for us to buy our raw cotton from America, and sell it manufactured to India and other countries, and to such an extent has this plan been pursued, that we have come to regard it as an unalterable, almost a divine, law, that we should buy our raw cotton from America, and sell it manufactured to India and the East.

Now, however, this condition of things is changing, and we are beginning to look to India as one of our most hopeful sources of supply of raw cotton. The land available is almost limitless,[1] her climate in many places is suitable, and in many others, where it is too dry, the defect could be remedied by irrigation.

The chief cotton districts at present are **Gujerat,** in the Bombay Presidency, the **North-West Provinces,** and the **Central Provinces,** also, to a smaller extent, the **Punjab,** and **Madras.**

In addition to these districts, there are thousands of acres in **Sind** and **Hyderabad** under cotton on **irrigated** lands, and millions more will be available as soon as the irrigation works are extended.

[1] In 1914 over 13 million acres were under cotton.

The chief cotton centres are **Cawnpore, Nagpur,** and **Mirzapur,** and the chief ports for export **Bombay** and **Surat.**

One great advantage which India possesses in connexion with cotton growing is her abundant supply of **cheap labour.** The long hours of work in the fields and the tediousness of picking cotton under a hot sun are not to an Indian the intolerable burden which they are to men bred in cooler climates and accustomed to a more complicated mode of existence.

The **length of staple** of the native **Indian** cotton is **shorter** than American or West Indian cotton, and in the past the bulk of the Indian export has gone to the Continent of Europe, chiefly to France and Germany, Austria, and Italy, there to be used in the manufacture of the coarser kinds of material, which these countries produce in great abundance for their own populations.

One result of this has been that more long-stapled cotton from America has been available for the mills of Lancashire, which, in addition to vast quantities of coarse cottons, produce an even greater abundance of materials remarkable for the extraordinary fineness of their texture. So skilful are the workpeople in the factories, and so perfect the complicated machinery which they use, that, aided by the dampness of the atmosphere, they are able to spin cotton threads as fine and supple as the most delicate silk.

Conditions in India, however, are changing; **long stapled cottons** are now grown, and the methods of cultivation are being improved, so that in the future there will in all probability be a great increase in the export of Indian cotton to Liverpool.

In connexion with this question of Indian produce, it must be remembered that in **Bombay,** and to a certain extent in other places, there are now a great many **factories,** which manufacture quantities of the coarser kinds of machine-made materials, which in former days were imported from England.

Egypt. In Egypt the soil of the Delta is very suitable for

cotton-growing, but the rainfall, which varies from fourteen inches at Alexandria to one and a half inches at Cairo, is insufficient. This disadvantage, however, is removed by irrigation, which in Egypt is marvellously skilful and extensive, so that cotton has in recent years become one of the most important crops.[1]

There are several varieties of cotton grown in Egypt, some of which have been grown from time immemorial, but that known generally as Egyptian,[2] though not so long stapled as Sea Island, has qualities of its own which render it especially valuable ; it is very strong and can be spun as fine as silk.

We have been accustomed to buy cotton from Egypt since the time of the American Civil War, when Egyptian growers, realizing their opportunity, devoted their energies to increasing their supplies. As a rule we buy about half their crop.

The Anglo-Egyptian Sudan. To the south of Khartoum stretches the great **Gezira Plain,** 'where Providence has already done half of man's work for him, and cleared and levelled the millions of acres that some day should be white with cotton'.[3] **Kassala,** in the east, and **Tokar,** near the Red Sea, as well as the **Atbara Basin** are considered suitable.

But here, as in many other places, three things are necessary: improved cultivation, irrigation, and the building of railways.

The progress made, however, is satisfactory, and 'in its live-stock and cotton the Sudan has two assets on which it may rest secure for its economic future'.[3]

The West Indies. The best variety of cotton, Sea Island, is said to be a native of the West Indies, and to have been introduced from there to the southern states of America as late as 1775.

In the beginning of the eighteenth century and onwards we bought most of our raw cotton from the West Indies, but

[1] At present about 1,800,000 acres are under cotton.

[2] This was introduced from the Isle of Bourbon (now called Réunion) by the French. In 1821 M. Jumelle saw the plant growing in a garden in Cairo, and at his suggestion seed of this kind was sown in large quantities in Lower Egypt.

[3] *The Sudan of To-day.*

the planters found that they could obtain greater profits from the cultivation of sugar, and, in consequence, cotton-growing was abandoned. When sugar failed them they turned again to cotton, and now they are able to export considerable amounts. In **St. Vincent** the Sea Island cotton industry has become the principal industry of the colony, and in **Barbados, Grenada,** and several other islands, cotton is an important crop.

West Africa. Kano, in **Northern Nigeria,** has for centuries been renowned for the manufacture of blue cotton cloth, which has been exported from there to many other parts of Northern Africa.[1] Both the soil and climate of this central belt of the Sudan are suitable for the cultivation of cotton and indigo, and in recent years long-stapled cotton has been introduced with excellent results. Large quantities are also grown in **Southern Nigeria** in the **Lagos** district.

In the highlands of **Nyasaland** they grow a special kind of cotton, having a long silky staple, but down in the lowlands by the Shiré River Egyptian cotton is grown. Both here and in **Uganda** cotton is the most important of all the crops cultivated.

In **Kenya Colony** cotton is being grown in rapidly increasing quantities, especially in the basin of the **Tana** River, and in **Rhodesia** it is considered a promising crop.

The cotton grown in **Cyprus** at present is harsh and short-stapled and only suitable for **coarse yarns,** but, with improved varieties of seed and better methods of cultivation, it is considered probable that cotton may become the chief export of the island.

Two other possible sources of supply in the future are **South Africa** and **Queensland.**

In the Transvaal, near Rustenburg, and in Cape Colony, in the neighbourhood of East London, in favourable seasons

[1] 'They go in a long cotton garment close about them like a woman's smocke, full of blue stripes, like feather bed tikes.'—'A Description of Guinea, A.D. 1600.'

cotton-growing has proved a success, but in times of drought the crops are liable to be destroyed. Nevertheless, it is believed that in the future cotton may become an important export. The industry is at present in the experimental stage, but three advantages point to a successful future : the excellent quality of the cotton produced, the suitability of the climate, and the abundance of cheap labour obtainable.

In Queensland, labour is the difficulty. There are many districts where both soil and climate are all that could be desired, but, as before explained, cotton-picking is a slow and tedious operation, and Australians do not care to engage in it. And, even if they did, their wages are so high that the final cost of the cotton produced would be much greater than that grown in other lands, where labour is cheaper and more abundant.

On the other hand, it is contended that the quality of Australian cotton is so good that it can command a high price, and it is suggested that by co-operation among growers the cost of picking might be reduced, so that the final price of cotton might enable them to compete with those of other countries.

Another suggestion made is that immigrants from over-crowded Malta, accustomed to work in the cotton-fields of their own island, might be encouraged to settle in Queensland and engage in similar work there.

SUMMARY. The amount of raw cotton consumed in the United Kingdom is **2,008 million pounds** a year, which works out to about 44 pounds for each person in the nation.[1]

Of this enormous quantity more than **three-quarters** comes from the **United States.**

Of the remainder **Egypt** supplies us with a little over 14 per cent., **India** 2 per cent., and other countries the rest.

The amount of empire-grown cotton (neglecting the Indian crop), exported to foreign countries, is calculated to be sufficient

[1] This is the average of the five years 1909–13, and of course takes no account of the cotton goods exported.

to supply 16 per cent. of our present consumption, so that, even if we imported all the cotton that the empire grows, we should have certainly less than 39 per cent. of the amount we need.[1]

On the other hand, India produces enormous quantities of cotton, and, if the quality were improved, the imports from India alone might go a long way towards making us self-supporting.

In addition to this, the output of other empire countries is constantly increasing, and the possibilities for future production are almost unlimited; the fertile plains of the **Anglo-Egyptian Sudan,** if sown with cotton, would, it is said, be capable of providing enough raw material to supply all the mills of Lancashire, without taking into account such prosperous countries as the **West Indies, West Africa, Kenya Colony, Uganda,** and **Nyasaland,** where the output is already such as to give cause for satisfaction in the present and hope for the future.

CHAPTER XIV

FIBRES (*continued*)

WOOL. 'Who shore me like a tame wether all my precious fleece.'—MILTON.

The sides and shoulders of a sheep furnish the best wool; that from the head and throat is of inferior quality. The first thing, therefore, that has to be done after the fleece is shorn from the sheep, is to separate the different qualities of wool from one another, and to clip off tufts of fibres which have become matted together.

SCOURING. The fleece contains a large quantity of a greasy compound called yolk or suint, and the next operation is to remove this. The wool is put into a long tank containing

[1] The amounts produced are: Egypt, 750 million lb.; West Africa, 4 million; East Africa, Uganda, and Nyasaland, together, 11 million; West Indies, 2 million.

pure soft water and soap or ammonia. The water is kept at a uniform temperature, and the wool is gently moved along from one end of the tank to the other, and at last passed between rollers, which squeeze out the dirty water. It is then dried.

CARDING.[1] When the wool has been thoroughly cleansed, it is necessary to open it out, and separate the fibres from one another. With this object it is passed through several machines which tear the fibres apart. The mass of wool to be operated upon is spread out on the feed-sheet and sprinkled with oil. The feed-sheet moves forward and carries the wool on to two rollers. As it passes through these it is caught up by the teeth of a revolving cylinder called a 'swift'.[2] Three other rollers, also studded with teeth, are placed at the top of the swift; these revolve in the opposite direction. The first one tears the wool from between the teeth of the swift and gives it back again, the second and third do likewise, and finally it emerges a fine white down. But it is not yet ready for spinning.

It next passes through the Carding Machine. The action of this machine is similar to that of the one just described, but the process is more thorough, and in it the fibres are separated literally one from the other. It consists of numerous revolving cylinders each covered with card-clothing, i.e. of leather into which sharp wire teeth have been inserted. In each carding machine there are about fifty-six million of these teeth operating on the wools.

CONDENSING. The last action of the carding machine is to divide this fine downy wool into narrow strips. These strips or slivers then pass through the condenser, where they are pressed between rollers. These rollers not only revolve, but also sway sideways, so that the slivers are compressed into loose soft threads, which only require twisting to make them into good strong yarns.

[1] See p. 166.
[2] It makes from 400 to 500 revolutions a minute.

Spinning. The spinning machine consists of two parts, one movable and one immovable. The latter holds the bobbins containing the loose sliver from the condensing machine. The bobbins revolve, and from them the sliver passes between rollers.

The movable part of the machine contains revolving spindles. The sliver from the rollers is attached to the spindles and the

AN AUSTRALIAN MERINO SHEEP

carriage containing them recedes a certain distance, and then the bobbins containing the sliver cease to revolve and no more sliver is given out. But the carriage still recedes and so the sliver is extenuated. At last the carriage, too, stops, but the spindles continue to revolve, and their speed is increased. As long as the sliver is not wound upon the spindles, and no more is given out from the bobbins, its length remains unaltered, and the revolutions of the spindles merely **twist** the thread. When sufficient twist has been given the thread is

wound upon the spindles and the carriage moves forward again.

Weaving. This operation is similar to that described on page 166.

Fulling. A fibre of wool besides being curly has an uneven surface ; it is covered with innumerable tiny notches, and this characteristic makes possible the operation of fulling. The

SHEEP SHEARING, SOUTH AFRICA

cloth, after the grease has been removed, is saturated with soapy water and pounded. This was formerly done by placing it in a trough and thumping it with great hammers ; now more complicated machinery is employed, but the result is the same. The heated soapy fibres expand, and the little notches dovetail into one another so that a compact surface is formed, and all traces of the original weft and warp entirely disappear.

Raising. A huge cylinder covered with thousands of teasel heads set in rows revolves, and the tips of the teasels raise up the surface of the cloth and make it rough.

Cutting. All these little roughnesses are next shorn off by a machine which acts on the same principle as a lawn-mower. Finally the cloth is steamed, and pressed, and it is then ready for use.

Felt. The wool of which felt is made is not spun or woven, only pressed. After the wool leaves the carding machine the thin lap is spread out and other layers placed upon it. These are then subjected to great pressure under rollers some of which contain steam. The heat, and moisture, and pressure cause the fibres to expand and mat together, so that a close compact cloth is formed ; it is called **felt.**

Mohair is the cloth woven from the long silky hair of the Angora goat. **Angora** is a town in Asia Minor whence these goats originally came. The word *mohair* is of Eastern origin.

Cashmere. The soft woolly hair of the Thibetan goat was woven into the handsome shawls, called, from the place of manufacture, Cashmere shawls. Later on the word was used to designate any fine soft woolly material.

Alpaca is a mixture of silk, and the long, fine, woolly hairs of the alpaca, an animal which in some respects resembles the camel. It is a native of Peru, and the word *alpaca* is of Peruvian origin.

Worsted. The slivers of fine downy wool which leave the carding machine consist of every sort of fibre intermixed in the most thorough manner possible, but for worsted only wool with the longest fibres is used, and these are carded so as to lie, as far as possible, side by side, in parallel lines. *Worsted* is a town in Norfolk where this method of preparing yarn was first practised.

Merino. This is a material very like cashmere, originally made of the fine wool of merino sheep. The word *merino* comes from a Latin word meaning *Inspector of sheep walks.*

In the winter Spanish sheep, from time immemorial, have been driven down from the bare and bleak uplands to the sheltered lowlands for pasturage. The Romans appointed officials to look after these sheep walks, and the word, which originally meant 'inspector', came to mean the animals inspected.

In the Middle Ages England produced wool, and Flanders manufactured it. But in the reign of Edward III Flemish weavers began to settle in the east of England, and **Norwich** became the centre of the woollen manufacture. These Flemings taught us the arts of fulling, bleaching, and dyeing cloth, and from this time onwards we began gradually to export woollen cloth instead of raw wool. The **Eastern Counties** became famous for their **worsted,** and the **Western** for their **broadcloths.** Later on, **York,** and **Halifax,** and **Manchester** were added to the list of woollen towns.

After the Industrial Revolution, however, all this was changed. As soon as machinery, worked by steam, took the place of the ancient spinning-wheel and hand-loom, the coal-fields determined the position of manufacturing districts, and the towns of Yorkshire outstripped in importance the older manufacturing towns of the south and west.

Sources of Supply. The chalk and limestone hills of England provide excellent pasturage, as do also the uplands and mountains of Scotland and Wales. On June 5, 1916, there were in the **United Kingdom** nearly 29 million sheep ![1] For our own use here at home we need 566 million pounds of wool a year, without reckoning the amount we use for our exports.[2] Our own sheep supply us with 136 million pounds a year, the rest we import.

We buy wool from various countries, but within our own empire we have an almost unlimited supply.

[1] In England 14 +, Scotland 7 +, Wales 3¾, Ireland 3¾ millions.

[2] In 1913 we exported 80 million pounds of yarn, and 105 million yards of woollen and worsted cloth, to say nothing of carpets, and flannels, and hosiery (over 2 million dozen pairs of stockings and socks), travelling rugs, &c.

Australia. In 1788 Captain Phillips, the first governor, brought with him from England 7 horses, 7 cattle, and **29 sheep,**[1] besides pigs and poultry. These were the first sheep in Australia. Later on, in 1797, some merinos were introduced into New South Wales, and from that year onwards **wool** began to be an important product.

New South Wales is the principal wool-producing state in Australia. From the base of the tableland westwards for over 600 miles stretch the **Great Plains.** In the eastern part of these plains, on the slopes of the tableland, the rainfall varies from 20 to 30 inches, and the temperature from 60° to 69° F.; but farther west the rainfall decreases, and over a great part is not more than 10 inches annually.

Except in the valleys of the rivers, these great plains are **treeless**, but over all this vast expanse there grow in abundance many kinds of **succulent grasses,** which nourish millions and millions of merino sheep. In dry seasons, when all these grasses are burnt up and the land looks a parched and barren wilderness, the **salt-bush** still survives, and affords sustenance to the animals.

In times of drought the difficulty is not so much to obtain food as to find **water** for the flocks. Across the plains the Murray-Darling and its many tributaries flow, and in wet seasons these overflow their banks and flood the country for miles around, so that the lakes within their basins become vast inland seas. But in dry seasons the rivers and lakes dwindle, and become merely a series of long-distance ponds, while mud, baked hard by a burning sun, occupies the space of what, in more favourable times, was a sheet of life-giving water.

Then the sufferings of the poor animals are terrible. In 1884 ten million sheep died of thirst, and this is no isolated instance; always in the past in dry seasons millions of animals have perished. The following poem vividly describes these conditions:

[1] In 1914 there were in Australia 82,014,296 sheep.

Drought[1]

My road is fenced with the bleached, white bones,
  And strewn with the blind, white sand,
Beside me a suffering, dumb world moans
  On the breast of a lonely land.

On the rim of the world the lightnings play,
  The heat-waves quiver and dance,
And the breath of the wind is a sword to slay,
  And the sunbeams each a lance.

I have withered the grass where my hot hoofs tread,
  I have withered the sapless trees,
I have driven the faint-heart rains ahead
  To hide in their soft green seas.

I have bound the plains with an iron band,
  I have stricken the slow streams dumb !
To the charge of my vanguards who shall stand ?
  Who stay when my cohorts come ?

The dust-storms follow and wrap me round ;
  The hot winds ride as a guard ;
Before me the fret of the swamps is bound,
  And the way of the wild-fowl barred.

I drop the whips on the loose-flanked steers ;
  I burn their necks with the bow ;
And the green-hide rips, and the iron sears
  Where the staggering, lean beasts go.

I lure the swagman out of the road
  To the gleam of a phantom lake ;
I have laid him down, I have taken his load,
  And he sleeps till the dead men wake.

My hurrying hoofs in the night go by,
  And the great flocks bleat their fear,
And follow the curve of the creeks burnt dry,
  And the plains scorched brown and sere.

The worn men start from their sleepless rest
  With faces haggard and drawn ;
They cursed the red Sun into the west,
  And they curse him out of the dawn.

[1] From *Hearts of Gold*, by Will. H. Ogilvie, quoted by special permission of Messrs. Angus and Robertson, Sydney, owners of the copyright.

They have carried their outposts far, far out,
But—blade of my sword for a sign !—
I am the Master, the dread King Drought,
And the great West Land is mine !

To remedy this state of things and provide water for the flocks is the crying need of the country, and in **irrigation** lies the hope of the future. At present not only is water being obtained from underground by means of **artesian** wells, but vast schemes also are in operation for **storing the surface water.**

One district which is well supplied with water from artesian wells is the lower basin of the **Gwydir**, a stream which rises in the New England Range. Many of these wells yield a million gallons a day, and convert what would otherwise be a series of ponds into rivers brimful of running water.

Of surface irrigation works, the most important is at **Burrinjuck**, three miles below the junction of the Murrumbidgee and Goodradijbee. Here an enormous dam has been constructed of solid masonry, capable of holding back water to a depth of 200 feet. Thirty-three million three hundred and eighty-one cubic feet of water will be contained in the reservoir, which, in addition to fertilizing large areas of arable land, will supply water to the thirsty flocks of one million acres of pastoral land.

Queensland. The area of Queensland is 688,000 square miles, and the treeless plains of the western interior, the sheep country, occupy about half this area. The conditions are similar to those of New South Wales, except that of course the temperature is higher. Here, too, are nutritive grasses, and the drought-resisting salt-bush, with its pale green leaves and its curious salty taste. Of the 360 different kinds of grasses, which grow in Australia, 270 are said to be natives of Queensland. And here, too, in these Queensland plains is the same lack of water and the same problems with regard to irrigation awaiting solution.

Artesian wells can be sunk over three-fifths of Queensland,

and many of these supply three million gallons of water a day. With regard to the utilization of the surface water, to take one instance, it is computed that the waters of the Diamantina, if arrested in time of flood, would, as in the case of the Murrumbidgee, form a large inland sea capable of watering many square miles of country; and there are many other rivers which could be utilized in a similar manner.

Victoria. In the western district to the south of **Wimmera** are miles and miles of rich undulating grassy plains which feed millions of sheep. This is the chief sheep-grazing district of Victoria, though in Wimmera itself and Mallee, and also in the mountains of the north-east, there are grazing lands.

The people of Victoria are beginning to manufacture their wool for themselves. At **Geelong,** on the western shore of Port Phillip, are nine **factories** which manufacture blankets, and tweeds, and many other materials.

The other states of Australia also graze sheep, and of these Western Australia and South Australia have the largest number. Tasmania, too, has over a million.

New Zealand. All the islands of New Zealand are mountainous, but nearly all the land is suitable for sheep, and they seem to thrive equally well on the cold hill slopes and on the warmer moister plains. New Zealand has no difficulties with regard to climate; it does not suffer from lack of rain, and, in consequence, there are no breaks or unevennesses in the fibres of wool, such as those which occur in the wool of sheep bred in dry countries; for when the unfortunate animals are suffering from thirst or hunger they are in poor condition, and their wool at that time is of poor quality too.

In the South Island on the east of the mountains are the famous **Canterbury Plains.** These are 130 miles long, and in their broadest part 30 miles wide, and all these 2,000 square miles or so of land are for the most part of a dead level, and of great fertility. At one time they were covered with rich grass and on them grazed millions of sheep. From here came our 'Canterbury mutton', but nowadays much of this land

is ploughed up and sown with wheat, and the sheep have to live on less valuable soils.

There are many different breeds: on the high mountain pastures and in the drier lands are merinos, while in the moister plains, Lincolns and Romney Marsh thrive best.

Much land that was at one time covered with forests is being cleared, and sown with grasses for sheep. When this has been done, it is estimated that there will be fourteen million acres in the North Island and thirteen millions acres in the South Island fit for sheep grazing.

The Union of South Africa. The Cape of Good Hope is more than twice the British Isles in area, the Karroo Plateaux having between them an area of 100,000 square miles. Of these plateaux the largest and most important is the Great Karroo lying between the Nieuwveld Mountains in the north and the Zwarte Bergen in the south. The Great Karroo alone is about half the size of England, and most of it is 3,000 feet above the level of the sea.

In the hot dry season nothing could be more desolate than these sun-baked plains; all vegetation is apparently burnt up, and the watercourses are dry. Dotted all over the land is a little insignificant bush, which never grows more than ten inches high, and which in summer looks like a miserable little bunch of dried-up twigs. Yet, like the salt-bush in the Australian plains, this Karroo bush affords sustenance for millions of sheep. Down by the watercourses the mimosas grow, and these are the favourite food of the Angora goats.

When the rains come, all these brown, dusty plains suddenly burst into life; the little Karroo bush becomes a pleasant shrub with pale green aromatic leaves, the heaths and mimosas blossom, and all the land is a glorious blaze of colour.

To the north of the Orange River is British Bechuanaland, the eastern half of which is a high, dry, grassy plateau supporting large numbers of sheep.

The Transvaal and Orange Free State. Of these the

Transvaal is about the size of the United Kingdom, and the Orange Free State the size of England.

In the Transvaal the lower parts of the Bush Veld are infested with the tsetse fly, and neither sheep nor cattle can live there, while on the higher parts of the High Veld the soil is too poor and stony for grass to grow, but with these exceptions the whole country is grazing land, and very large sheep and cattle farms are characteristic of it.

The Orange Free State is one large grassy plateau affording ample pasture for sheep and cattle.

Natal is about two-thirds the size of Scotland, and the inner terrace, the uplands, has excellent grass on which sheep and goats live.

With regard to the rest of British Africa, the high dry plateaux all afford excellent pasture; especially is this the case in the eastern part of the Protectorate of Bechuanaland, in Basutoland, in Swaziland, in Matabeleland (i. e. the southern part of Southern Rhodesia), and in the western part of British East Africa.

In **India** the sheep pastures are chiefly on the hills in the north-west.

Sheep are long-suffering, hardy animals. Not only do they thrive on the dry, hot plateaux of Australia and Africa, but they seem equally at home in the cool, moist, ungenial climate of the Falkland Isles. Indeed, here grass and sheep are the only features of the landscape, and wool is the only product.

In the Dominion of **Canada** the principal sheep pastures are situated on the eastern slopes of the Rockies and in Ontario.

SUMMARY.[1] The amount of wool consumed in the United Kingdom shows a steady increase. The average yearly consumption amounts to 566 million pounds, which works out to between 12 and 13 pounds per head of the population.

Our own sheep in the **British Isles** produce enough to supply us with about 24 per cent. of our requirements, but

[1] Taking the average of the years 1909–1913.

empire countries (**Australia, New Zealand, South Africa, British India,**[1] **Egypt,**[2] and the **Falkland Islands**) produce not only sufficient for all our needs at home, but almost **twice the amount** necessary for the needs of the whole **empire.**

Not only so, but of all the wool produced in the **world,** over **40 per cent.** is from empire sources.[3]

Nevertheless we import from many foreign countries, the largest amounts coming from South America (the Argentine, Chili, Uruguay, Peru) and France.

CHAPTER XV

FIBRES (*continued*)

FLAX (A.S. *flax*, Latin *linum*). 'And the flax and the barley was smitten: for the barley was in the ear and the flax was bolled.'—Exodus ix. 31.

In England we call the **plant** by its Saxon name **flax**, but the **material,** which is woven from its fibres, we call **linen,** from *linum*, the Latin name for flax.

There are many plants belonging to the flax tribe, but the one from which linen is made is *linum usitatissimum.* It is not the one which we find growing wild on chalky and sandy land, though the two plants are very similar. *Linum usitatissimum* grows about two feet high. It generally has one stalk with little slender leaves on alternate sides of it, while towards the end smaller stems branch out, each bearing one pale blue flower with five petals.

When the petals fall, and the fruit is formed, in the place of the pretty blue flowers are little round brown balls, each containing ten small seed about a quarter of an inch long.

[1] Australia, 702 million pounds; New Zealand, 197; South Africa, 145; British India, 60; other places (chiefly Egypt and the Falkland Isles), 6. But though Australia produced this enormous quantity, of the wool actually consumed in the United Kingdom only 25 per cent. came from Australia.

[2] All the Egyptian wool, and a good deal of the Indian, is coarse carpet wool.

[3] Of the merino wool imported into Germany 80 per cent. was from the British Empire.

They, too, are brown in colour, and smooth, and flat. Inside they are almost white. These seed-vessels are sometimes called *bolls*, and when the flax is in seed it is said to be **bolled.**

Harvesting. Flax has to be pulled up by the roots, and the best time for doing this, if a fine solid fibre is required, is just before the seeds begin to ripen.

Rippling. 'To rip' is to tear something away from something else, and a ripple is an instrument for separating the seeds from the stalks of flax. It consists of a comb having pointed iron teeth about eighteen inches long. This comb is fixed in a wooden frame and the flax is pulled through it; the space between the teeth is too small for the seeds to pass, and they fall on to the ground below.

FLAX

Retting. When the seeds have been removed, the stalks have to be steeped in water until they begin to *ret* or *rot*. Besides the fibres from which linen is woven, the stalks contain a woody core, and the object of retting is to remove the gummy matter which binds the fibres to this core.

Bundles of flax are placed upright in a shallow pond, with their roots downwards, and kept immersed for about a fortnight. At the end of that time it is found that the woody part can be separated from the fibre, and the bundles are then taken out from the water and spread upon grass for a few days to dry.

The water in which flax is retted must be soft water; in some countries the flax is simply retted by exposure to moist

air and dew. It is then said to be *dew-retted.* This takes longer but produces good results.

Breaking. After the flax has been dried it is passed between rollers so that the woody part may be thoroughly broken.

Scutching. It is next beaten or scutched. This is either done by hand or machinery. In both cases the method is the same. The flax is hung up and beaten from top to bottom by the blade of a knife, so as to beat out the woody core.

Heckling. Finally the fibres have to be combed out and the long perfect ones separated from the short broken ones. This is done either by hand or machinery. A hand-heckle is simply a piece of wood covered with steel teeth. The small broken pieces of flax which are combed out are called **tow.**

At last, after all these processes, the flax is ready to be spun and woven into linen.

One of the advantages which flax possesses over other plants is that its fibres are very long, and fine, and supple, so that linen, besides being one of our most beautiful fabrics, is also exceedingly durable.

There are many different kinds of linen. For instance, there are the coarse heavy materials, such as ticks, and huckabacks, and crash, and fine ones such as cambric and damask. Beautiful lace, too, such as Valenciennes lace, is made from fine linen yarn.

Linseed. Not only the fibre but also the seeds of the flax plant are very valuable. These seeds when crushed yield **linseed oil,** which is used chiefly in paints and varnishes. After the oil has been extracted, there remains a crushed mass of seed which is called **oil-cake** ; it is used for feeding cattle. Ground up, this oil-cake is called **linseed meal ;** we use it for making poultices, &c. **Carron oil** is a mixture of equal parts of linseed oil and lime water ; it is used for burns.

LINOLEUM (from *linum,* flax ; and *oleum,* oil) is made in the following way : boiled linseed oil is poured on to a layer of cotton material and allowed to dry. This operation is repeated, until the mass of dried oil is about half an inch thick ; it is

then cut up and ground to powder, and mixed with resin and kauri gum. Powdered cork is added, and colouring matter, and the whole mixture spread on to a sheet of jute, and rolled to the required thickness. **Kirkcaldy** manufactures linoleum.

History. Linen is one of the oldest materials known to us. The quotation from the Book of Exodus refers to the plague of hail, which 'smote every herb of the field' in Egypt, when Pharaoh refused to let the Israelites depart from his land. This happened about 1491 B.C. There are many other references to flax in the Old Testament; the Egyptians were very skilful in weaving it, and we are told that their mummy-cloths are made of linen as fine as any that is woven nowadays.

As time went on, the cultivation of flax spread to the north of Europe, to France, Flanders, Britain, and other countries. The famous Bayeux Tapestry was worked on linen. In Henry III's reign many Flemish weavers settled in England and improved our methods of spinning and weaving. Later on, in Edward III's reign, some Scots settled in the north-east of Ireland and grew flax and manufactured linen. The province of **Ulster** is now the principal seat of the linen industry in the British Isles. **Belfast** is the chief manufacturing town.

In **Scotland** the eastern counties have long been famous for their linen; **Dundee, Dunfermline, Kirkcaldy** are the chief towns.

Our home-grown supplies, however, long ago ceased to be sufficient for our needs, and we imported most of our flax from **Russia**, and also a considerable amount from **Belgium** and **Holland**. Since the war, we are growing more flax in our own country, and at present Essex, Somerset, and Yorkshire have considerable areas under this crop.

Flax grows equally well in temperate and in hot climates, and though hitherto the amount of fibre grown within the empire has not been great, there is no reason why this should continue to be the case.

Canada. Flax for seed has long been grown in Canada, but

now increasing attention is being devoted to its cultivation for fibre. In the south of **Ontario** hundreds of tons have already been produced, and **Quebec** and **British Columbia** have shown that they can grow it successfully.

Egypt for many years has devoted her chief attention to cotton, but since the war she has begun to grow more flax, and now has many acres under this crop.

Kenya Colony produces good fibre, especially in the highlands, at **Lumbwa.**

In the Commonwealth of **Australia, Victoria** is the chief flax-growing state at present.

Linseed or Flaxseed. Canada and **India** supply us with most of our linseed, though we also buy large quantities from the **Argentine** and from **Russia.**

Silk. More than 2,000 years before the birth of Christ, silkworms, we are told, were reared for their silk in **China,** but it was not until the sixth century A.D. that silkworms were brought to Europe. In the beginning of that century two Persian monks, travelling westwards, concealed some eggs in the hollow of a cane, and brought them to Constantinople. From this small beginning the wonderful modern silk industry of **Southern Europe** has come into existence.

Within the empire our interest centres at present in **India.** At **Changa Manga**, in the Punjab, stands a great mulberry forest, and in the heart of this forest is a silk camp at which many workers and students are engaged in rearing silkworms. The forest, we are told, was planted by accident. A plantation of Shisham trees was being made, but the canal waters brought down from the Himalayas great quantities of mulberry seeds, which sprouted and grew, and, eventually, ousted the original plants, so that in course of time there stood a glorious mulberry forest.

At first, it was only valued because its wood made good fuel, but this fuel was found to be so valuable that other forests were planted, so that to-day in the **Punjab** there are quantities of mulberry trees the leaves of which are now being

used to feed silkworms, and as a result of this before long there will in all probability be a flourishing silk industry in the Punjab, as there is already in the neighbouring state of **Kashmir**. What is possible in the Punjab and Kashmir is possible in other parts of India and Ceylon, and the Government are now taking energetic measures to revive the ancient silk industry of these countries. Working in conjunction with the Government is the Salvation Army, from whose admirable report this account is mainly derived.

'"Grow Mulberry" is an order which should be issued in capital letters which "he who runs may read" to all Government Departments having anything to do with the planting of trees. *Morus Indica* is a native of India, as its name implies. It is one of the richest and most neglected gifts of God to India. . . . You can cut the tree to its root every fifteen years and sell its timber, and it will spring up again luxuriantly without the trouble of replanting, and present its owner with a second forest in another fifteen years. Scatter its seed along water-courses and in forests and it will take care of itself.'[1]

One ounce of eggs produces 30,000 silkworms,[2] which consume about half a ton of mulberry leaves, so that for every ounce of eggs fifteen to twenty trees are required. Kashmir, with an annual output of 40,000 ounces, requires nearly one million trees.

Besides the silkworm which feeds on mulberry leaves (i.e. the *Bombyx mori*) there are in India many kinds of so-called 'wild' silkworms which live on many other kinds of trees. The two most important of these 'wild' varieties are the **Tasar** and **Eri.**

Tasar is a Hindoo word, which the French first corrupted to **tussore**, and since its introduction into England various other incorrect spellings have from time to time been adopted. The Tasar is a native of Central and South India, and is found living on about twenty-five different kinds of trees.

[1] *The Annual Report on the Silk Centres of the Salvation Army in India and Ceylon, 1915–16*, by F. Le L. Booth-Tucker.

[2] The Salvation Army imported 350 ounces of seed in 1915, and distributed it to various centres throughout India.

The name 'Tussore' is, however, applied to almost any kind of native Indian fawn-coloured silk, whether it comes from the Tasar moth or not.

In Assam there is a silkworm which lives on the **Castor-oil Plant**, which is there known by the name of **Eri,** and hence this name is given to the silkworm. The silk from the Eri cocoons cannot be reeled off in the same way as that from ordinary cocoons; it has to be spun for weaving (just as cotton is), hence the silk is called **spun silk.** Large quantities of it are manufactured in Yorkshire, Lancashire, Cheshire, and Staffordshire. As the castor-oil plant grows wild in many parts of the empire (e.g. in the West Indies and Kenya Colony) there seems no reason why we should not be able to produce large quantities of beautiful spun silk in the future.

It must be remembered, however, that, with silk as with cotton, a large amount of cheap labour is required, and it appears to be hopeless to try to produce silk in countries where this labour is unobtainable.

We import silk from **China, France, Japan, Italy,** and **British India.** This was the order of importance in 1913, but during the war the imports from France have very seriously declined and those from **Japan** greatly increased.

JUTE (*Corchorus capsularis*). As you walk along the quays of Dundee you see the great ships unloading their merchandise. Many of these ships have come from **Calcutta,** and from their holds the cranes haul up great bales of drab-coloured *jute*, and deposit them upon the pavement.

In its native soil in **Bengal** the jute plant grows to about ten feet high; sometimes it even reaches fourteen feet. It requires great heat and plenty of moisture, though the best kind of fibre is obtained from plants raised in well-drained land. When grown on muddy swamps they are taller, but their fibre is coarser. Jute is raised from seed, and the sowing usually takes place in March or April; it bears yellow flowers, and when these appear it is time to cut the plants down. This usually happens in August or September.

Like flax, jute must be retted in order to separate the fibre from the other parts of the stem. It is also passed between rollers, so that the hard parts may be thoroughly broken. In order to soften the whole mass, oil and water are sprinkled upon it before the rolling takes place.

'Every homestead in Bengal has suspended from a beam in the roof of the verandah a few bundles of jute fibre, which while talking pleasantly with a neighbour the peasant twists into twine of varying thickness intended for domestic purposes or for the yarn from which the women prepare the homespun cloth or *gunny-bags*.'[1]

At one time all the poorer people of India were clothed in material woven by their own hands from jute, but nowadays all this is changed, and cheap, brightly-coloured, machine-made cotton goods have largely taken the place of their own jute fabrics. Besides clothes, they made coarse **sacks** to put their grain into; these are called *gon*, or *guni*, hence our word *gunny*.

When our ships began to bring some of this grain to England, we needed sacks to bring it in, and we bought these jute gunny-bags from the peasants of India. Later on, when grain from America, and Australia, and Africa was added to the world's supply of food, more and more bags were needed by us and by other countries, and the making of jute gunny-bags became an industry by itself.

It was in 1832 that a Dundee manufacturer found that jute could in many cases be used as a substitute for hemp, and from that time onward it began to be imported in increasing quantities. Gunny-bags were made by machinery in Dundee and exported all over the world. During the Crimean War, when supplies of flax from Russia were cut off, Dundee concentrated her attention more and more closely upon jute, so that now its manufacture is carried on on a gigantic scale.

There are very many different qualities of jute fibre, but they all have certain drawbacks; they cannot be bleached

[1] Dr. Watt, *Dictionary of Economic Products*.

a pure white, and when dyed they do not keep their colour; they are also easily rotted by moisture, so that fabrics wholly or even partly made of jute cannot be constantly washed as cotton and linen can; it is not durable. But it can be grown and manufactured at a small cost, and therefore things made of it are cheap, and for that reason enormous quantities are used.

Besides coarse materials such as Hessians, and tarpaulins, and foundations for linoleum, and sail-cloth, various finer fabrics are made of it. Every devout Mohammedan, no matter where he may be, at certain hours of the day turns his face towards Mecca, and kneels down to say his prayers. He carries with him for this purpose a small prayer-mat, and thousands and thousands of these small brightly-coloured prayer-mats, made of jute, are sent out year by year from the mills of Dundee. Besides these **prayer-mats** many ordinary cheap **carpets** are nowadays made of jute. It is also often made to look like silk, and either used alone or with real silk to adulterate it. Towels and sheeting, too, are often made partly of jute, and partly of linen or cotton. On account of its cheapness it is an invaluable substance for all materials where strength and durability are not essential.

In Bengal over three million acres are under jute, and, though now the mills of Calcutta manufacture all the sacks that are required for Indian produce, the amount of raw jute exported shows no signs of decreasing, and this is hardly surprising when we remember that nearly all the sacks in the world are made of it, in addition to the various other uses to which it is put.

In **1828,** 364 cwt. were sent to Europe; in **1913** we imported from India 347,548 tons, and we exported more than 313 million yards of jute material, besides over 41 million pounds weight of yarn.

HEMP (*Cannabis sativa*). The hemp plant is an annual, which grows to a height of from three to ten feet. It has a slender rough stalk, with numerous patinate-shaped leaves growing out from it. Each leaf consists generally of five

leaflets, the edges of which are indented like the edges of a saw. The flowers are pale yellow.

The **fibre** obtained from the stalks is exceedingly **strong,** and is used for making **ropes,** and **twine,** and **sailcloth,** and other materials of great strength and durability. Old hempen ropes pulled to pieces are called **oakum ;** this is used for caulking ships, that is, stuffing up the crevices between the boards.

Hemp, like flax, grows in temperate as well as in warm climates, and, though frost kills it, it can be cultivated in places where the winter is very severe, because it grows quickly, and forms its seeds before the frost comes.

SOURCES OF SUPPLY. **Russia,** at present, is the great hemp-producing country of the world, and we buy large quantities from her, especially for use in the navy. **Italy,** however, produces the *best* hemp, and during the war our imports from her have increased.

The **seeds** of hemp, which are about one-twelfth of an inch long, are of a pale brownish-grey colour, and are used for feeding birds. When pressed they yield an **oil,** which is used in making varnish.

We also buy large quantities of hemp from **India,** but it is another kind, known as **Bengal hemp ;** its fibre is not so strong as that of *Cannabis sativa.* Still another kind is that obtained from the *Musa textilis,* a plant allied to the banana, growing in the Philippines ; it is called **Manila hemp,** and our imports of it are even greater than those of Russian hemp.

SISAL HEMP, or SISAL (*Agave sisalana*) is often called the American aloe, though it is not really an aloe at all. Its original home is **Yucatan,** where it grows in great profusion ; indeed its name *sisalana* was given to it because it was first exported from Sisal, a town on the coast of Yucatan.

The plant has a short trunk, and all round this great leaves grow out, like iris leaves in shape ; they vary in length from three to six feet. Sometimes it continues to grow for seventy years without blooming, and then, at last, from the middle

of the plant a gigantic stalk shoots forth, twenty, thirty, or even forty feet high. From each side of this stalk or 'pole' smaller stems branch out, and at the end of each are clusters of flowers. After a time the flowers wither, and then at the

HEMP

base of the flower-stalks little buds occur, which after growing about two inches long fall to the ground; it is from these buds that the new plants are generally produced.

The original plant having flowered withers and dies. Its length of life varies considerably; seventy years is an extreme age. In Mexico it generally lives for about twenty years, and in hotter countries its life is shorter still.

The **fibre** is obtained from its great sword-like leaves, and is very strong; it can be used instead of ordinary hemp fibre (*Cannabis sativa*). When the plant is four years old some of its leaves are ready for cutting, and the cutting is continued until the plant flowers. The fibre is now generally extracted by machinery, and after being washed is hung out in the air to dry; it is of a pale straw-colour.

Sisal hemp requires heat and a moist atmosphere, but not

FIELD OF SISAL HEMP

too much actual rain. The soil in which it grows must be well drained.

Sources of Supply. The **Bahamas** are famous for their sisal production, but nearly all their crop goes to the United States, where the fibre is used to make binder twine to tie up the great bundles of cereals in the harvest-time. It is now, however, cultivated successfully in **Kenya Colony.** 'Experiments in the cultivation of sisal were begun by the Department of Agriculture in the Nairobi district seven years ago, and more recently in the Coast-belt and other districts. During the past few years extensive sisal plantations have

been established along the coast, with factories for treating the fibre. The soil, temperature, and rainfall are admirably adapted to the growth of the plant. The leaves attain a length of five to six feet; the yield and quality of the fibre are both considered excellent.' **Nyasaland,** too, has sisal plantations in the neighbourhood of **Blantyre,** and now that the railway to Blantyre from Port Herald is completed, most probably more plantations will be made. It is also grown in Papua; and many other places, such as Fiji, Mauritius, Queensland, and Jamaica are considered promising for its cultivation in the future.

RAMIE

RAMIE (Malay *zami*) is a plant in many respects like the stinging nettle, though it does not sting. It grows from three to eight feet in height, and has large leaves (almost white on the underside), and little insignificant, pale-green flowers arranged along a slender stalk.

It is valuable for its fibre, which occurs under the outer covering of its stems, but it is difficult to obtain, as it is united to the bark by a very sticky gum, which has to be removed. This fibre, however, is one of the strongest known fibres in existence, and, when satisfactory machinery has been invented for decorticating the stems, the plant will be even more widely cultivated than it is at present; for, given a fairly equable rainfall, it is easy to grow, and its strong fibre is useful for a variety of purposes, besides the manufacture of

incandescent gas mantles. **Paper,** for instance, can be made of it, and **ropes** and **canvas.**

SOURCES OF SUPPLY. **Malaya** and **Further India** are considered to be the original home of the ramie plant, but it is now extensively cultivated in many other places. Within the

PHORMIUM TENAX

empire **India,** the **West Indies** (especially **Jamaica**), **Queensland,** and **Kenya Colony** are the chief sources of supply.

Phormium tenax. This plant is a native of New Zealand, where on swampy lands it grows wild in great abundance.

It is sometimes called the **New Zealand Flax,** but it bears no resemblance to the flax plant. It belongs to the natural order *Liliaceae*, and grows in great tufts, from the centre of which it sends up a long spike of yellowish-brown flowers. The leaves are often six feet in length, and it is from these that the fibre is obtained. They are softened by being laid

in water for a few days, and then the fibre is separated from the gummy matter which is mixed with it.

Just as the peasants of India used to clothe themselves in material woven from their native jute, so the Maoris of New Zealand used to make their garments from this native flax. The fibre is very strong. Besides clothing, they made ropes, twine, and baskets, and many other things from it. The fact that they used it for making baskets has given it its name *Phormium*, which is taken from a Greek word meaning *Basket.*

The Maoris extracted the fibre by hand, but this is now done by machinery. It is a difficult operation, and efforts are constantly being made to improve the machinery. The chief mills are at **Wellington,** though there are others at **Otago** and **Auckland.**

The cultivation of *Phormium tenax* has been introduced into **St. Helena,** where it is hoped that it will flourish and help to bring prosperity to the island.

KAPOK is a fibre obtained from the *Eriodendron anfractuosum* or **white cotton tree.**

It is a tall tree, rather like our elm in shape, but with a straight smooth trunk. It bears white flowers, and its seeds are covered with a fine floss and are contained in a pod, which when ripe bursts open in the same way as cotton bolls do. The floss is blown to the ground, and has to be separated from its seeds, and from the leaves, and twigs, and dirt, with which it gets mixed up.

Its **fibres** are too short and brittle for weaving; but for **upholstery** work of all kinds they are invaluable, for not only are they elastic and waterproof, but they are also bad conductors of heat, and exceedingly light, so that bedding made of Kapok is very comfortable and hygienic.

In consequence of its extreme lightness (it is six times lighter than cotton), and its impermeability, it does not sink in water, and for this reason increasing quantities are being imported for making **life-jackets** and similar garments.

The tree grows in the hot forests of India and Ceylon, and also in the East Indies and West Indies and in tropical Africa and America.

SOURCES OF SUPPLY. At present we import Kapok chiefly from **Java ;** but India, and Ceylon, and the Sudan, and New Zealand will probably be sources of supply in the future.

SUMMARY. With regard to fibres the empire is **rich** in **wool,** but **poor,** at present, in **cotton.**

More than 40 per cent. of all the wool produced in the world is produced within the empire,[1] and this is nearly twice the amount the empire needs for its own consumption.

Of cotton, the empire[2] produces only 39 per cent. of the amount consumed in the United Kingdom ;[3] but the production is increasing.

Flax and **silk,** too, though not at present produced in sufficient quantities to make us self-supporting, yet show signs of improvement, and afford hope of increasing supplies in the future.

Jute and **Phormium tenax** are practically empire monopolies ; the former the product of **India,** the latter of **New Zealand.**

Sisal hemp and **Russian hemp** at present we import from foreign countries, but sisal is being grown in increasing quantities in the Bahamas, Kenya Colony, and Nyasaland.

Kapok, though at present imported only from Java, is grown in India and Malaya, and in the future will probably be imported from those and other British countries.

[1] Australia, New Zealand, the United Kingdom, South Africa, India, the Falkland Isles, Egypt.

[2] Egypt, East Africa, West Africa, Sudan, West Indies, Nyasaland, Uganda. This is neglecting the Indian supply, see p. 170.

[3] The amount imported from foreign countries into other parts of the empire is not great

Summary : Fibres

	Sources of Supply.		
	Foreign.	*British.*	*Remarks.*
Cotton.	**United States,** Brazil, Peru.	**Egypt,** India, Kenya Colony, West Africa, Sudan, West Indies, Nyasaland, Uganda, Cyprus.	Three-quarters of our supplies come from the **United States,** and a small amount from other foreign countries. Of empire countries, **Egypt** is our most important source of supply. Omitting India, the cotton produced in the **empire** is sufficient to supply only **39 per cent.** of the amount consumed in the **United Kingdom.**
Wool (i.e. sheep or lamb's wool).	The Argentine, France, Chili, and other countries.	**Australia, New Zealand, The United Kingdom, South Africa,** India, the Falkland Isles, Egypt.	The **United Kingdom** produces **24 per cent.** of the amount it consumes, but the **empire** produces **double the amount** the **empire** consumes and over **40 per cent.** of all the wool produced in the **world.**
Flax.	**Russia,** Belgium, and other countries.	The United Kingdom. Possible future sources : Egypt, Kenya Colony, Victoria.	At present the imports from empire countries are small compared with those from foreign countries. Russia supplies us with 80 per cent. of our total imports.
Jute.		**India.**	Practically all the jute of the world is grown in India.
Hemp.	Russia, Italy.		
Bengal hemp.		India.	
Phormium tenax.		**New Zealand.**	New Zealand produces practically the world's supply.
Sisal hemp.	Yucatan.	Bahamas, Kenya Colony, Nyasaland.	Most of the Bahama crop is exported to the United States.
Ramie grass.		India, West Indies, Kenya Colony.	
Kapok.	Java.		
Silk.	China, Japan, France, **Turkey.**	British India.	Not much more than 3 per cent. from British sources.

CHAPTER XVI

METALS

ALUMINIUM. This is a comparatively new metal. It was not until 1886, after repeated experiments and discoveries by distinguished scientists of various nationalities, that an English chemist found a method by which it could be prepared cheaply in sufficiently large quantities for use in commerce.

Aluminium is obtained from various sources, but chiefly from clay, and of all the clays which contain it, **bauxite** yields the largest quantities. Ten miles north-east of Arles, in the Rhone Valley, is the village of *Les Baux*, and the particular kind of clay from which aluminium is now obtained was first found there ; hence this clay is now called bauxite.

After the bauxite has been purified it is mixed with molten cryolite.[1] The mixture is then electrolysed, when the melted aluminium sinks to the bottom of the vessel and is drawn off. Hence aluminium extraction works are usually situated near waterfalls, so that electricity may be generated easily.

Aluminium has many valuable qualities, chief among which is its *lightness* : it is four times lighter than silver. It is not very tenacious, however, and therefore when strength as well as lightness is required, alloys of it instead of the pure metal are employed.

These alloys are used in the construction of parts of torpedo boats, and air-ships, and submarines, and motor-cars, and for all parts of ordinary ships where it is desirable to save weight.

Besides lightness, aluminium has other valuable qualities. It does not corrode with acid, nor tarnish in dry air, and it is a good conductor of heat. For these reasons it is very suitable for making surgical instruments, and chemical apparatus, and cooking utensils. But none of these should be washed in

[1] The only place in the world in which this mineral is being worked is Ivigtut in Greenland. The deposit is owned by a Danish company.

soda-water, as soda quickly attacks aluminium; nor should the brown film which forms on the inside surface of aluminium kettles be removed, for this is caused by the action of boiling water on the metal, and serves to protect it.

SOURCES OF SUPPLY. Bauxite clay occurs in **Antrim** in the north of **Ireland.** It is sent by way of Loch Linnhe and the Caledonian Canal to be treated at the works situated by the Falls of Foyers on Loch Ness. There are also known deposits in India, and British Guiana, and in New South Wales and Western Australia, but at present these are not much worked.

In **Canada** there are great aluminium works at Shawinigan Falls, twenty-one miles from the mouth of the St. Maurice River, which flows south into the St. Lawrence at Three Rivers; but the bauxite is imported from the United States, and after the aluminium is obtained it is exported to that country.

We have not, however, at present enough to supply our needs, and we import it from foreign countries.

ANTIMONY is a white metal very much like tin in appearance. It is hard and brittle, and a bad conductor of heat. Sometimes it is found alone, but more often in combination with sulphur, forming a grey ore called *stibnite.* To remove the sulphur the ore is powdered, and mixed with old pieces of iron, and heated. The iron then unites with the sulphur, and the antimony is set free.

On account of its brittleness antimony is not used alone, but its extreme **hardness** makes it a very useful component of **alloys** in combination with softer metals. It is used, for instance, with lead to make *bullets*, especially those called *shrapnel*, contained in explosive shells. Britannia metal, too, is a hard alloy consisting chiefly of block tin and antimony.

Molten antimony **expands** as it cools, and for this reason is used with other metals to form alloys, which are to be moulded to an exact shape. In printing, the raised letters called *type* are made by pouring molten **type-metal,** a mixture

of lead, antimony, and tin[1] (in the proportion of lead 75, antimony 20, and tin 5), into moulds, formed in the shape of the letters required. As the alloy cools, it expands, and fills up each little crevice in the mould, so that the tinest letters are shaped with perfect accuracy.

SOURCES OF SUPPLY. Antimony is widely distributed throughout the world, but **China** contains the largest known deposits.

Within the empire, **Australia** is our chief source of supply. There are mines at Costerfield in **Victoria,** whence a considerable quantity is exported; and at Hillgrove, in **New South Wales;** and near Northcote, in **Queensland.**

Antimony is also produced in **Canada,** and to a small extent in New Zealand and South Africa, and it is believed that when the deposits in these countries are worked to their full extent they will be able to satisfy our needs.

At present we import from **China** and **Mexico** as well as from **Australia** and **Canada.**

ASBESTOS (from Greek *asbestos*, indestructible). This wonderful substance is found lying in seams in rocks, sometimes as long silky fibres, and sometimes as a compact mass. It is usually of a *whitish-grey* colour, but sometimes it is green, sometimes blue. The fibres are flexible, and can be separated from one another, and woven into cloth.

In ancient days dead bodies were wrapped in asbestos cloth before they were placed upon the funeral pyre; the body inside the wrapping was burnt to ashes, but the cloth itself remained intact, and so it was possible to secure the ashes of the body, unmixed with any others.

Nowadays we use asbestos for a very great variety of purposes. As the fibres give out great heat, but do not themselves burn away, they are used in the construction of gas stoves. The asbestos is enclosed in a network of iron, and jets of gas placed under it. When these are lit they raise the asbestos to a white heat, and so long as the gas is alight the asbestos

[1] Sometimes the proportions are altered and bismuth is added to the other metals.

is incandescent and radiates heat. It is also used for table-covers; a table covered with asbestos remains uninjured even though red-hot vessels be placed upon it. In theatres and other places of public entertainment, the great curtain [1] which divides the stage from the other part of the building is made of it.

SOURCES OF SUPPLY. The **Province of Quebec** (south of the St. Lawrence River) is the main source of the world's supply of asbestos.

'It is quite clear that the Canadian production is more than sufficient to meet the demand for raw asbestos within the British Empire, but it is to be noted that the United Kingdom, although possessing the most up-to-date plants and methods, is largely dependent on foreign sources for the manufactured asbestos it uses.' [2]

The reason of this is, that the bulk of the Canadian output is exported to the United States (whence some of it is re-exported to us), and we have to make up our deficiency from **Russian** and other foreign supplies, although we do import a certain amount from **South Africa.**

Other countries within the empire produce asbestos, but not at present in large quantities. These countries are Rhodesia, Newfoundland, Tasmania, and Cyprus.

COBALT. Until recently cobalt was chiefly valued because oxides of it were useful for colouring pottery and glass.

The metal itself, however, is very similar to *nickel*, both in appearance and qualities, and it can be used for many purposes for which nickel at present is exclusively employed, so that in the future it will probably be still more highly valued than it has been in the past.

SOURCES OF SUPPLY. The **Cobalt District** near the eastern boundary of **Ontario** is the chief source of the world's supply of cobalt; so that the empire could be entirely self-supporting with regard to this valuable metal.

COPPER. This beautiful metal has many valuable qualities and was one of the earliest substances known to man. Large

[1] Most asbestos goods in sheet form contain a large proportion of china clay, and become very friable after being highly heated.

[2] Dominions Royal Commission.

deposits of it were found in Cyprus, and it was known simply as the Cyprus metal, *Cyprium aes.*

It is sometimes found pure, but more often in the form of ores, the most important of which is *copper pyrites,* or sulphide of copper and iron.

Copper is very tenacious, though not quite so strong as iron; it is also very malleable, and can be beaten at ordinary temperatures into almost any shape or design. As a conductor of heat and electricity it stands next to silver, and hence large quantities of it are used for telegraph wires, lightning conductors, and for all kinds of electrical apparatus.

But though used alone for a great number of purposes, it is perhaps still more useful as an **alloy.** Mixed with zinc it forms **brass,** with tin, **bronze.**

Sources of Supply. The copper mines of Cornwall were once very famous, but they are now nearly worked out.

We still mine copper in North Wales, and in Wicklow, but the output is small, and in consequence we have to import most of our supplies from abroad.[1]

These **imported ores** are smelted at **Swansea, Widnes,** and **Glasgow.**

Within the empire the chief copper-producing countries are **Australia, Canada, South Africa.**

1. Australia. (*a*) **South Australia** yields more copper than any other state in the Commonwealth. One of the most famous mines is at **Wallaroo,** in Yorke's Peninsula, to the east of Spencer Gulf.

(*b*) **Queensland. Mount Morgan,** south-west of Rockhampton, the **Cloncurry** district, and the hinterland of the port of **Cairns,** are the chief copper districts. Of the Cloncurry district we read that 'it is the largest tract of copper-bearing country in Australia, and one of the largest in the world. As the crow flies it extends north and south for more than 150 miles, and east and west some 80 or 90 miles. Over this large area, covering at least 15,000 square miles, copper has

[1] 27 per cent. from empire sources, 73 per cent. foreign sources.

been proved to exist. The outcrops throughout the district have been described by the Government geologists as innumerable and phenomenally rich '.[1] Cloncurry is 480 miles west of Townsville, with which it is connected by rail.

(*c*) **New South Wales.** The Great **Cobar** Mine, 464 miles west of Sydney, is the most important mine worked at present; though copper occurs in many other places.

(*d*) **Western Australia.** Copper is widely distributed, though the mines at present are not much worked.

(*e*) **Tasmania. Mount Lyell,** in the west of the island, is one of the principal sources of supply in Australia.

2. Canada. (*a*) **British Columbia** supplies more than half the Canadian output. The mines are chiefly in the south, in the boundary district, though large bodies of ore are known to exist in many other places.

(*b*) In **Ontario** copper ores occur mixed with nickel ores in the **Sudbury** district, north of Lake Huron. There are also small deposits in the Province of Quebec (chiefly at Sherbrooke, south of the St. Lawrence) and in the Yukon district.

3. South Africa. Copper stands second in importance among the mineral products of South Africa. **Oakiep,** in *Namaqualand*, ninety-two miles from Port Nolloth, and **Concordia** are the chief centres, though mining is also carried on in the north of the **Transvaal,** and to some extent in the Orange Free State and Natal.

In all these places the amount of metal at present produced bears but a small proportion to that which is known to exist. Yet it is estimated that the present actual production of copper within the empire is sufficient to supply 72 per cent. of Britain's requirements and **60 per cent.** of the whole empire's requirements.

We import, however, now, from empire sources only 27 per cent. of what we use.

GRAPHITE is a form of carbon and is chemically identical with the diamond. As it is black, and was formerly supposed

[1] *Our First Half Century: a Review of Queensland Progress.*

to contain lead, it was called **black-lead** or **plumbago** (Latin *plumbum*, lead).

The name **graphite** was given to it because it makes marks on paper, from *graphein*, to write.

It is found in very ancient rocks, such as gneiss, sometimes in layers and sometimes in great lumps.

Pencils are not now made of graphite alone, but of a mixture of graphite and fine clay. Both substances are ground to a fine powder, and then mixed with water to form a stiff paste. This is put into a cylindrical vessel, perforated with holes in the bottom, and forced through them. It emerges in the form of long thin sticks. These are cut into convenient lengths and allowed to dry. They are then made red hot, after which they are ready to be inserted into the cedar-wood holders prepared for them.

Graphite is used as a **dry lubricant** for machinery, and for this purpose alone we import large quantities every year; it is also used to polish fire-grates.

As graphite is a very poor conductor of heat it is used to **line moulds** into which white-hot metals are to be poured, and (mixed with clay and sand) to make **crucibles,** in which to melt ore and metals. These are its two most important uses.

Sources of Supply. Borrowdale, in Cumberland, in former days produced large quantities of graphite, but these mines are now practically exhausted.

Of countries within the empire **Ceylon** is the most important contributor, though **India,** and to a smaller extent **Canada,** send us supplies. Australia, and New Zealand, and the Transvaal have deposits, but at present they are not much worked.

The **Ceylon** mines are in the southern mountains, and the 'output is much more than sufficient to render the empire independent of foreign sources of supply'.[1]

As, however, she sends us only about one-fifth of her total export, we have to buy more than half our supplies from foreign countries.

[1] The Dominions Royal Commission.

IRON.

Gold is for the mistress—silver for the maid,
Copper for the craftsman, cunning at his trade.
'Good!' said the Baron, sitting in his hall,
'But Iron—Cold Iron—is the master of them all.'

RUDYARD KIPLING.

Although iron is so valuable and so widely diffused (there is scarcely a country in which it is not found), it was not one of the first metals employed in the service of man. One of the reasons for this is that it is scarcely ever found pure, but always mixed with some other substance forming what are called **iron ores.** These ores are very different in appearance from iron, and it was long before men discovered that it was possible to extract iron from them, and even after the discovery, the process was always slow and difficult.

The chief iron ores are:

1. Magnetic Iron Ore, or black oxide of iron. This is a mixture of iron and oxygen, and contains more iron than any other of the iron ores.

2. Haematite (Greek *haimatites*, blood-like). There are two varieties of this ore, one called Red Haematite, the other Brown Haematite. They are compounds of iron and oxygen, but both contain a little more oxygen than the magnetic ore, and mixed with the brown haematite is a certain amount of water.

3. Carbonate of Iron is a compound of iron and carbon and oxygen. An impure form of this, mixed with clay, is called **clay-band ironstone,** and another containing, besides clay, a considerable proportion of coaly or bituminous matter, is called **blackband ironstone.**

When the ores have been dug up out of the ground, the next step is to separate the iron from the other substances with which it is combined. The ores themselves, however, are rarely pure, and pure iron (which is white in colour) is never obtained except in a chemical laboratory. Carbon when heated joins very readily with oxygen, and the easiest way of

obtaining iron was to heat iron ore and carbon together in a furnace. The carbon then joined with the oxygen of the iron ore, and the molten iron, united with some of the carbon, flowed out from the bottom of the furnace.

In some such primitive fashion as this the Romans smelted iron in the Forest of Dean, but so imperfect were their methods that, after they had extracted all the iron they could, the great heaps of refuse left by them supplied iron ore in later times to numerous factories worked under more modern conditions.

The carbon used in smelting was always charcoal (made by charring wood under turf), and as a consequence of this practice the forests of England were to a great extent destroyed. It is true, of course, that wood was almost exclusively used for house fuel; still, the amount used in smelting iron was enormous.

To obtain one ton of pig-iron four loads of timber were required, and so serious was the destruction of forests that in 1581 an Act was passed making it penal to convert wood into fuel within fourteen miles of London, to erect new ironworks within twenty-two miles, or to increase the number of Sussex, Surrey, and Kent furnaces beyond certain limits. The Sussex industry never recovered from this blow, and by 1790 had died out altogether.

'The din of the iron hammer was hushed, the glare of the furnace faded, the last blast of the bellows was blown, and the district returned to its original solitude. Some of the furnace ponds were drained and planted with hops and willows, others formed beautiful lakes in retired pleasure grounds.' [1]

At last, in 1619, James I granted to Dud Dudley, the son of Lord Dudley of Wolverhampton, a monopoly 'of the mystery and art of smelting iron ore and of making the same into cast works or bars with sea-coals or pit-coals in furnaces with bellows'.

One of the chief difficulties of the early smelters was

[1] Dr. Smiles.

to keep the fire in their furnaces alight, and from the earliest time some sort of bellows was used. To-day the blast furnace has taken the place of the ancient bellows.

A modern blast furnace is a great hollow iron tower (sometimes as high as 100 feet) lined with firebrick. Near the bottom of this tower are pipes called *tuyères* (French *tuyau*, a pipe), through which a blast of hot air is driven at a pressure varying from 8 to 20 lb. per square inch, and at a temperature of 800° to 1,100° C. (In the Black Country they call these tuyères, *twyers*, or *two irons*.)

Into the furnace are put iron ore, or 'mine',[1] coke, and limestone. As before explained, the oxygen of the iron ore unites with the carbon, and the iron is set free, though some of the carbon unites with the iron. The lime mixes with some of the various other impurities and form *slag* or *cinder*, which being lighter than the molten iron, floats on top of it. This slag is let out from a hole in the furnace, and lower down the iron is run off from another hole into moulds made of sand. The pieces of new cast-iron in the moulds are called **pigs,** and the iron is called **pig-iron.** Each pig weighs about one hundredweight. The iron still contains a good deal of carbon and other impurities and is very brittle.

Cast-iron articles are obtained by melting together various qualities of pig-iron, mixed with some scrap iron, and then casting it into sand-moulds of the shape of the article required. It can stand great heat, but is still rather brittle.

Wrought Iron. Pig-iron is put into a reverberatory furnace, i.e. a furnace in which the fuel is in a separate compartment from the iron. The flame from the coal passes through the compartment containing the iron. The roof of this compartment slopes downwards and the flame is beaten down on to

[1] Often the ironstone or ore is heaped up in beds or 'rucks' about 4 feet high, 20 to 50 feet wide, and 100 or more feet long, and is burned or calcined in the open air, the carbon, hydrogen, and sulphur contained in the ore in some cases contains sufficient fuel to burn the whole bed; these and other impurities are thus separated from the mass, the residue being the 'mine' or iron in its first stage of manufacture, and a varying percentage of ashes containing silica, &c.

the iron, hence the name *reverberatory*. The flame passes onwards and finally escapes from a chimney.

The walls of the compartment are lined with oxide of iron, and the heat causes the oxygen of the oxide to be set free; some of it unites with the impurities of the iron and forms other oxides.

The purified iron is not melted, only made soft by the heat, and while in this condition is worked or wrought by long bars of iron put through a hole in the furnace door. It is then taken out, and, while still soft, is hammered with great steam hammers, and then rolled under steam rollers. Wrought iron is not brittle, and at a red heat may be hammered into any shape required, and two pieces may be welded together. This latter quality is a very valuable one, and is possessed by very few of the metals.

STEEL is iron combined with a small quantity of carbon, the proportion of carbon varying from $\frac{1}{4}$ to $2\frac{1}{2}$ per cent. The ancient iron makers had no means of regulating the amount of carbon contained in their steel, and, in consequence, though it was often of excellent quality, there was no fixed standard by which it could be judged. Modern methods have overcome this difficulty.

There are various methods of producing steel, and we can now obtain it from ores of various degrees of purity, though the finest steel, called **crucible steel,** is made from the purest ores and the purest carbon. This is the steel used in making cutlery.

In 1856 **Sir Henry Bessemer** invented his method of making steel. The principle is first to get rid of all the carbon, and some of the other impurities of pig-iron, and then to put back carbon in the proportion required.

Impure molten pig-iron is poured into a great pear-shaped vessel, called a converter, at the bottom of which is a plug riddled with holes.

Through these a fierce blast of air is driven, the pressure of which is so great that not only is the molten iron prevented

from falling through the holes, but it is made white hot and forced to bubble about like water boiling inside a kettle. The air-blast is continued until all the carbon in the iron has united with the oxygen of the air. (This takes about twenty minutes, and during this time some of the other impurities unite with the oxygen and form other oxides.)

Next molten *spiegeleisen* is poured in. This is a mixture containing iron, carbon, and manganese, in known proportions, so that the amount of carbon added to a given amount of iron can be regulated.

The steel is then poured into moulds, and left until the outside has become solid, and while still hot is pressed between shaped rollers, and finally is cut into the lengths required.

The iron most suitable for this process is the **Red Haematite,** which occurs in great abundance in the **Furness** district of North Lancashire. **Barrow** is the centre of this district.

Iron is also mined :

(*a*) In the **oolitic limestone** of (i) the **Cleveland** district of the North York moors. The ore which occurs here is an impure form of **clay-band** ironstone, yet it is from this region that we obtain nearly **half** our total output of iron. **Middlesbrough** is the chief town. (ii) The hills of **Lincolnshire, Leicester,** and **Northampton.**

(*b*) In the **carboniferous limestone** of **South Lancashire, North Staffordshire, South Staffordshire, West Cumberland, Ayrshire, Lanarkshire, Stirling, Clackmannan, Edinburgh,** and **Fifeshire.**

The fact that so much of our iron was mined near our coalfields, that these fields were near navigable rivers, or near the sea-coast, and that it was in Britain that the chief inventions connected with improved methods of producing iron were made, caused us to become in the nineteenth century the greatest iron-producing country in the world, but districts that once produced iron produce them no longer, so that we now stand third [1] among iron-producing countries and do not produce much more than half the iron we require. It

[1] 1, the United States ; 2, Germany ; 3, Britain.

therefore becomes very important for us to consider from what parts of our own empire we can supply our needs.

Newfoundland and Canada (Ontario, British Columbia, and Nova Scotia) both send us supplies, by far the largest amount coming from **Newfoundland.** There is a wonderful iron mine in **Bell Island** off the coast of **Newfoundland.** The iron-bearing district in which it stands extends along the shore and under the sea ; the amount of ore which it is estimated to contain is no less than three or four billion tons. There is iron, too, in other parts of Newfoundland.

South Australia. Iron Knob, in the north of **Eyre's Peninsula,** and **Iron Monarch** are described as ' mountains of solid iron ore ', and the iron is of excellent quality.

In **Tasmania** valuable deposits occur, especially near the north coast, in the **Blythe River Valley,** but they are not yet worked.

In **New South Wales** iron is found in various parts of the state ; it is mined chiefly in the **Blue Mountains,** at **Carcoar,** and at **Cadia,** where the beds are estimated to contain millions of tons of ore.

In **Queensland,** too, there is an abundance of ironstone : mining is carried on chiefly at **Rockhampton, Cloncurry,** and **Chillagoe.**

In **New Zealand,** at **Parapara,** on the west coast of the **North Island,** there is a large deposit of iron ore, and on the west coast there are wonderful iron sands, from which inexhaustible supplies of iron could be obtained.

South Africa. In the Cape Province and in the Transvaal and in other parts of the Union large quantities of iron ore are known to exist, but they are not yet worked.

At present, then, we produce in **Britain** about **one-half** of the iron we need, and the bulk of the **imported ore** comes from **foreign countries** (chiefly from Spain, and Norway, and Sweden).

Yet the deposits within the **empire** are enormous and **sufficient to supply all our needs.**

The difficulty of carrying such a heavy substance as iron ore long distances is very great; still, it is to be hoped that in the future this difficulty will be overcome and that our own Dominions, especially **Newfoundland,** will be able to send us large supplies.

CHAPTER XVII

METALS (*continued*)

TIN (A.S. *tin*, Latin *stannum*). Opposite Penzance, surrounded at high tide with the brilliant blue sea of the Cornish Riviera, but at low tide joined to the mainland, stands the little hill called St. Michael's Mount, whither in ancient days the merchants brought their tin for sale.

'They prepare tin, working the earth which yields it with great skill. . . . After casting this into the form of cubes they carry it to a certain island adjoining Britain called *Iktis*. During the ebb of the tide the space intervening is left dry, and they transport large quantities of tin to this place in their carts. From hence, then, the merchants buy tin from the natives and carry it into Gaul, and at last after travelling through Gaul on foot for about thirty days they bring their burdens on horseback to the mouth of the River Rhone.' [1]

This export of tin continued through the centuries, and so extensive did it become that in the fifteenth century we were the chief tin-exporting country in Europe. The Black Prince in the preceding century, we are told, paid his expenses in the French wars from the proceeds of his tin mines in Cornwall and Devonshire.

But at the present time these mines do not supply us with sufficient for our needs, and we have to buy it from abroad. The country which stands foremost in the world's supply of tin is the **Malay Peninsula.** Formerly two-thirds of all the tin used in the world came from there; now it produces about one-half of the total supply.

[1] Diodorus Siculus (first century, B.C.), quoted by Archibald Williams.

Stretching down the whole length of the Peninsula from north-west to south-east is a long range of granite mountains, flanked with hills of slate and similar rocks. In these highlands veins or lodes of tin ore occur. The rainfall of the Malay Peninsula varies from 68 inches to 167 inches a year, the average over the whole Peninsula being 90 inches. These heavy rains in course of time have worn down the highland,

CHINESE WOMEN CLEANING TIN ORE

and washed down the tin-bearing rocks to the lowlands and valleys, so that vast alluvial deposits have been formed, and in these 'nearly pure tin ore occurs in the finest of dust up to lumps several hundred pounds in weight'.

In the Peninsula tin 'is found in every conceivable kind of soil from the stiffest of clays to the lightest of sands; from the very grass roots down to depths of 250 feet; in the lowest valleys and on the tops of mountains. The tin-bearing ground may be in some exceptional cases so rich as to be black with grains of tin ore',[1] and yet on the other hand, worked with modern machinery, even land yielding half a pound or a quarter of a pound of tin ore to the ton of ground may be worked with profit.

[1] *Mining in Malaya*, by F. J. B. Dykes, F.G.S.

Pure **tin ore** or **cassiterite** is a compound of tin and oxygen, and the removal of the oxygen is effected by heating the ore in a furnace with coal and lime. The oxygen combines with the carbon of the coal, and the lime with the other impurities (for the ore is seldom pure), and the tin is set free; it is run off, and poured into moulds, where it forms **blocks** or **ingots** of tin.

Pure tin is a silvery-white metal, harder than lead, though not so hard as gold. It is so malleable that it can be hammered out to the thinness of $\frac{1}{1000}$th part of an inch. These thin leaves, or, as they are called, **tinfoil,** are used for making capsules, for wrapping up delicate articles and for many other purposes.

Alloyed with lead, tin forms **pewter ;** with copper, **bronze.** It possesses one great advantage over iron in that it is but slightly acted upon by air and water, whereas iron very quickly rusts and wears away.

For this reason tin is used as a coating for iron, and thus a substance is obtained having the strength of iron, and the air-resisting power of tin. This **tinplate** industry is chiefly carried on at **Swansea** in South Wales. When the iron has been cut to the required size it is subjected to various processes until it has become quite clean and bright. It is then immersed in melted grease, and left until it is perfectly coated, after which it is dipped into a bath of molten tin.

Afterwards the superfluous tin is removed by putting the plates into a vessel containing tallow and palm oil, maintained at a temperature just high enough to allow the tin to run off. (The melting-point of tin is 449° F.)

Besides Cornwall and the Malay Peninsula, tin is mined in **Tasmania,** where it forms one of the most important mineral products. The best-known mine is at **Mount Bischoff,** in the west of the island, but there are others. **Tin-smelting** is carried on at **Launceston.**

Queensland. The **Herberton** district of Northern Queensland is the principal, though by no means the only, tin-field The port of **Cairns** is the outlet for this district.

New South Wales (chiefly in the New England Tableland), and **Western Australia,** and **South Australia** also have deposits of tin, and it is mined in South Africa, near Stellenbosch, in Cape Colony ; and in the Rustenburg and Waterburg districts, in the Transvaal.

Northern Nigeria has enormous areas of tin-bearing land, and 'it is anticipated that the tin-mining industry will ultimately develop into one of the greatest sources of wealth of the Protectorate '.

From these places we buy tin in the form of blocks, ingots, bars, and slabs, as well as in the form of ore, to such an extent that only small quantities are imported from foreign countries.

And these foreign imports are not due to necessity, for not only does the **Empire** produce **enough tin for its own use,** but (including the tin used in tin-plate) **foreign countries** are dependent on us to the extent of **nearly 60 per cent.** of their requirements.

LEAD (A.S. *lead*, Latin *plumbum*).

> The lazy leaden-stepping hours
> Whose speed is but the heavy plummet's pace.
>
> MILTON.

This heaviness of lead is one of its best-known characteristics, and one which caused it to be used from early times for all kinds of weights, and, later on, for bullets and shot of every description.

Some metals, notably iron, when exposed to moist air combine with its oxygen to form oxides, or as we say to rust or tarnish, and though this happens at first in the case of lead, so that it quickly loses its lustre and becomes dull looking or wan, yet afterwards oxidation proceeds so slowly that lead can be used for making cisterns, and water-pipes, and roofs, and for various similar purposes.

As neither sulphuric acid nor hydrochloric acid in the dilute state act on lead, it is largely used in the fittings of chemical works. It is so soft that it can be scratched with the nail and can be easily hammered into any shape required,

but unlike copper, its tenacity is small, a wire of one-twelfth of an inch in thickness being unable to support a weight of 20 lb.

Another useful property of lead is its fusibility at comparatively low temperatures, and for this reason it is used with tin to form **solder** (from Latin *solidus*), an alloy for uniting the surfaces of two metals less fusible than itself.

Lead united with tin forms **pewter,** with tin and antimony **type metal.**

GALENA, or sulphide of lead, a compound of lead and sulphur, is, like the pure metal, of a bluish-grey colour. It is the commonest of lead ores, and was supposed to exert a calming influence in cases of extreme suffering, hence its Greek name, *galene*, tranquillity, stillness of the sea.

Mixed with the galena is nearly always a certain amount of silver, and after the sulphur and other impurities have been removed, the silver has to be separated from the lead.

SOURCES OF SUPPLY. The chief lead mines of Britain are in the Crossfell district of the **Pennines,** in the **Lake District,** in **Derbyshire,** and in **Lanarkshire,** in the **Isle of Man,** in **North Wales,** and in **Wicklow.** There are smelting works at **Alston Moor,** in Cumberland, at **Holywell** in Flintshire, but most of the imported ore is smelted at **Swansea.**

As in the case of some other minerals, the mines of **Britain** supply us with but a **small** proportion of the amount we need. Fortunately, however, our own Dominions have an abundance of the metal, though at present we buy only about half our imported supplies from them.

In the west of **New South Wales,** near the border of South Australia, 333 miles from Adelaide, and 809 miles from Sydney, amid arid and desolate country stands **Broken Hill,** at the southern extremity of the Barrier Range of mountains. Here are the most important lead and zinc mines of the British Empire, and with the lead occur large quantities of silver. Thousands of miners are employed here, and the town of Broken Hill has a population of 33,900 people. At **Port**

Pirie, on the north-east side of Spencer Gulf, increasing quantities of this lead are smelted.

Next in importance comes **Tasmania,** with her mines at **Zeeham,** in the rainy, mountainous county of Montagu in the west.

Queensland and **Western Australia** also have important mines, those of Queensland are in the **Burketown** district of the west as well as in the mineral belt of the east, while those of Western Australia are in the **Northampton Field,** to the north of Geraldton.

British Columbia produces most of the Canadian lead, the mines being at **Kootenay,** in the south of the state; but smaller amounts occur in the Yukon Territory, and in Ontario.

Newfoundland and South Africa also have deposits of lead, but their output at present is not great.

One of the newest and most promising sources of supply for the future is **Burma.** The silver-lead mines are at **Bawdwin,** in the Northern Shan States, and the produce can be brought down by rail to Mandalay and thence to Rangoon.

It is estimated that the output of these mines, in addition to the other empire supplies, will enable us to be entirely self-supporting.

MANGANESE is a greyish metal slightly tinged with red. It is extremely hard, and brittle, and difficult to melt. It is not found alone, but generally in combination with oxygen (MnO_2); iron, too, is often present in the manganese ores.

Manganese is used in colouring pottery and in removing the yellowish tinge from glass; it is used in electricity, in making disinfectants, and for many other purposes, but its most important use is in **hardening steel.**

Manganese steel, besides being very **hard,** is also **tough,** and it has **no magnetic power,** so that when used in shipbuilding it has no influence on the ship's compass.

SOURCES OF SUPPLY. **British India**[1] produces more manganese

[1] The most important mines are at **Gosalpur,** in the **Jabalpur** District of the **Central Provinces,** but there are also mines in the Nilgiris, in Mysore, in Hyderabad, and in many other places.

than any other country in the world, and could easily satisfy all our needs, but at present we receive from her less than a third of her total export: the rest (except for a small quantity which we produce ourselves in Carnarvonshire) we buy from **Russia** and **Brazil.**

Manganese is also found in all the states of Australia, and in New Zealand; in Canada, South Africa, and West Africa, but the output from these countries at present is small. Egypt, too, has large deposits of a manganese ore very rich in iron, and Newfoundland has abundant supplies, near Conception Bay, in the south of the island.

MONAZITE. In the extreme south of Southern India, within the Presidency of Madras, lies the state of **Travancore,** one of the most progressive of the native Indian states. From Cape Comorin it extends along the west coast northwards for 150 miles, and inland to the crests of the mountains. The climate is very hot, and the rainfall abundant, so that the slopes of the mountains and hills are clothed with thick forests, and in the lowlands are plantations of rice, and sago palms. There are very many rivers, and these on reaching the coast are pushed back by the currents of the Arabian Ocean and form lagoons along the shore. The mountains and hills are made of ancient rocks, such as granite, and in them occur particles of the mineral **Monazite.**

The torrential rains beating down upon the land, year after year, through the ages, have worn away the surface of the rocks, and washed down the débris to the valleys of the mountains. Among this débris are the precious Monazite crystals, which being heavier than the other constituents of the rocks, sink to the ground first, and are now found in the lower layers of the sands and gravels, on the margins of the rivers, and streams, and lagoons.

To obtain the mineral the sand and gravel is powdered and put into a trough, through which a stream of water is driven; the monazite being heavier, sinks to the bottom, and the lighter constituents are carried away by the water.

Monazite contains many useful elements, among the best known at present being **Thorium** and **Cerium,** both of which are used in the making of **incandescent mantles.**

After much labour, and many experiments, it was found that a little mesh of cotton, soaked in a solution containing nitrate of thorium, and a very small proportion of nitrate of cerium, burned with an intensely bright light, and after many more experiments the modern incandescent mantle was produced.

Instead of cotton, **ramie fibre** is now generally employed. A small cylinder of ramie net is soaked in the solution until it is completely saturated. It is then wrung out and drawn together at one end by an asbestos thread ; a loop of the same material is added. The ramie is then burnt off and a very delicate network of the oxides of the metals is left behind. This is strengthened by being dipped in collodion,[1] which in its turn is burnt off, after the mantle has been placed in position on the gas-burner.

Not only gas, but oil is used with incandescent mantles. For instance, the Bell Rock Lighthouse, ten miles out at sea from Arbroath, is lit by oil lamps having incandescent burners. These throw a light across the waters equal in brilliance to that of many million candles, and it is interesting to remember that the intensity of this light is due to a large extent to the elements thorium aud cerium.

Cerium also helps to produce the brightness of searchlights, and it is useful in many other ways.

NICKEL is a hard silvery-white metal, and a small proportion of it added to steel makes the latter exceedingly **tough,** so that nickel steel is used when especial toughness and strength are required. It is also **lighter** than ordinary steel. Armour-plates, and parts of motor-cars, and burglar-proof safes, and various munitions of war are made of it.

Another valuable property of nickel besides its hardness

[1] Cotton soaked in nitric and sulphuric acid becomes highly explosive and is called gun-cotton. Collodion is gun-cotton dissolved in ether or alcohol.

is the fact that it tarnishes but slightly in damp air. For this reason it is used to coat or plate other metals, thus rendering them brighter and safe from rust. Rifle bullets are sheathed with it.

SOURCES OF SUPPLY. **Sudbury** in **Ontario** produces two-thirds of all the nickel in the world. The nickel-ore district covers an area of 800 square miles, and 'there is no doubt that **Canada** is able to furnish all the nickel ore required for use in the empire'.

There are also deposits in Tasmania, Newfoundland, South Africa, and Egypt.

Tungsten is not found alone in nature, but always in combination with some of the other metals. It occurs principally in *wolfram* and *schulite*.

Wolfram ($FeWO_4$) is a dark-brown mineral consisting of iron and tungsten combined with oxygen, and the tungsten (generally in the form of a powder) has to be extracted from it by a complicated process.

In schulite ($CaWO_4$) calcium takes the place of iron. The importance of tungsten lies in the fact that a small proportion of it added to **steel** increases the **hardness** of the latter in the most wonderful manner, and not only its hardness, but its '**temper**', for it can be made red-hot without changing its quality.

Thus, all sorts of **cutting tools** are made of tungsten steel, for these need special hardness, as they have to cut hard substances such as iron and steel.

To take one instance. A modern ship is built of steel. After the keel has been laid down, and the ribs securely fastened into place, the whole is covered with large plates of steel. These plates are fastened on to the framework of the ship with rivets. In each plate holes are bored or punched out, and these are placed over corresponding holes in the framework. Then a white-hot rivet about two inches long is put through each hole and hammered flat at each end, so that it becomes in shape like a double-headed nail. As it

cools it contracts, and so draws the plates firmly against the frame.

The whole ship is thus put together by rivets, so that in a large vessel there are many millions of them, and the holes through which they pass have all been drilled or cut by tungsten steel tools.

In battle-ships the armour-plates are made of a very hard tungsten alloy, and, indeed, the need for specially hard steel in all engines of war is vital.

MOLYBDENUM, which occurs in a mineral called molybdenite, also like tungsten hardens steel, and is sometimes employed instead of tungsten.

SOURCES OF SUPPLY of tungsten and molybdenum :

In **Cornwall** wolfram ore is found, but generally in association with tin ore, from which it has to be separated before the tungsten can be obtained from it.

Burma. The principal wolfram mines are at **Tavoy,** on the coast of Tenasserim, and the output of these mines is about one-third of the world's total production. There are deposits in other parts of Burma, but these are not so extensively worked, on account of difficulties of transport.

Australia. From Port Cairns, on the Queensland coast, a railway runs inland to Georgetown. There is a branch southwards to Herberton and one northwards to Chillagoe. The wolfram-bearing country in this part of **Queensland** is estimated to extend over an area of three thousand five hundred square miles, and it is stated that these **Chillagoe** and **Herberton** mineral fields alone 'can supply the world's demands and have a good deal to spare afterwards'. Besides wolfram, molybdenite is extensively mined.

In **New South Wales** wolfram occurs in many places, but the chief mining centre at present is at **Torrington** to the north of Emmaville, on the New England tableland.

Victoria has deposits of wolfram, molybdenite, and schulite, and **Tasmania** of wolfram, and there are deposits of schulite in **New Zealand.**

In **Canada** the production of molybdenite is rapidly increasing, and both wolfram and schulite are found in the **Malay States**.

Great factories have now been erected at **Widnes,** in South Lancashire, for refining the ores and obtaining tungsten, and within our own empire we can produce sufficient quantities for our needs.

ZINC is a comparatively modern metal, its usefulness not having been fully discovered until early in the nineteenth century. When pure it is of a bluish-white colour, but when exposed to the atmosphere it loses this brilliancy and becomes coated with a greyish film, though, as in the case of lead, after this first tarnishing little further action takes place, so that zinc is very useful for coating objects which are to be exposed to a damp atmosphere.

Aloysis Galvani of Bologna in the eighteenth century discovered a new method of coating one metal with a dissimilar one by means of electricity, and iron coated with zinc is now called *galvanized* iron, though at present the coating is generally accomplished in a similar manner to that used in the tin-plate industry, i. e. by plunging the iron, when perfectly cleaned and polished, into a bath of melted zinc.

Zinc is harder than lead or tin, but not so hard as *brass* (an alloy of copper and zinc). At ordinary temperatures it is rather brittle, but when heated to the temperature of 300° to 320° F. it becomes malleable and ductile. It was the discovery of this property which led to its extensive use in sheets.

The ores of zinc, namely blende, or sulphide of zinc, and calamine, or carbonate of zinc, frequently occur with lead ores.

Sources of Supply. In Britain zinc ores are found in Cumberland, North Wales, Leadhills (in Lanarkshire), and the Isle of Man, but the amount of zinc produced is small.

In the production of zinc, as of lead, **Australia** stands first in the empire, enormous quantities being mined at **Broken Hill** (N.S.W.) and at other places, notably in **Tasmania,**

The Canadian zinc mines are chiefly in the **Kootenay** district of **British Columbia,** though Quebec and Ontario produce a certain amount.

In Newfoundland there are said to be extensive deposits, along with silver and lead, in the Red Indian Lake District.

Bawdwin, in the Northern Shan States of **Burma,** besides lead, has large deposits of zinc ores and is regarded as a promising source of future supplies.

It is estimated that the output from these mines is sufficient to make the empire self-supporting, though at present we import from various foreign countries, chiefly from Italy, Spain, Algeria, and (before the war) from Germany.

CHAPTER XVIII

METALS (*continued*)

GOLD. We read that in ancient days Jason, accompanied by all the heroes of Greece, sailed in the good ship *Argo* to Colchis, on the Euxine, to fetch the Golden Fleece, which hung on an oak-tree in the grove of Mars, and was guarded night and day by a fiery dragon.

Since Jason's day men have been willing to brave 'fiery dragons' innumerable in order to obtain the precious metal, which on account of its beauty and its many valuable qualities has always been an object of intense desire.

Gold is one of the heaviest of the metals, and it is extraordinarily malleable and ductile; it can be beaten out into 'sheets' or 'leaves' so thin that 250,000 of these placed one on top of the other measure only one inch in thickness, while one grain in weight can be drawn out into a wire 167 yards long. In consequence of its softness it is not used pure either for ornaments or coins, a certain amount of copper or some other metal being used with it to harden it.[1]

[1] English sovereigns contain 8·33 per cent. of copper. Often the proportion of gold is reckoned according to the number of parts out of 24. Each

Gold has a great affinity for mercury, but it does not join readily with oxygen, nor is it acted upon by acids, hence it is not affected by exposure to the atmosphere and remains always bright and clean. It is a good conductor of heat and electricity.

The men who first found gold found it in the sands by the side of a stream, or in the bed of the river itself. Sometimes they fastened down a sheep-skin in the current of the stream to catch the golden grains as they sank to the bottom, and the skin became indeed a 'golden fleece'. This was how the inhabitants of Colchis obtained gold from the River Phasis, and in the same manner to-day gold is obtained from the rivers of Hungary.

All sorts of theories were propounded by the ancients to account for the presence of these grains of gold by the side of streams. The Lydian Pactolus, for instance, a tributary of the Hermus, was extraordinarily rich in gold, and this was the explanation which was given. Midas, one of the kings of Phrygia, had asked in his folly that everything he touched might be turned to gold, and lo! his prayer was answered, so that even his food on its way to his mouth was changed into gold. To remove this curse he was bidden to go up into the mountains, and bathe in the springs which fed the Pactolus. This he did, and was cured, but ever after the stream washed down precious grains of gold, so that Croesus and other kings of Lydia became by-words for their wealth.

In modern times men were not content with such explanations. They followed the streams up into the mountains, and after patient search found the origin of the golden sands. Imbedded in the heart of the rocks, they discovered veins or lodes of pure gold. Many different kinds of rock contain these veins, but quartz is the commonest.

It was from these that the river-side grains had come, for wind and weather had in course of time broken off solid

twenty-fourth part is called a *carat*; so that 22 carat gold consists of 22 parts of pure gold, and 2 parts of another metal.

lumps of rock and gold, which, tossed about from place to place, had been further reduced, and finally washed down by the streams to the beds of the rivers.

All this gold thus 'washed down' is called **Alluvial Gold,** and the gold-bearing sands are called **Placers,** from a Spanish word *placer* having that signification, and used by the Spaniards in their mines in Brazil and Mexico. Sometimes the grains are so small as to be invisible to the naked eye, at others so large as to constitute a fortune for the lucky finder. These large pieces are called **Nuggets.** At **Ballarat** (in Victoria) one inch below the surface of the ground a nugget weighing 2,520 ounces was found. It was called 'The Welcome Stranger'.

Placers often occur in the beds of rivers which have long since ceased to flow, and are therefore now found many miles away from present-day streams, sometimes even on the tops of mountains, so much has the surface of the earth changed in the course of the ages.

In the early days of modern gold-mining the miners simply dug up the soil ('pay-dirt', as they called it) by the river side, and washed it in a *pan.* They held the top of the *pan* just under the surface of the water, and stirred the contents, so that the lighter materials were carried off by the current, and the heavier gold sank to the bottom of the pan. Nowadays improved methods are used, but the principle on which they depend is the same, namely, the sinking of the heavy gold and the floating away of the lighter materials.

Mercury is often added to the water in which the gold is washed. It unites with the gold so that even the finest particles are not lost; afterwards this mercury is volatilized and the gold recovered.

In order to obtain gold from the **veins** or **lodes** in rocks the whole auriferous mass has to be crushed, and the gold is obtained from the powdered material by methods similar to those in use in alluvial mining. In the goldfields of the **Transvaal,** and other places where the rocks have to be crushed, the noise is described as deafening. Enormous iron

stamps, shaped like a pestle, and weighing from 600 to 900 lb. or more, deliver from 30 to 100 blows a minute on to the masses of rock placed beneath them. Mining for gold from veins in the solid rock is called **vein-mining.**

In addition to **free** gold found in **alluvial sands,** and in the **solid rocks,** there is the gold found in **combination** with other metals. The methods for obtaining the gold from these ores vary according to the minerals with which they are combined. The following is an account of the principal goldfields.

Australia.

1. Victoria. In the beginning of 1851 on the northern slopes of the Great Dividing Range was situated the Ravenswood sheep-run, many square miles in extent and supporting many thousands of sheep. Part of it was called **Bendigo's Creek,** from the name of a famous shepherd who worked there.

On December 10, 1851, gold was discovered here, and by the next year 40,000 miners were encamped on the spot. We read that 'vast areas of ground were turned over and rifled of their treasures. Whole forests of great iron-bark trees with the dense undergrowth growing beneath them disappeared'.[1]

Gold had been found in several other places during the preceding year, notably at **Ballarat,** and a feverish 'rush' to the goldfields began. In **Melbourne** work was at a standstill; farmers, shop-assistants, lawyers, the crews from the ships in the harbour, all rushed off to the goldfields, and later on when gold-seekers from other parts of the world arrived, tents had to be erected for their accommodation in the outskirts of Melbourne. The pioneers, as usual, suffered terrible hardships, though as the gold country was situated among the sheep-runs of the squatters, meat was available from their flocks and herds, and we read to-day without a thrill that butcher's meat rose from 1*d.* to 6*d.* per pound. A cabbage, however, cost 5*s.*

[1] Bernard Mannix, *Mines and their Story.*

These and several other goldfields were discovered as the result of a reward offered for the discovery of gold within 200 miles of Melbourne.

The Bendigo goldfield is fifteen miles long and three miles wide. Many of the mines on it are very deep; one called the Victoria Shaft is 4,614 feet down.

The town of Bendigo is the chief gold-mining town of Victoria, and it is the third largest town in the state; Ballarat is the second. Other goldfields are situated in the centre and east of Victoria, and of all the minerals found in the state, gold is the most important.

2. Western Australia. The most important goldfield of Western Australia is **East Coolgardie,** 360 miles inland by rail from Perth. It was discovered in 1892. The average yearly rainfall is 10 inches, or less, so that the country is practically a desert; bare monotonous dreary sandy wastes with a few bushes and gum trees here and there, 'a gaunt land stricken with barrenness and thirst'. The long lines of Afghan camels with their tinkling bells are the only objects which impart a little life and interest to this depressing wilderness.

The area of the goldfields is 632 square miles, one square mile of which is so extraordinarily rich as to be known as the 'Golden Mile'. It was discovered in 1893 and is near the present town of **Kalgoorlie.** To the west of Kalgoorlie is the town of **Coolgardie,** the Government Head-quarters of the West Australian goldfields. Water is brought to these and other mining towns in the neighbourhood by pipes from the hills near Perth.

Mount Margaret, to the north-east of Coolgardie, and **Murchison,** 200 miles or so east of Geraldton, are also important 'fields', and there are others, for West Australia is the most important gold-producing state of Australia, and is responsible for **half** the total yield of the Commonwealth.

3. New South Wales. Although gold was discovered in New South Wales in 1851, and was for many years the most valuable of the minerals produced, at present this state stands

fourth among the gold-producing states of the Commonwealth. The chief gold-mines are those of the **Cobar** field.

4. Queensland. Gold is widely distributed in Queensland. The principal mines are at **Gympie** to the north of Brisbane, **Charters Towers** south-west of Townsville, and **Mount Morgan** south-west of Rockhampton.

New Zealand. The chief gold-mines are in the districts of Auckland, West Coast, and Otago ; the production is not so great as formerly, but gold is still an important article of export.

Gold is also found in **Tasmania,** at Beaconsfield, on the north coast, and in some districts of South Australia.

South Africa.

1. The Transvaal. About thirty-five miles south of Pretoria, rising above the high, treeless, grassy plateau, extending due east and west for about eighty miles, is a low range of hills known as the **Witwatersrand,** i. e. the White Water Ridge.

At both ends the **Ridge** or **Rand** curves southwards towards the Vaal, in the west towards Klerksdorp, and in the east past Heidelberg. For fifty miles along the northern rim of this basin the rocks contain gold. Its presence was discovered in 1885 by a man working on a farm in the district, and soon the usual ' rush ' of gold seekers followed. They pitched their tents and tied up their wagons on the spot where Johannesburg now stands. The town was laid out towards the end of 1886.

The rock in which the gold occurs is a conglomerate of sand, and clay, and quartz. The white lumps of quartz resemble the almonds in almond toffee, and hence the ridges or reefs are known as *banket* reefs, *banket* being the Dutch word for *almond toffee.*

The gold is distributed uniformly throughout the sand and clay, and is in such minute particles that it is invisible to the naked eye, yet the quantity obtained is so enormous that Transvaal gold is the most important of all the products of South Africa. No other country in the world produces so much.

Other goldfields are at **Lydenburg** and **Barberton** in the east of the Transvaal, but these are of less importance than those of the Rand.

2. Rhodesia. The chief mines are in Southern Rhodesia in the district of **Gwanda,** about 100 miles south-east of Buluwayo. The country here is well wooded, and not far away is the Tuli coalfield.

GOLD MINING, JOHANNESBURG. QUARTZ BEING RUN INTO TRUCKS FOR CRUSHER.

3. Swaziland, 4. Bechuanaland Protectorate, and 5. Natal also produce gold, but compared with the Transvaal and Rhodesia their output is insignificant.

West Africa.

1. The Gold Coast. From time immemorial gold has been found among the sands of the sea-shore, and the margins of the rivers, of that part of West Africa known as the Gold Coast Colony, but in modern times it was the Portuguese who were the first to work the diggings, and later on, when in Charles II's reign we acquired this territory, we struck a new

coin called the *guinea* because it was made of gold from the colony whose shores are washed by the Gulf of Guinea.

The unhealthiness of the climate and the difficulties of transport hindered exploration, so that, although alluvial gold was worked, the rocks in which the gold veins were imbedded remained untouched until about 1880, when a French trader called attention to the presence of gold at **Tarkwa** in the west of the colony. A railway has now been built from **Sekondi,** on the coast, through **Tarkwa,** on to **Kumasi,** in **Ashanti,** and the yield of gold from the colony is now considerable.

In British Guiana, too, gold is found in the river gravels, but, as in West Africa, the climate and dense vegetation have hindered progress.

Canada.

1. British Columbia. In 1857 and 1858 gold was discovered in the sands and gravels of the **Fraser** and **Columbia** Rivers, but these early ' finds ' have been superseded by the quartz mines of other districts, chiefly by those in the **West Kootenay** district, and in the south of the province. Here the chief mining town is **Rossland,** reached by rail over the Crow's Nest Pass of the Rockies.

2. Klondike. From 1886 onwards gold had been obtained in the **Yukon** Valley, but it was not until ten years later that miners, working their way up the various tributaries of the main river, discovered the rich ' fields ' of Klondike. Then ensued the usual *rush,* and in the desolate inhospitable waste **Dawson City** arose. It stands at the junction of the Yukon and Klondike Rivers.

The average temperature for January in this district is $-5°$ F., i. e. thirty-seven degrees of frost, and during the other winter months the cold is not much less intense. Under these circumstances the ground becomes as hard as cast-iron and digging is an impossibility. After various experiments the miners hit upon the following plan. They lit great fires which thawed the ground under them, and, while the earth was still soft, the men dug it out and piled it up, ready for

'washing' in the summer when the river-ice would be melted. In the holes thus excavated they built more fires, thus gradually working their way down. Later on they adopted another method. By means of a strong hose and sharp nozzle they injected a continuous supply of hot steam from a huge cylinder into the earth and thus melted it.

There are various routes to Klondike, but all of them are long and difficult, so that the wonder is that men were willing to endure such hardships in their search for gold. Yet in four years' time no less than 30,000 miners had entered the country.

In the short summer from the beginning of June to the end of September it is possible to proceed from St. Michael at the mouth of the Yukon by a river steamer up to Dawson City, a long and uncomfortable journey.

The usual way now is to start from **Skagway,** on the coast of **Alaska,** go by rail over the White Horse Pass to **White Horse** on the Lewes River, and thence by steamer down the Lewes and Yukon to Dawson. But in early days this railway did not exist, and many a pioneer lost his life in journeying over the pass.

The gold in the Klondike district is found in **alluvial gravels,** and so far no veins or lodes in the rocks have been discovered. In consequence, the miners, having to a certain extent exhausted the surface workings, are drifting away from Klondike lower down the Yukon into Alaska, and the Klondike output is not so great as it was.

3. Ontario. Gold is found in various places in Ontario, but at present **Porcupine,** to the north of Sudbury, is the most productive 'field'.

There is also gold in Nova Scotia, but the yield is decreasing in quantity.

Canada as a whole stands **fourth** in the list of gold-producing countries within the empire.

British India.

Mysore, in the south, produces most gold, though a certain amount is found in the valleys of the Himalayas and in the Central Provinces.

SUMMARY. Among British countries the **Transvaal** and **West Australia** stand pre-eminent as gold-producing countries, the former producing about eight times as much as the latter.

Next in order of importance come **Rhodesia, Canada, British India, Victoria, Gold Coast Colony, New South Wales, British Guiana, Tasmania.**

Smaller quantities of gold are also produced in the territory of Papua, Swaziland, South Australia, Bechuanaland Protectorate, and Natal.

Altogether the empire produces about 60 per cent. of the world's total output of gold, so that we could be entirely self-supporting with regard to this commodity.

SILVER, though a soft metal, and exceedingly malleable and ductile, is, nevertheless, harder, and less malleable and ductile than gold.

It occurs in nature either pure, or in ores wherein silver is the only metal present, or in ores which contain other metals as well as silver. Two of the commonest silver ores are silver glance, or sulphide of silver, and horn silver, or chloride of silver ; and of other metals which occur in silver-bearing ores, lead, cobalt, copper, and gold are the commonest.

The celebrated **Broken Hill Mines,** in **New South Wales,** are silver-lead mines, and they are described as ' the richest silver-fields of modern times '. Next in importance come the silver-cobalt mines of the cobalt district of **Ontario,** and others are the Rossland mines of **British Columbia.** These last form part of the great silver region, which extends all along the Western Cordilleras of North and South America, and in which occur the rich mines of Nevada, Colorado, Montana, &c. in the United States, and of Peru, Bolivia, and Chile in South America.

Japan also has important silver mines, and there are mines, though of less importance, in Germany, Spain, and Austria.

SUMMARY. It thus appears that, as regards iron, copper, lead, and antimony, the present actual output from mines within the empire is not sufficient to supply the needs of the empire, but that there are undeveloped resources in these metals, which are more than sufficient to make us self-supporting.

With regard to asbestos, graphite, cobalt, manganese, nickel, tungsten, zinc, and tin, the empire's production is sufficient for its needs, while in the case of tin and gold we not only produce sufficient for ourselves, but actually supply 60 per cent. of the whole world's needs.

SUMMARY

	Sources of Supply.			
	Foreign.	*British.*		
Metal.		*Present.*	*Future.*	*Remarks.*
Aluminium.	France, United States, Italy.	Ireland.	British Guiana, India, Australia.	
Antimony.	**China,** Mexico.	Australia.	New Zealand, Canada, South Africa, Newfoundland, India, Transvaal.	The present empire supplies are **not** sufficient for the empire's needs.
Asbestos.	Russia.	**Canada** (Quebec). South Africa	Rhodesia, Newfoundland, Tasmania, South Australia, New Zealand, Cyprus.	The Canadian deposits alone are **more than sufficient** for the empire's needs.
Cobalt.	New Caledonia.	**Canada** (Ontario).		
Copper.	United States, Chile, Japan, Mexico, Spain, Portugal, and many others.	Britain (5 per cent.), **Australia,** Canada, South Africa.	Rhodesia.	Present empire supplies are sufficient for **60 per cent.** of the empire's needs.

Metal.	Sources of Supply. Foreign.	British. Present.	British. Future.	Remarks.
Graphite.	Japan, Germany, Madagascar, Italy.	**Ceylon,** India, Canada.	Australia, New Zealand, Transvaal.	The Ceylon output is **more than sufficient** for the empire's needs.
Iron.	Spain, Sweden, Algeria, Norway.	Britain (50 per cent.), Newfoundland, Canada.	South Africa, Australia, New Zealand.	Present empire supplies are sufficient for **58 per cent.** of the empire's needs.
Lead.	Spain, United States, Mexico.	Britain, **Australia,** Canada.	Burma.	Present empire supplies sufficient for **73 per cent.** of the empire's needs.
Manganese.	Russia, Brazil.	Britain (small), **British India.**	Australia, New Zealand, Canada, Newfoundland, Cape Province, Egypt, West Africa.	The Indian supply **is sufficient** for the empire's needs.
Molybdenum.	Norway.	Australia.	Canada, New Zealand, South Africa, Newfoundland.	
Monazite.	Brazil.	**India** (Travancore).		
Nickel.	New Caledonia.	**Canada.**	Tasmania, Newfoundland, South Africa, Egypt.	The Canadian output **is sufficient** for the empire's needs.
Tin.	Bolivia, Chili.	Cornwall, **Malaya,** Australia, Nigeria, South Africa.		The present output of the empire is **more than sufficient** for the empire's needs.
Tungsten.		Cornwall (small), **Burma,** Australia, New Zealand.	Malaya.	The present empire output **is probably equal** to the empire's needs.

Metal.	Source of Supply. Foreign.	British. Present.	British. Future.	Remarks.
Zinc.	Italy, Spain, Algeria, Germany (Silesia).	Britain (small), **Australia,** Canada.	Burma.	The present empire output **is sufficient** for the empire's needs.
Gold.		**Transvaal, West Australia,** Rhodesia, Canada, India, Victoria, Gold Coast, New South Wales, British Guiana, Tasmania.		The empire produces about **60 per cent.** of the world's total output of gold.
Silver.		New South Wales, Ontario, British Columbia.		

CHAPTER XIX

COAL

Our word COAL is derived from the Anglo-Saxon *col*, which at first meant a piece of glowing fuel, and, later on, fuel of any kind, whether alive or dead. The different kinds of fuel, or coal, were distinguished by different prefixes, and the coal, which was dug out of the earth, was called *pit-coal*.

But in England, owing to the supreme importance of pit-coal, we gradually omitted the prefix, and called it simply *coal*.

Origin of Coal. Once upon a time, a very, very long time ago, dense, silent, gloomy forests covered enormous areas of what is now Britain. Year after year, century after century,

the trees in these forests lived and died, and the forests became denser, and gloomier, and the masses of decaying vegetation more and more impenetrable.

In course of time, owing to changes taking place on the surface of the earth, these forests were submerged ; the tossing restless sea covered them, sand and mud fell upon them, and the weight of the waters crushed them to death.

Thousands of years passed by, and the forests had ceased to be forests ; in their place had been produced a hard, shiny, black mass, which we call *coal.* Yet in the coal we can still find traces of these ancient trees, and can in imagination picture the bygone forests of the carboniferous age.

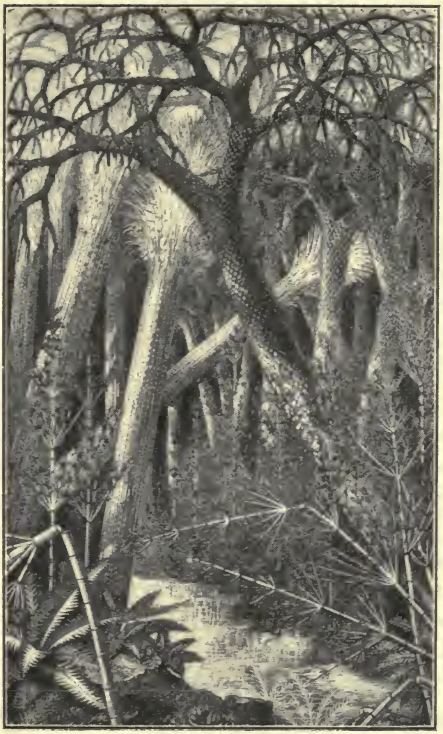
Nowadays, wandering over a desolate moor, or climbing the steep sides of a lofty mountain, we may come upon little mosses, which bear a most curious resemblance to the fossils found in the coal-beds.

One of these mosses is called *Selaginella.* It is a species of club moss, and produces spores which contain resin. In the coal-beds great fossil trunks, forty feet long, or more, have been found, which are exactly like the trunks of the selaginella, and spores, and other parts, too, have been discovered which correspond to the spores of the selaginella. These trees are called *Lepidodendrons*, from *lepis*, a scale, and *dendron*, a tree. They are on the right-hand side in the picture.

In a similar way the little *equisetum*, or horsetail, of our marshes, corresponds to the *calamite* of the coal forest ; another very important tree was the *Sigillaria*, and besides these there are fossil remains of many other great trees, and ferns, and mosses.

Still the centuries rolled by, and other changes occurred in the earth's crust ; the sea receded, and the accumulations of sand, pressed by the weight of the waters into sandstone, became dry land ; plants again grew, and other forests were formed, and so on during countless ages, until there came a time when the surface and vegetation of the land were such

as we know them now, and men wandered over hill, and plain, and cut down forest trees for fuel, all unaware that, deep down under their feet, lay these vast stores of hard black



A FOREST OF THE COAL PERIOD

coal, whose use would one day work such wonderful changes in the life of the nation.

The Discovery of Coal. Sometimes, owing to a bending of the earth's surface, the seams of coal instead of lying horizontally lie in a sloping position, and one end of the slope comes to the surface. This was probably how the existence of coal was discovered. At any rate, here, in England, at the time of

the Romans, coal was mined, but the quantity obtained was very small. It was not until **1238** that the first coal-mine was opened at **Newcastle,** and after that date, very gradually, coal became an article of commerce.

Difficulties connected with Coal-mining. One of the great difficulties is to keep the mines free from water, and the miners of old days had very inadequate pumps for this purpose. Then there is the difficulty of raising the coal from the depths of the earth, where it is mined, to the surface; the difficulty of taking it from the pit's mouth to the place where it is to be used; and many other difficulties, all due to the fact that coal lies underground and is exceedingly heavy.

Not much, therefore, could be accomplished until some force was discovered whereby the water could be pumped out from the mines and the coal moved from place to place.

James Watt. In the year 1736 there was born at Greenock one who was described later as 'no common child', and he it was who invented the wonderful **steam engine.** Difficulties which had before been insuperable now vanished; new mines were discovered and worked, the iron trade revived, cotton and woollen manufactures increased by leaps and bounds; and there took place what was known as the **Industrial Revolution.**

Before the revolution, wherever the grass nourished good sheep and there were streams in which their wool could be washed, there the **woollen cloth** was woven; and the east, with **Norwich** as the centre, and the west, with **Stroud** and **Taunton,** were the chief woollen manufacturing districts of England.

The cotton industry was as yet in its infancy, and the bare hills and bleak uplands of the north were but thinly populated. With the advent of the steam-engine, and the working of the coal- and iron-mines, all this was changed. Instead of lonely mills by the side of little mountain streams, there grew up enormous factories and prosperous towns wherever there was

coal, so that the population of England shifted from the south to the north, and the position of the coalfields determined the position of the towns.

Not only did the population increase and the position of the populous areas change, but the wealth of England also increased enormously; and it was largely owing to this increase in wealth that we were able to emerge victoriously from the devastating wars of the beginning of the nineteenth century, and that at their termination we were 'the foremost nation of Europe in economic matters and, consequently, in all other matters also'.[1]

Since, then, coal is of such paramount importance to our national well-being, it becomes interesting to consider what supplies exist in Britain and the empire, and whether there is anything else which could take its place when the mines are exhausted or become too expensive to work.

Nowadays we obtain our supplies of coal from seams deep down under the surface of the earth. The seams vary in thickness, and 4,000 feet is considered to be the maximum depth for profitable working. The layers, or strata of rocks, occur in a certain order, and geologists know where coal-bearing rocks are likely to occur. They make a small hole with a sharply-pointed rod, and then fasten on other rods until they have cut down to the place where they believe the coal to be. They then pull up the rods, and insert a small scoop at the end of them. The scoop brings up fragments of rock, and if coal is found among them they know that their surmises are correct. In a similar manner they try other places, and at last ascertain the district in which coal is to be found. This coal-bearing district is called a **coalfield.**

Next they cut a deep pit down to where the coal seams are, and build a wall of bricks round it. This is called **sinking a shaft.** The shafts vary in size and shape, but generally they are round, and about twenty feet in diameter. They are divided across the middle by a framework of steel.

[1] H. de B. Gibbins, *Industrial History of England.*

The miners descend into the mine in a cage, to which is attached a rope, two inches thick, of twisted steel wire. This rope passes over a pulley, which lets down and pulls up the cages. The cage consists of a wooden floor, supporting an open iron framework, something like a large box with open sides; it has two or more stages or decks, and holds about twenty men.

The miner cuts the coal with a sharp-pointed, double-ended pick. One of the most important of his operations is holing. This consists in cutting a horizontal slit, about three feet deep, in the wall of coal, so that the overhanging mass falls of its own weight. To do this he has to lie upon his side, or in some other cramped position, and the darkness in which he works is barely relieved by the glimmer of his lamp.

When the coal has been cut, it is put upon wagons and brought to the bottom of the shaft. Here it is placed on a cage and pulled up to the pit's mouth. The amount of coal brought up varies in different mines, but is generally from 100 to 150 tons per hour.

Dangers in Coal-mining. During the period when the woody fibre of the trees and plants was fossilizing, or changing into coal, some of the carbon of the fibre united with hydrogen to form **Marsh Gas.** This is an inflammable gas, which, when united with air, becomes explosive. It occurs in all coal-mines, and often escapes with great violence during the working of coal-seams. It is the presence of this gas that sometimes causes terrible explosions in mines, and it is for this reason that miners carry safety lamps.[1]

Sometimes, too, **water** enters a mine, and the miners are in danger of being cut off from their comrades. A very exciting adventure of this kind is described in *Sans Famille*, by Hector Malot.

[1] Marsh gas is the 'Fire damp' of the miner. During an explosion a chemical change takes place, and large quantities of carbon dioxide are formed. This carbon dioxide is the 'choke damp' of the miner, and probably causes more deaths than the actual explosion.

THE COALFIELDS OF BRITAIN.

Name.	*Position.*	*Output (in tons)*
1. The Yorkshire coalfield.	Between Leeds and Derby, in Yorkshire, Derby, and Nottingham.	68 million.
2. The South Wales coalfield.	Between Pontypool and St. Bride's Bay, in Monmouth, Glamorgan, Carmarthen, Brecon, Pembroke.	50 million.
3. The Northumberland and Durham coalfield.	Between Warkworth and Darlington.	44 million.
4. The Scottish coalfields.	Chiefly in Lanark, Fife, Ayr, Stirling, Edinburgh, Linlithgow, Haddington.	35 million.
5. The Lancashire coalfield.	Between the Ribble and Dee in South Lancashire and Cheshire.	21 million.
6. The Staffordshire coalfields.	In North Staffordshire and South Staffordshire.	13 million
7. The Warwick coalfield.	In Warwickshire.	4 million.
8. The Leicester coalfield.	In Leicester.	3 million.
9. The North Wales coalfield.	In Denbigh and Flint.	3 million.
10. The Cumberland coalfield.	In the west of Cumberland.	2 million.
11. The Gloucester coalfields.	In the Forest of Dean and near Bristol.	1 million.
12. The Somerset coalfield.	In the west of Somerset.	1 million.
13. The Shropshire coalfield.	Near Coalbrookdale in the east of Shropshire.	782 thousand.
14. Kent.		158 thousand.
15. The Irish coalfields.	In Kilkenny, Queen's County, Tipperary, Roscommon.	82 thousand.

Different kinds of Coal. There are many varieties of coal, the three chief ones being: **1. Steam coal,** or **Welsh coal,** or **Anthracite** (from the Greek *anthrax*, charcoal). This is a very hard coal, containing only a small proportion of bitumen. It gives out great heat, and burns without smoke or flame. The ships of the navy are coaled with it, our supplies being obtained from the **South Wales Coalfield.**

2. Bituminous coal contains bitumen, or pitch, and is softer than anthracite, and lights more easily. It produces flame and smoke.

3. Brown coal, or **Lignite** (from the Latin *lignum,* wood), retains its woody texture and smell. It is of later formation than the other varieties of coal, and at present is chiefly useful for producing gas.

With regard to coal it is important to remember that a **definite quantity** of it exists, and that every ton we burn lessens that quantity. From time to time attempts have been made to estimate how much coal still remains in the kingdom. In 1905 a Final Report was issued by the Royal Commission on Coal Supplies. This is what they said : 'We have adopted 4,000 feet as the limit of practicable depth in working, and one foot as the minimum workable thickness and . . . we estimate the quantity of coal in the Proved Coalfields of the United Kingdom to be 100,914,668,167 tons.

Probable duration of our Coal Supplies. In 1913 the output of coal in the United Kingdom was 287 million tons. But from year to year the output varies, and the Commissioners say 'we hesitate to prophesy how long our coal resources are likely to last . . . we look forward to a time, not far distant, when the rate of increase of output will be slower, to be followed by a period of stationary output, and then a gradual decline '.[1]

POSSIBLE SUBSTITUTES.

1. Petroleum. It is possible to use this instead of coal for many purposes, see p. 264.

2. Water-Power. The only part of the United Kingdom in which we can look forward to a large development of water-power is Scotland, and even there only a few places are capable of developing powers of over 1,000 horse-power during the whole year.[2]

Tides. There remain the tides. The rise and fall of the sea all around our shores seems to offer an illimitable source of

[1] *Final Report of the Royal Commission on Coal Supplies.*

[2] 'The water power of the Dominions, especially of Canada and New Zealand, are great, and as they provide a cheap, convenient, cleanly, and inexhaustible form of energy, their potentialities in respect of industrial development are immense.'—*Dominions Royal Commission.*

power, but the cost involved in utilizing it renders it unavailable.

Finally the Commissioners say: 'We are convinced that coal is our only reliable source of power, and that there is no real substitute. There are, however, some possible sources of power which might slightly relieve the demand for coal.'

Reserves of Coal in the Empire. It is cheering to find that, in addition to our own still considerable reserves of coal, there are vast stores within the empire. At *Toronto*, in Canada, there was held recently an International Geological Congress to which was presented a *Report on the Coal Resources of the World.* This Report puts our reserves in Britain at a higher figure than that given by the Commissioners of 1905, and gives the following estimate for the Dominions:

	Million Tons.
Canada	408,323
Australia	2,253
New Zealand	985
Union of South Africa	55,322
Newfoundland	92

In addition to these actual reserves there are vast probable and possible reserves.

Canadian Coalfields.

1. Nova Scotia. (*a*) At the far eastern extremity of **Cape Breton Island,** stretching for miles under the Atlantic Ocean, is situated the chief colliery district of Nova Scotia. The collieries give employment to thousands of miners, and supply the iron and steel works of Sydney, which has risen from a small fishing village to a large and prosperous town. This is the coalfield nearest to England.

(*b*) On the mainland, along **Northumberland Strait,** in **Pictou** County, is a group of little mining towns. They are near the Transcontinental Railway which runs from Halifax to Montreal, and thence across Canada.

Half the coal in Canada is obtained from the collieries of Nova Scotia, and the coal is of excellent quality.

2. **British Columbia.** (*a*) The principal coalfields of British Columbia are on **Vancouver Island,** at **Nanaimo,** on the eastern coast, where there is a magnificent harbour, and excellent facilities for shipment. Nanaimo is opposite the town of Vancouver, the terminus of the Canadian Pacific Railway, and it is connected by rail with Victoria, the capital of British Columbia.

Sixty miles to the north of Nanaimo is Comox, where there are more coalfields.

(*b*) In **Queen Charlotte Islands** there are large deposits of very good coal. These are opposite the town of Prince Rupert, the terminus of the Grand Trunk Line.

(*c*) There are also enormous deposits of coal in the south-eastern extremity of British Columbia near the **Crow's Nest Pass.** A branch railway from the Canadian Pacific goes over this pass to Rossland in British Columbia.

3. **Alberta.** (*a*) There are important coal-mines at **Lethbridge,** and other places in the south of Alberta, on the branch line from the Canadian Pacific to the United States.

(*b*) On the Alberta side of the boundary by the Crow's Nest Pass.

'The coal deposits of **Canada** are enormous, amounting . . . to one-seventh of the world's known supplies, the estimate for Alberta alone being over a million million tons.

'A very large proportion of this great total, however, is **lignite,** or lignitic, and the amount of this quality now raised is the merest scratching of the surface of these deposits. . . . Careful thought and study and scientific research are being devoted to the ascertainment of the best means of utilizing this lignite for developing power and for domestic purposes.'[1]

Australian Coalfields.

New South Wales is the chief coal-producing state of Australia. The mines are situated up the Hunter River at **Maitland,** at **Newcastle** (where there is a large export trade, but where many of the collieries are nearly exhausted), at

[1] *Royal Commission on the Natural Resources of His Majesty's Dominions.*

Illawarra, about fifteen miles south of Newcastle, and at **Lithgow,** ninety-five miles from Sydney.

In **Queensland,** too, coal-mining is one of the most prosperous mining industries of the state. The chief mines are at **Ipswich, Maryborough, Rockhampton,** and on the Darling Downs.

Both **Victoria** and **Tasmania** have large deposits of brown coal, but at **Monthaggi,** in Gippsland (between the South Australian Alps and the sea), and near **Fingal,** in the eastern part of Tasmania, good bituminous coal is also mined.

Western Australia has a small deposit of coal at Collie, to the south-east of Perth.

'So far as it is possible to forecast the industrial conditions of the future, coal will remain in Australia in superabundant supply.'[1]

The **New Zealand** coalfields are chiefly in the South Island, at **Greymouth** and **Westport,** and in the valley of the **Clutha,** though there are also mines in the **Waikoto** Valley of the North Island. Though the supply is not abundant, the coal is of good quality, and the Westport mines are regularly used to supply the navy.

The South African Coalfields.

In the **Transvaal** the chief collieries are at **Middleburg,** to the east of Pretoria; and at **Boksburg,** to the east, and **Vereeniging,** to the south, of Johannesburg.

In **Natal** the mines are at **Dundee** and **Newcastle** to the west, and at **Utrecht** and **Vryheid** to the east, of the Buffalo River, and in the Valley of the **Klip** (a tributary of the Upper Vaal).

These two states are the main sources of supply in the Union of South Africa (though the Orange Free State has collieries at Heilbron, and there are also collieries at Molteno in the Cape of Good Hope), and besides supplying the needs of the home market they export a considerable amount to the east, and to South America.

The encouraging fact about the South African collieries is that the present output is 'utterly insignificant in comparison with

[1] Ibid.

the actual existing deposits. . . . An enormous proportion of this coal is, of course, at present inaccessible, but undoubtedly railways will be provided as soon as it becomes profitable to work the seams, and meanwhile it is obvious that one of the essential elements of industrial enterprise exists in abundance.'[1]

There are also deposits of coal in many parts of **Rhodesia,** the chief mines at present worked being at **Wankie,** to the north-west of Buluwayo.

Coal is also being mined in **Nigeria.**

In **India,** the principal coal-mines are in Western Bengal, in the **Damodar** Valley; and there are also mines in the **Narbada** and **Godavari** Valleys; in the hills of **Chutia Nagpur;** and in the north-east of **Assam.** The output compared with ours in Britain is **small,** but it has increased in recent years.

To sum up, then, Britain's stores of coal, though vast, are not inexhaustible; they are variously estimated as sufficient to last from three to five hundred years.

In substitutes for coal, such as petroleum and water-power, she is not rich; the idea of using the tides as a source of power is fascinating and a projeet is at present under the consideration of the Government.

In other parts of the empire there are immense deposits of coal, for the most part undeveloped, but representing a possibility of enormous economic power in the future; while Canada and New Zealand possess, in addition to coal, vast stores of potential energy in their unlimited supply of water-power.

CHAPTER XX

DYES

DYES (A.S. *deag*, colour). 'Fine linen with broidered work from Egypt was that which thou spreadest forth to be thy sail; blue and purple from the isles of Elishah was that which covered thee.'—Ezekiel xxvii. 7. 588 B.C.

[1] *Royal Commission on Natural Resources.*

These words occur in Ezekiel's Lamentation for Tyre, written about 588 years before the birth of Christ, and, together with very many other references to colours by ancient writers, testify to the antiquity of the art of dyeing.

Of all the ancient dyes, the **Tyrian purple** was the most famous ; it was adopted as the badge of royalty, and camels laden with it crossed the burning deserts of Asia to convey it to distant kings, while nearer home the costly treasure was carried in ships to the shores of the Mediterranean Sea.

It is believed to have been discovered by an inhabitant of Tyre 1,500 years B.C., and the Roman writer Pliny tells us how the dye was prepared. It was derived from a species of *murex*, a kind of *whelk*. A single drop of fluid was obtained from a sac in the throat of each animal, and this after a complicated process yielded the coveted dye.

Two other very ancient dyes are **Indigo** and **Madder.** From time immemorial the art of dyeing has been practised in India, and Persia, and China, and from these countries the dyes were brought by Arab merchants to Phoenicia and Egypt. Some of the mummy-cloths of the ancient Egyptians are embroidered with blue and red threads, and it has been ascertained that these dyes were obtained from the indigo and madder plants.

From Phoenicia and Egypt the art of dyeing spread to Greece and Rome, but we know little about the use of colour by the Greeks and Romans; and during the time of the barbarian invasions, from the fifth century onwards, men had little leisure to think about beautifying their surroundings, and the art of dyeing almost disappeared.

In the beginning of the thirteenth century, however, matters improved. The Venetians grew rich by the importation of eastern merchandise from Egypt, and in Venice and Florence the art of dyeing revived. It was a Venetian who later on in 1429 published the first European book on dyeing, and the Florentines by their trade in coloured cloths grew so rich

that they were enabled to erect those stately buildings which are still the admiration of the world.

From Italy, Germany, France, and Flanders learned the art, and in Edward III's reign a Guild of Dyers was formed in London, but it was not until the reign of James I that we began to practise the art to any considerable extent.

INDIGO. FINISHING STEEPING VAT

The dyes used were nearly all vegetable dyes, such as indigo and madder. It was not until the middle of the **nineteenth century** that **Coal Tar** dyes were discovered.

Since then their use has become more and more extended, so that most of the time-honoured vegetable dyes seem likely to be ousted altogether.

Some of them, however, still hold their own, and quite recently vegetable indigo has begun to win back some of its former renown.

Indigo (from Latin *Indicum*, indigo, from *Indicus*, Indian). Indigo is, therefore, the Indian dye.

The plant from which the blue colouring matter called indigo is obtained is a small shrub which grows between four and six feet high; its stem is about a quarter of an inch thick. It has slender spreading branches and its leaves resemble those of the acacia, that is to say, they consist of several leaflets arranged in opposite pairs along the leaf-

INDIGO. HAND BEATING

stalk. Its flowers are pinkish in colour, and they grow along a stalk just in the same way as the flowers of currant bushes do. The seeds are contained in dark-brown pods, eight or ten to a pod.

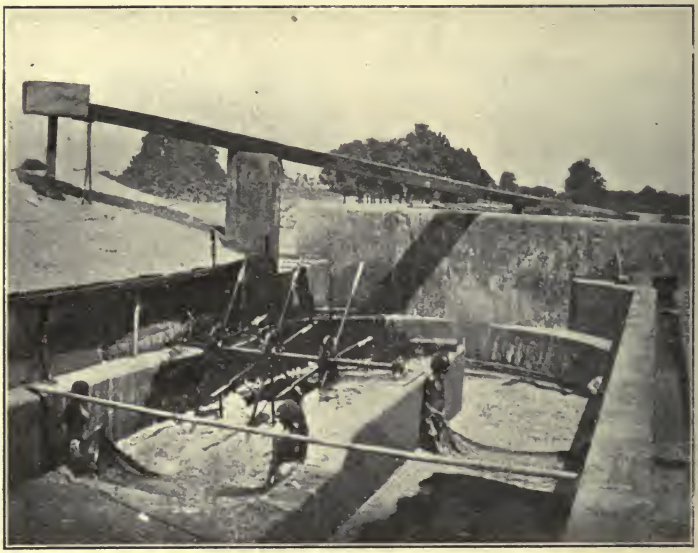
There is nothing at all in the appearance of the plant to suggest blue dye, yet on an indigo plantation in the manufacturing season everybody and everything is stained blue.

Though a shrub, the indigo plant is usually grown from seed every year, and before the seed is sown, the ground is very carefully prepared; after several ploughings, women and

children are finally sent into the fields to break up any lumps of earth which may still remain.

Sowing takes place just before the rainy season, in Bengal usually at the beginning of March, and by the middle of June, just before they begin to flower, the plants are ready to cut.

The stems quickly sprout up again after cutting, so that two and sometimes three harvests are obtained from the same



INDIGO. BEATING WHEEL

plant. Nevertheless, the indigo crop is a precarious one; too much or too little rain, or rain too soon after the seed is sown, will spoil the whole crop, and the sowing has to be done all over again.

As soon as the plants are cut, they are loaded up on carts and sent to the factory. 'At a moderate-sized factory some hundreds of cart-loads of plant are treated every day throughout the manufacturing season. The scene presented in the morning round the steeping vats, with long lines of

heavily laden bullock-carts slowly wending their way from various points towards the factory, is a busy and imposing one.'

The plants are stacked in the steeping vats in a more or less upright position, and the vats are then nearly filled with water. During the first hour or two nothing happens, for the indigo plant is covered with little hairs and so is not easily

CUTTING INDIGO INTO CAKES

wetted, but later on the water is seen to rise in the vat and the surface becomes covered with a thick foam.

After about ten hours the steeping is finished and the liquid is run off into the beating vats ; it is now of a bright orange colour, which, however, quickly changes to olive-green. When the beating is done by hand, as it still is in many parts of India, coolies armed with long sticks go into the vat and energetically beat the liquid.

When machinery is employed, in each vat three great wheels,

each bearing six spokes terminating in large flat blades, churn up the liquid for two or three hours, during which time its colour changes from green to dark blue.

The indigo in the water is now left to settle, after which the clear water is drawn off, and the colouring matter is taken to the boiling tank, where it is generally boiled for about a quarter of an hour, after which it is allowed to settle again; the clear water is once more drawn off and the remaining indigo-saturated liquid is strained, and filtered, and at last the pulpy mass of colouring matter is ready for pressing.

After this operation it is cut into cubes of about three inches deep; these little cubes are laid out on shelves in the drying-room; and after they have dried there for two or three months they are ready for market.

'Fowre things are required in Nil:[1] a pure graine, a violet colour, his glosse in the Sun, and that it be dry and light, so that swimming in water, or burning in the fire, is cast forth a pure light-violet vapour.'[2]

Woad (*Isatis tinctoria*). This plant, a biennial which grows about three feet high, was formerly extensively cultivated on account of the **blue dye** obtained from its leaves. It is the *vitrum*, mentioned by Caesar, with which the ancient Britons stained their bodies. Its flowers are yellow, and it forms curious large brown seed-pods, each about two inches wide and half an inch long.

Sir Arthur Young, in his *Agricultural Survey of Lincolnshire* (1799), gives a minute account of the preparation of the dye from the plant. The leaves were ground in a mill, and subsequently formed into balls, which were dried in the sun; inside they were of a violet colour.

For many years after woad ceased to be used as a dye by itself, it was used in combination with indigo, the colour

[1] From the Sanskrit *nila*, blue; whence the Arabic *al-nil* or *an-nil*, the indigo plant, and the Spanish *anil*.

[2] 'Observations of William Finch, Merchant, taken out of his large Journall, 1607' (*Purchas his Pilgrimes*).

thus produced being considered superior to that produced by either alone.

Woad (*Reseda luteola*). This is our own native plant which grows on the waste places of chalky or limestone soils. It has various names, such as Dyer's Rocket, Yellow Weed, Weld or Wold. It is very much like wild mignonette, but grows taller, sometimes attaining a height of three feet, and its spikes of flowers are longer and more slender. It yields a beautiful **yellow** dye which, when mixed with indigo, produces a fine green colour.

Cutch, or catechu, is a dry, brown substance obtained from the wood of the *Acacia catechu*, in India and Burmah. The wood is boiled in water, after which the water is evaporated and the cutch remains. The tannin it contains can be dissolved out with cold water and the dye separated from it.

It is still extensively used. It produces on cotton a cheap and very good fast **brown,** but the cotton is made somewhat harsh and the process is long; it is, therefore, used for dyeing awnings and for similar purposes where harshness of texture does not matter.

Madder (*Rubia tinctorum*). This is the plant whose roots yield the brilliant **red** colour known as Turkey red. It used to be extensively cultivated in the south of Europe, and afterwards in France and Holland, being after indigo the most important of the vegetable dyes. It is a bramble with rough leaves, and stems, and sharp prickles; it bears small yellow flowers and forms a black fruit. As a dye it has been superseded by **artificial alizarin.**

Logwood is the heart-wood of *Haematoxylon campeachianum*, a tree growing abundantly throughout Central America and the West Indies. It is a red, heavy wood, containing a yellow substance from which the colouring principle is subsequently obtained.

The dye is cheap, and produces fast **blues** and **blacks,** especially on silk and leather; it is likely to continue to be an important dye-stuff. The imported wood is called logwood because it is brought over in logs.

Persian Berries are the fruit of a tree called *Rhamus infectorius*. They are about the size of a pea, and a decoction of them yields a bright **yellow** dye.

Fustic is also a **yellow** dye. It is obtained from the wood of the *Morus tinctoria*, a species of mulberry tree growing in the West Indies.

Quercitron is the inner bark of the *Quercus tinctoria*, or Dyer's Oak, which grows abundantly in the forests of Eastern Canada and the United States. The bark yields a **yellow** dye.

Cochineal, or little berry, so called because for a long time it was believed to be the grain or seed of a plant, is an insect, having six minute legs, no wings, and a tiny head, in appearance very much like our ladybird.

These insects feed on the sap of a species of Mexican cactus to which they remain attached until brushed off by the collector. They are killed by being put into a bucket and then shut up in a great hot stove. The colouring matter, called **carmine,** is afterwards extracted from them by boiling them in water. It takes about 70,000 to produce a pound of dye. This carmine is often used for colouring sweetmeats, as it is not poisonous.

Cutch, Logwood, and **Fustic** are the only vegetable dyes which still maintain their position in the dyeing industry; the others tend more and more to be superseded by artificial preparations, though during the war indigo won back some of its former renown.

Coal-Tar Dyes. 'Without experiment I am nothing. Still try, for who knows what is possible?'—MICHAEL FARADAY (b. 1794, d. 1867).

During the Easter Vacation of 1856 Mr. W. H. Perkin, an assistant at the Royal College of Chemistry in London, was engaged in trying to make artificial quinine. He was eighteen years old. In the course of his experiments he produced 'a dirty black powder, which seemed to promise nothing', but 'he washed the deposit; he liquefied it, and the lovely colour **Mauve** was revealed to his almost bewildered gaze'.

The next year, with money lent to him by his father, who risked all his hard-earned capital in the enterprise, he set up works at Greenford Green, near Harrow, on the Grand Junction Canal, and here in company with his brothers he produced the new dye, which soon became the rage.

'As I look out of my window now,' remarks a writer of 1859, 'the apotheosis of Perkin's purple seems at hand: purple hands wave from open carriages, purple hands shake each other at street doors, purple hands threaten each other from opposite sides of the street; purple stripe gowns cram barouches, jam up cabs, throng steamers, fill railway stations, all flying countryward like so many migrating birds of paradise; purple ribbons fill the windows; purple gowns circle out at shop entrances; purple feather fans beckon to you in windows. We shall soon have purple omnibuses and purple houses; there is everywhere a glut of this white and violet which is a great deal more agreeable than perpetual partridge.' [1]

This was the beginning of the Coal-tar Colour Industry, for Perkin obtained his mauve from **Aniline,** and aniline is obtained from **Coal Tar.**

If we put some powdered coal into the bowl of a clay pipe, and seal it up so that no air can get to it, and then heat it, after a time gas issues from the other end of the pipe. This is the coal gas which we burn in our houses. In gas works, in the place of the bowl of a pipe great retorts are used which are heated by furnaces, and the gas which is obtained is stored in those enormous gasometers with which we are all familiar. But the gas which issues from the retorts is not pure, and, in order to purify it, it is passed into water contained in a great pipe called a hydraulic main.

Some of the impurities sink to the bottom of the main, and some pass on with the gas, which has to be subjected to other processes of purification before it is suitable for purposes of illumination. The impurities at the bottom of the hydraulic main form a thick, black, sticky substance, called **Coal Tar**.

[1] Quoted in Burnley's *Romance of Modern Industry.*

In early days this coal tar was a source of great annoyance to gas companies: they did not know how to get rid of it. We know now, and the enormous quantities we produce are one of our most precious sources of wealth.

When coal tar is subjected to dry distillation, i.e. put into a closed retort and heated, there issue from it vapours which, on being passed through a spiral pipe and cooled, condense into various kinds of **oils.**

The first oils which are condensed are called **light oils**; then, as the temperature of the retort is increased, various **heavy oils,** known as **carbolic** oils, and **creosote** oils, and **anthracene** oils are obtained.

On further distillation the light oils yield among other products **Benzene.**[1] It is a clear, colourless liquid, which, when acted upon by nitric acid, produces nitro-benzole, which again when treated with nascent hydrogen produces **Aniline,** a combination of carbon, hydrogen, and nitrogen.

Aniline [2] is itself a colourless, oily liquid, but, when acted upon by various other chemicals, it produces many compounds of beautiful colours, known as **aniline purple, aniline green, aniline magenta,** &c.

Aniline had been discovered in 1826 as a product of the dry distillation of indigo; it was called aniline from the Spanish *anil*, this being the name given by the Spaniards to the indigo plant of the West Indies.

But though aniline existed it was very rare and costly, and found only in a few scientific laboratories: it was only after Perkin discovered that it could be obtained from coal tar that its use became a commercial possibility, but from 1856 onwards its production has constantly increased, and aniline dyes have tended more and more to take the place of the older vegetable dyes.

When the Aniline Mauve was first introduced, the silk dyers [3]

[1] Benzine C_6H_6.

[2] Aniline C_6H_7N.

[3] Sir Robert Pullar on seeing the first specimen wrote: 'If it is possible to apply that in a practical way it should be a very valuable thing.'

adopted it at once, but it was not until the French had shown what beautiful patterns could be produced upon cotton fabrics by its use that English cotton-printers realized its value. After this its use spread very rapidly. There is an amusing story told of how a traveller wandering in the regions of North-West America came upon a party of native Indians dyed to a man from head to foot in Perkin's mauve !

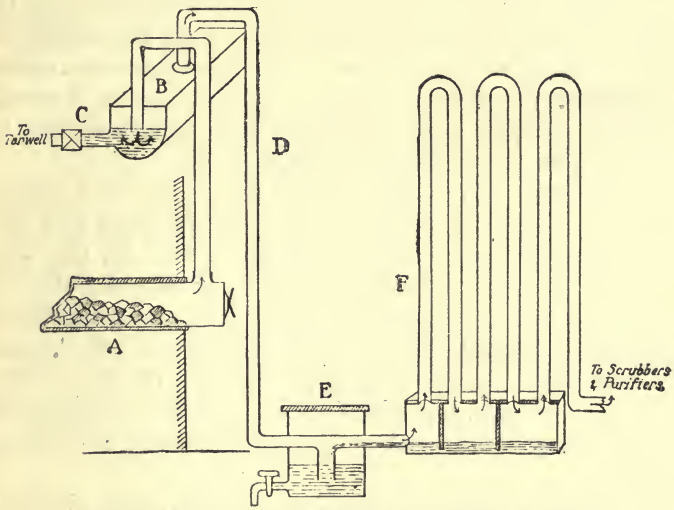


DIAGRAM OF A GAS-MANUFACTURING PLANT

A, retort in which coal is heated. B, the hydraulic main. C, outlet for the tar. D, gas pipe. E, tank in which the ammoniacal liquor collects. F, cooling pipes.

The next important discovery was made by Messrs. Graebe and Liebermann in 1868 and 1869, and independently by Perkin in 1869. Perkin found that **Alizarin,** the colouring principle of **Madder,** could be produced from **Anthracene,** another product of coal tar, and thenceforth this artificial madder ousted the natural dye.

In 1879 Professor Baeyer announced the chemical composition of *Indigo,* and in 1880 he found how it could be produced artificially, but it was too dear for general use.

Since then various methods have been tried, and at present *Indigo* is produced by a very complicated process in which naphthalene,[1] another coal-tar product, is the initial component.

It is now produced cheaply and in large quantities, and is a serious rival to natural or vegetable indigo.

ANALYSIS AND SYNTHESIS. **Water** is composed of hydrogen and oxygen. It can be separated into its component parts by passing steam over heated magnesium, when the **oxygen** of the steam joins with the magnesium to form magnesium oxide, and **hydrogen** is given off as a gas. In this case an **Analysis** of water has been made (Greek *analusis*, from *analuein*, to unloose, from *ana*, again, and *luein*, to loose).

On the other hand, when hydrogen is passed over copper oxide (i.e. copper and oxygen), the hydrogen joins with the oxygen to form water, and the copper is left. In this way water has been formed **synthetically,** by putting together its elements (Greek *sunthesis*, from *suntithenai*, to put together).

The whole history of the discovery of artificial dyes consists of these two processes; first, an analysis of the natural product, in order to find out of what elements it is composed, and then a synthesis of these elements, obtained from other sources.

There are at present about 700 *Synthetic* **Dyes,** obtained from **Coal-tar Products.**

Although the foundation of the coal-tar colour industry was laid by an Englishman, and although many subsequent discoveries were made by us, the bulk of the trade passed into German hands, so that in 1910 out of £20,000,000 worth of coal-tar dyes, three-quarters were produced in Germany.

During the war we have tried to remove this national disgrace, and to some extent have succeeded, although five years' strenuous effort has not been sufficient to make up for forty years of slackness.

[1] $C_{10} H_8$; it is a white solid, one of the products of the carbolic oils

CHAPTER XXI

PETROLEUM

PETROLEUM (Latin, *petra*, a rock; *oleum*, oil).

'Lord! Lord! this great airth holds a hundred things covered up for them as knows how to look, and do not mind digging. But, gentlemen, the greatest gift the airth has to bestow, she gave to me—abundant, spontaneous, etarnal free—and that is Ile! Ile!'[1]

This is what Gilead P. Beck said about petroleum, and we are told how, when he had made up his mind that oil existed in a certain district, in spite of ridicule from his neighbours, he went on boring and boring, until at last to his delight one day oil did indeed come welling up to the surface. He had 'struck ile!' This happened in the United States in the 'sixties.

But in many cases a great deal of valuable oil was wasted, because the finders had made no preparation for gathering it or storing it, and it went flowing away over the land to the nearest stream, and finally was lost in the sea.

Soon, however, they grew wiser, and the oil was put into barrels and carried away in carts to the nearest railway station, and then sent off by ordinary trains to its destination. Other improvements followed, and nowadays in oil districts the oil is made to flow from the wells into underground pipes, from which it is pumped into great storage tanks or into tank steamers.

Petroleum is a bituminous oil which oozes from hollows in sedimentary rocks such as sandstone. It is mainly composed of carbon and hydrogen, and is very inflammable. In colour it varies from pale yellow to almost black.

From very early days people knew about it; they found it floating on the surface of the water in wells or on ponds,

Walter Besant, *The Golden Butterfly.*

and they used it for a variety of purposes, but it is only in modern days that its use has become so extensive.[1]

The depth at which oil occurs varies ; in Ontario the wells are about 400 feet deep. Sometimes it comes up of its own accord, but more often it has to be pumped up. The oil thus obtained is **crude oil,** and before it can be used it has to be refined.

A large iron cylinder, called a still, is filled with oil and then heated. The vapour from the boiling oil passes through a long pipe which is kept immersed in cold water. In this pipe the vapour condenses into naphtha and refined oils of various kinds. These are further purified, and at last petroleum such as we know it is obtained. In the still there remains a residuum, which on being distilled yields oil and vaseline. Altogether during the process of refining about 200 useful by-products are obtained.

Petrol, such as is used in all kinds of motors, is a volatile spirit obtained from petroleum by distillation, and the amount required for this purpose alone is enormous and is continually increasing. In addition to this, experiments are constantly being made with oil as fuel instead of coal, and as a result of these experiments we shall in the future most certainly require larger and larger supplies of petroleum.

Far and away the largest producer at present is the **United States,** and next in order comes **Russia,** who possesses important wells at Baku on the Caspian Sea. Roumania and Galicia, too, have large oilfields, though small compared with those of the United States.

In our own empire, unfortunately, our supplies are altogether insufficient for our needs, but there are many promising fields for experiments and enterprise, and there is but

[1] 'Neere unto this Town (Baku), is a very strange and wonderfull Fountaine under ground, out of which there springeth and issueth a marvellous quantitie of blacke Oyle, which serveth all the parts of Persia to burne in their houses ; and they usually carrie it all over the Country, upon Kine and Asses, whereof you shall oftentimes meete three or foure hundred in company.'—John Cartwright, 1603 (*Purchas his Pilgrimes*).

little doubt that we shall greatly increase our output in the future.

India. One of our oldest oilfields is in the valley of the **Irrawaddy** in **Upper Burmah,** and there are also wells in the Punjab, and in Beluchistan and Assam.

Trinidad. Petroleum, exposed to the air, thickens, and becomes solid, or nearly solid ; it is then known as **asphalt,** and less correctly as pitch. The Asphalt Lake of Trinidad has long been famous, and immense quantities are taken from it every year. There is, however, no perceptible diminution, as new supplies continually rise from below. 'The very ship anchors in pitch ; the passengers disembark on a pitch wharf ; pitch lies heaped up everywhere ; in whatever direction the eyes are turned they light on nothing but pitch ; pitch, and the current market price of pitch, is the one burden of conversation.' 'The Lake is so solid that people can walk on it, and yet it is in a state of continual " boil ".'[1]

It was not until 1912, however, that Trinidad began to export petroleum. Mr. Algernon Aspinall[2] gives an interesting account of the difficulties and discomforts of the pioneer work in connexion with these oilfields. He tells how one day a hunter brought in a sample of oil, which he had found in the forest, but it was so pure in quality that the expert who examined it refused to believe the man's story, and considered that he was trying to palm off a specimen of refined oil as the crude product, and so nothing was done.

However, courageous and enterprising men persevered in their researches, and at last, on April 29, 1912, at Brighton, in the south of the island, the governor turned on a tap, and oil from the wells flowed through the pipe into a tank steamer which lay alongside the quay, and the next day she sailed away with her cargo.

Ever since that date petroleum has been regularly exported, and the quantity is steadily increasing.

[1] Meiklejohn, *A New Comparative Geography.*
[2] A. E. Aspinall, *The British West Indies.*

Egypt. One of the most interesting ' finds ' of oil of recent date is at **Jemsa,** at the southern extremity of the Gulf of **Suez,** and these fields, and others in that locality, are being energetically developed; and though it is early yet to say whether they will yield large supplies in the future, if they do their importance will be great, as they lie on the sea-route to India, and ships would be able to ' oil ' from them.

THE FIRST PETROLEUM WELL IN TRINIDAD

New Zealand produces some oil of very excellent quality, but the quantity at present is small. Papua, too, is believed to contain oil, but boring has not yet been begun.

There are extensive oilfields in the south-west of Ontario in Kent and Lambton counties, between Lakes Huron and Erie, but the yield from the wells is decreasing. In New Brunswick, too, a certain amount of oil is produced, and in Newfoundland, but these supplies are small in importance with those believed to exist in **Alberta,** in

the Athabasca Valley, and indeed in the **Mackenzie Basin** generally.

'Reference must be made to the indications that a mineral asset of the Mackenzie Basin, and one of enormous importance, is oil, for it appears from the evidence that here is one of the largest areas of oil-bearing country yet unexplored on the face of the earth. It is estimated that the rocks, the Devonian

OILFIELD IN TRINIDAD

strata, which are believed to be the source of this oil, cover an area of not less than 300,000 square miles.

'It is hardly possible to exaggerate the importance of this deposit, the exploitation of which cannot be long deferred, for the oil reserves of the United States are estimated by the United States Geological Survey to be sufficient at the present rate of output for about thirty years, and no other part of the North American Continent gives such promise of new oilfields as the Basin of the Mackenzie River.'[1]

Shale Oil or **Paraffin.** Shale is hardened clay, and when

[1] *Dominions Royal Commission.*

there is sufficient bitumen in it so that it will burn, it is called **bituminous shale.**

In addition to petroleum, obtained from wells, mineral oil identical with or at any rate very closely resembling well petroleum is obtained from bituminous shale, one ton of shale yielding on an average forty gallons of crude oil.

The shale is heated in a retort and bituminous vapour passes off. This is condensed, and an oily green liquid is obtained similar to crude petroleum.

In **Scotland,** chiefly in the counties of Lanark, Linlithgow, Edinburgh, and Fife, large quantities of oil are obtained from shale.

Considerable areas of bituminous shale are known to exist in South Africa, and in Newfoundland, and the eastern provinces of Canada, and also in Tasmania.

In view of the extreme importance to us of having within our own empire a sufficient supply of petroleum for all our varied and ever-increasing needs, it behoves us to make every effort to ascertain where oil-bearing lands exist and to develop them with all the energy and resources at our command.

SUMMARY. Our imports of ordinary petroleum (i.e. refined for burning in lamps and oil stoves), and also of fuel oil and lubricating oil, and of motor spirit, come mainly from the **United States,** Roumania, Russia, and Mexico; though the Dutch East Indies also send us large quantities of motor spirit, and crude petroleum comes chiefly from Mexico.

From our own possessions, too, we import crude petroleum and lubricating oils, while, in addition to these, Canada and the West Indies send us fuel oil, and India, the Straits Settlements, and the West Indies, motor spirit, but the quantities imported are at present small compared with those from other countries.

CHAPTER XXII

RUBBER

RUBBER (*Hevea brasiliensis*). We read that when Columbus was in Hayti he observed that the balls with which the children played bounced better than the windballs of the Spanish children at home, and it was found on inquiry that these West Indian balls were made of a substance which exuded from certain trees. They were in fact made of 'rubber', as ours are to-day, but rubber at that time had never been heard of in Europe, and the Spanish children had to be content with a very poor bounce to their balls.

In 1735, the distinguished French traveller, La Condamine, made a voyage to the Equator for the purpose of determining the dimensions of the earth. On his return he published an account of his ten years' journey, and among other marvels he described the rubber tree and its wonderful juice. The tree he called *He'vé*, and the solidified juice *Cahuchu*. These were both South American names. We called the solidified juice rubber, because it rubbed out pencil marks. Dr. Priestly discovered this in 1770, and one-inch cubes of rubber sold for 7*s*. 6*d*. each.

Gradually rubber was found to possess many other valuable qualities; for instance, that it was impermeable to water, and in 1823 Charles Macintosh made his famous waterproof cloaks of it. The material of which these 'macintoshes' were made was obtained by uniting two layers of cloth with a layer of rubber between them. As time went on other waterproof articles were made of it, and high hopes were entertained of its increasing usefulness.

There were, however, certain drawbacks. Things made of rubber were found to get soft and sticky in hot weather, and to become hard and brittle in cold weather.

Then followed other wonderful discoveries: it was found that **Rubber** mixed with a small quantity of **Sulphur,** and

subjected to a high degree of heat during the process, not only lost its stickiness, but was able to endure great extremes of heat and cold without deteriorating.[1]

As Vulcan was the god of fire, who presided over the working of metals, this process was called **Vulcanization.** The more sulphur added, the harder the rubber, and by adding a sufficiently large quantity a solid black substance is obtained, called **vulcanite** or ebonite. Vulcanized rubber, it was found, could be used for a very great many purposes, and from this time forward the demand for it increased enormously.

There are a great many different kinds of trees which produce rubber, altogether about a **hundred,** and they all grow in hot climates. The forests of the **Amazon Valley** and of the **Congo** were for a long time the chief sources of supply.

The methods of the native collectors were primitive and extremely wasteful. More often than not the trees were killed, and the collectors had to probe more and more deeply into the forests to obtain supplies. (Some of the South American rubber has to travel 3,000 miles before it is put on board ship, and it does not reach us till a year after it has been gathered.)

The very best rubber of all is obtained from the tree called *Hevea brasiliensis*. It grows in the Amazon forests, and is especially vigorous and abundant on the plateau between the **Tapajos** and **Madeira** Rivers in **Brazil.**

Sir Joseph Hooker, at that time Director of Kew Gardens, ardently desired to obtain some seeds of these trees, and to plant them in suitable regions of the empire, so that in course of time we might produce our own rubber.

It was a great idea, but almost insuperable difficulties stood in the way of its realization. To begin with, the seeds remain good only a short time after they fall from the tree (it is best to plant them within a week), and therefore it is not surprising

[1] By accident Charles Goodyear, who was experimenting in rubber, dropped some of it on a hot stove and found to his surprise that it did not melt.

to learn that great patience and perseverance were needed on the part of those who brought the seeds to England.

'The credit of initiating the cultivation of rubber in British territory belongs to the late Marquess of Salisbury, then Secretary of State for India. With the object of obtaining seeds or plants for the purpose of introducing the industry into India, Lord Salisbury communicated with Sir Joseph Hooker, the Director of Kew Gardens. . . . The British Government authorized the dispatch of an expedition to the Amazons to procure seeds and plants for cultivation in India, and in 1873 Mr. James Collins (afterwards Government Botanist at Singapore) went to Brazil and obtained some hundreds of seeds of Pará rubber. . . . From the seeds sent by him about a dozen plants were raised at Kew. Six were sent to Calcutta, but they died.'[1]

At last, in 1876, a commission was given by the authorities at Kew to Mr. Wickham for the 'introduction of the tree which produced the true **Para**[2] rubber of commerce'.

Mr. Wickham was himself at that time engaged in cultivating *Hevea brasiliensis* at Santarem, near the junction of the Tapajos and Amazon Rivers, and in his book (*On the Plantation, Cultivation, and Growing of Para Indian Rubber*) he gives a fascinating account of how he successfully overcame every difficulty that stood in his way.

All around were the great hot forests, and in them, growing in glorious profusion, were the wonderful Hevea trees. The season for the ripening of their seeds was drawing near, and if they were not gathered now a whole year must elapse before anything further could be done. But it was useless to gather them, for the problem still remained, how to convey them quickly to England.

Just at that time the S.S. *Amazonas*, the first of the new Inman Line of steamers, had come up the river, and Mr. Wickham and a few other planters were invited to dinner on board. They passed a pleasant evening and the steamer proceeded on her way up the river.

[1] C. Malcolm Cumming, *Rubber Planting in Malaya.*
[2] Pará is a state in Brazil, and one of its ports is also called Pará.

The season for gathering the seeds, meanwhile, came nearer and nearer, and the problem of transport still remained unsolved. And then came his chance. News was brought down the river that the captain of the *Amazonas* was left stranded with the ship on his hands, and no chance of a return cargo, the men who were in charge of these matters having stripped the ship, and then abandoned her.

Mr. Wickham boldly chartered the ship in the name of the Indian Government, and arranged to meet the captain on a certain day at the junction of the Tapajos and Amazon. He engaged as many Indians as he could get and crossed the river into the pathless forests between the Tapajos and Madeira. Here day by day they ranged the forests, filling up their baskets with as heavy loads as their backs would bear, and at the appointed hour he arrived with his precious burden.

To his unspeakable relief he found the ship awaiting him. The seeds were safely stowed on board, and for the moment all anxiety was over. The weather was fine, and they made their way down the river quickly.

But then occurred a new difficulty. How were they to avoid delay at Pará? In all probability they would be detained here while inquiries were made of the authorities at Rio as to whether the ship should be allowed to proceed on her journey, and by the time the necessary permission was obtained the seeds would be spoiled. However, thanks to the exertions of our Consul, matters were speedily arranged with the Portuguese authorities, and the good ship *Amazonas* steered out into the ocean.

June 14, 1876, must always be regarded as a red-letter day in the history of British commerce, for on that day the *Amazonas* arrived at **Liverpool** docks with her precious freight of **seven thousand rubber seeds.** From Kew Gardens a night train was sent to meet the ship, and a fortnight later in the glass-houses of Kew row upon row of young Hevea plants gladdened the eyes of their owners.

Not all of these plants lived, but 1,919 of them were sent to

Ceylon, and some few to **Perak** in the Malay Peninsula. Of those sent to Ceylon the greater number survived and flourished, while seven of the Perak ones were planted in the garden of the Residency at Kuala Kangsar. Later on plants were reared successfully at **Singapore.**[1] It is from these small beginnings that the present enormous production of British rubber has sprung.

Climate. *Hevea brasiliensis* requires both heat and moisture, but it does not as a rule do well in a swamp ; in the Tapajos Plateau, where it thrives abundantly, the soil is exceedingly well drained.

It will grow in suitable climates within latitudes 15° N. and 15° S. of the equator, but of all the places in which it is cultivated, the Malay Peninsula seems to present the most favourable conditions.

The Malay Peninsula. Here the climate is hot and damp, but moderated by sea-breezes, and there are no extremes of heat and cold, and no long dry or wet season ; the rain is abundant, but evenly distributed throughout the year.

Along the coast are extensive lowlands, but farther away from the sea the country is undulating. In the middle of the peninsula, stretching its whole length, are lofty mountains. The rubber plantations are on the lowlands and the undulating country. Much of this region was already under coffee, and in that case it was merely a question of planting rubber instead of coffee, but the greater part was primaeval forest, and this had to be cut down and burnt.

Cultivation. After the ground has been well prepared, the little seedling rubber trees are planted. As the object in growing a rubber tree is to obtain a tree with as big a trunk as possible, plenty of room must be left between each tree ;

[1] In his Annual Report for 1882 Sir Hugh Low, the British Resident in Perak, states that 'seeds and plants of *Hevea brasiliensis* have been distributed to Java and Singapore, to Ceylon and India'.

about fifty trees to one acre is generally considered to be the right number.

Tapping. When the tree is about four years old, tapping begins. An incision is made in the bark lengthways (A to B) and then two or three more on each side of the A–B line so that the result is a kind of herring-bone pattern.

TAPPING RUBBER TREES, latex cart on right.

The cutting must be done very carefully, for if too deep a cut is made it reaches the **Cambium** or **living layer,** and the tree is injured and perhaps killed.

A little tin cup is placed at the base of the tree, and the **Latex** (as the juice is called) flows out from the side-cuts into the vertical one, and then down into the gutter which leads to the cup at the base. A cart goes round and collects the latex from all the little cups and takes it to the factory.

A tapper usually has about three hundred trees placed under his care, and every morning at sunrise he goes round to them and cuts off a very, very thin slice from the upper edge of each of the side-cuts.

Manufacture of Rubber. On reaching the factory the latex is strained and poured into trays : a small amount of acetic

DRYING AND PACKING RUBBER

acid is added to it. After twelve hours or so it has curdled and become white and soft like cream cheese. It is next passed under rollers, which press it together and squeeze out the water; it emerges firm and elastic.

Drying is the next operation. The sheets of rubber are put into a shed full of the smoke from dried coco-nut husks. Rubber prepared in this way is called **Smoked Sheet Rubber.** It is dark in colour.

Often, however, the latex is curdled in large quantities and then passed under heavy rollers, which press it out into long

thin creped or crisped strips, which are dried without smoke in large well-ventilated rooms. It is **Amber** in colour and is called **Crepe Rubber.**

Ceylon also has large plantations, and the method of preparing the rubber is practically the same as in Malaya, though in both countries improvements in the methods of cultivation and manufacture are constantly being made.

Sources of Supply. Though the bulk of our supplies comes from **Malaya** and **Ceylon,** rubber is also exported to us from British India, the Gold Coast, Nigeria, and British Borneo, besides small quantities from other British countries.[1]

Doubtless in the future its cultivation will be greatly extended in other parts of the empire, especially in British Guiana,[2] where both climate and soil are almost exactly similar to the climate and soil of the Brazilian forests.

Uses of Rubber. It seems almost impossible to produce too much rubber, considering the great variety of uses to which it can be put. It is required for the great rubber tyres for motors of all kinds, and for the smaller tyres of other vehicles ; even perambulators nowadays have rubber tyres. Rubber-soled shoes of various kinds use up large quantities. It is used in electrical, and scientific, and medical, and surgical apparatus. In electrical appliances it is especially valuable, as it is a non-conductor of electricity. In the future it is most probable its use will be greatly extended ; floors will be covered with it, and footpaths paved with it.

Rubber Tree Oil. In addition to rubber produced from the juice of the tree, **Oil** produced from its **seeds** is a valuable product. It can be used in many cases instead of linseed oil.

Three seeds are contained in each pod, and in the Brazilian forests these are greedily devoured by all the animals who can secure them. On the plantations, as a result of numerous

[1] And we still import a good deal from Brazil.

[2] 'The *balata* collecting industry . . . is the third most important industry of British Guiana.'

experiments, **Oil Cake** for feeding cattle has been made from them.

We cannot help feeling a deep debt of gratitude to those who introduced the tree into our empire and enabled us to be self-supporting in such a valuable commodity.

CHAPTER XXIII

TIMBER

Canada has an area of more than three and a half million square miles, i.e. it is a little smaller than Europe and a little larger than the United States. Stretching right across the Continent for some three thousand miles, from the Atlantic to the Pacific, are the great forests, having a width from north to south of two hundred or three hundred miles. The trees in them are mostly **spruces** and **larches,** but, to the south of these conifers, in **Eastern Canada,** is a great belt of **deciduous trees,** containing many different species, one of the most characteristic being the sugar-maple, whose red and yellow leaves make the Canadian woods in autumn a wonderland of beauty. In **British Columbia,** on the western slopes of the mountains facing the sea, the moist, equable climate favours the growth of such giants as the **Douglas firs** and **cedars.**

The Commissioners say that these forests 'undoubtedly form one of the most valuable assets of the empire'. The number of acres covered with timber that can be sawn up and sold is estimated at 250 million, and besides this there are quantities which are useful for making wood-pulp and for providing fuel and for various other purposes. **Quebec** has 100 million acres of forest land, and next in order come **Ontario, British Columbia, New Brunswick, Nova Scotia,** and last of all Alberta, Saskatchewan, and Manitoba.

As one travels through these endless forests for weeks and weeks, and sees, day by day, countless thousands of beautiful trees, it is almost impossible to resist the conclusion that

here at least are inexhaustible supplies, and that man is too small a creature to make much impression on these mighty reserves of timber. And yet 'it has been estimated that, if the present cut of timber is maintained in Canada, the supply of saw timber will be exhausted in 120 years; but, if the rate of cutting increases, the supply may be exhausted in half that period. That the latter contingency is probable may be gauged from the fact that in spite of the large number of substitutes available, the demand for wood is continually growing.'

Until comparatively recent years no attempt was made to preserve this vast store of wealth, and not only ruthless felling but insect pests and forest fires were allowed to carry on their work of destruction unchecked. Now, however, forestry is becoming year by year a subject of greater importance among Government experts, and the best means of conserving the forests is a matter of continual study.

Newfoundland, too, has large areas of forest land and exports lumber, but during the last few years she has developed a very successful **wood-pulp paper** industry, one factory alone producing 200 tons of paper a day, besides having a considerable amount of wood-pulp for export, and it is believed that Newfoundland 'will become one of the most important contributors to the world's supply of wood-pulp and paper'.

In **Australia,** on the coastal highlands, there are extensive forests, and in **Tasmania** two-thirds of the island are forested. Some of the principal trees in Australia are **Ironbarks** and various kinds of **Eucalyptus,** of which the specially hard **Jarrah**[1] and **Karri** are characteristic of Western Australia.

New Zealand is famous for its **Kauri Pines,** which take from 600 to 1,200 years to reach maturity, and from which the wonderful kauri gum is obtained (practically a monopoly of New Zealand), and there are many other valuable forest trees; but here, as in other parts of the empire, reckless felling has been the rule in the past, and the Royal Commission on

[1] We import some of this for sleepers.

Forestry says: 'It is at best a guess, and no one can truly say whether the amount be too much or too little. Our opinion is that it is not safe to conclude that there will be any supply of moment at the expiration of thirty years from the present time (1913), and that unless more stringent methods are adopted to conserve the supply as far as possible, the period of supply may be even shortened.'

FOREST SCENE, BRITISH COLUMBIA

The forests of **India,** too, are exceedingly valuable, especially those of **Burmah,** whence the bulk of the world's requirements of **teak** are supplied.

SUMMARY. Although the forests of Canada and Newfoundland are so extensive, the bulk of our imported wood (with the exception of teak and mahogany) comes from foreign countries.

With regard to all kinds of **firs** and **pines, Russia** stands head and shoulders above all other contributors, though we

buy considerable quantities from Germany and the United States, Sweden and Norway, and smaller amounts from Canada, Newfoundland, and New Zealand.

In addition to our ordinary imports we buy $3\frac{3}{4}$ million tons per annum of wood for **pit-props,** and for this we are dependent to the extent of 80 per cent. of our requirements on foreign countries. **Russia** again is our chief source of supply, though France, Sweden and Norway, Spain and Portugal send us considerable quantities.

During the war, as a result of investigation, it was found that Newfoundland and the maritime provinces of Eastern Canada had almost inexhaustible stores of wood suitable for these props, and as a result a certain amount has recently been bought from these countries.

With regard to wood-pulp the truth appears to be that the actual production in Canada and Newfoundland is in excess of our needs, but the bulk of the Canadian produce goes to the United States, and we import our supplies mainly from Norway, though Sweden, Canada, and Newfoundland also contribute to our needs.

Teak comes to us chiefly from **Burmah,** and **mahogany** from **French West Africa,** the **Gold Coast, Nigeria,** and **British Honduras.**

CHAPTER XXIV

CONCLUSION

Some facts emerge. According to the present state of our knowledge it appears that of some commodities we are able to produce enough to satisfy the needs of all the inhabitants of the empire (some 445 million souls) without having to buy from other countries; that is to say, we are (or could be if we chose) self-supporting. Not only so, but in many cases we have enough and to spare, so that, after providing for our own needs, we have a surplus which we can sell to other countries; of some again we have practically a monopoly.

There is a second class of commodities, however, in which we are at present not self-supporting, and still another in which we are entirely dependent for supplies on other countries, as our own empire is deficient in them.

In the first class, that is, commodities in which the empire is **self-supporting,** we must place, among minerals, asbestos, chromium, coal, cobalt, gold, graphite, manganese, mica, monazite sand, nickel, tin, tungsten, zinc. With regard to nickel, cobalt, asbestos, and mica, not only are we self-supporting, but we produce the bulk of the world's output of these, while with regard to tin 'foreign countries are dependent on the empire to the extent of nearly 60 per cent. of their total supplies', and with regard to gold the 'empire produces over 60 per cent. of the world's output'.

Among food products, empire production is equal, or nearly equal, to empire demands in the case of fish, spices, oil-seeds, cheese, and wheat.

Our fisheries are an invaluable asset, for not only are we able to produce enough for our own consumption, but we are able to export large quantities to other countries.

The empire, too, is very rich in spices, especially cinnamon, ginger, allspice, and cloves, producing indeed of these last the greater part of the world's supply.

In oils and oil-seeds also we are very rich. West Africa has a practical monopoly of palm oil and palm kernels, while India and Ceylon export enormous quantities of copra, linseed, castor seeds, cotton seeds, rape seeds, and sesame. In addition to these, ground-nuts from West Africa and India have become increasingly important during the war; and though at present olive oil and almond oil are not produced in sufficient quantities to supply our needs, yet even of these there are hopeful indications of a much greater production in the future than in the past, while there are very many other oil-seeds at present but little known, such as shea nuts, cashew nuts, and mowra seeds, to name only a few, which the empire is capable of producing in very large quantities.

Canada is at present the chief cheese-exporting country in the empire, but the production of New Zealand is very considerable and is increasing, while in all probability South Africa will in a few years time be in a position to export supplies and thus render the empire more than self-supporting in this respect.

The case of wheat is more complicated. The United Kingdom does not at present produce more than one-fifth of the wheat she consumes; the empire, however, as a whole produces 95 per cent. of the amount required by the empire, but much of this is sold to other countries.

We come next to fibres, and we find that in the case of wool the empire produces more than 40 per cent. of the whole world's consumption, while of jute and phormium tenax she possesses a monopoly.

With regard to rubber, although we still import a certain amount of wild rubber from Brazil, what is called plantation rubber is practically an empire monopoly, Malaya and Ceylon supplying the bulk of the world's needs, though these are 'merely the big brothers of the tropical family under the British flag which has gone in for rubber. From Papua and North Queensland to British Guiana and Tobago, the world is encircled by a rubber band of British make.'

Two other virtual monopolies of the empire are diamonds and ostrich feathers, both products of South Africa.

In the **second** class, that is, those commodities in which at present we are **not self-supporting,** we must place, among minerals, aluminium, antimony, copper, iron, and lead. With regard to antimony it appears that it might be possible to make the empire self-supporting, and with regard to iron, although at present the amount of pig-iron produced in the empire is only sufficient to satisfy her requirements to the extent of 58 per cent., yet the amount of iron ore known to exist in empire countries is enormous, and 'more than enough to satisfy the demand for many years to come'; while with regard to lead, the mines of Burma are expected to make up our deficiencies.

Among the food products which come in this second class we must put meat, oats, barley, maize, fruits, tea, coffee, cocoa, sugar, butter, eggs.

The position with regard to meat appears to be that in the United Kingdom we produce about 60 per cent. of our requirements, and the rest we have to import. New Zealand sends us large quantities of mutton, and Australia both of mutton and beef, yet we are largely dependent on foreign countries for our supplies: on the Argentine for beef and mutton, on the Netherlands and Denmark for pork and bacon, and on the United States for hams. Nevertheless, there seems every reason to hope that in the future conditions may be improved, and that not only Australia and New Zealand, but Canada, South Africa, Rhodesia, and the Sudan may multiply their flocks and herds and eventually render the empire self-supporting.

The empire has made enormous strides of late years in the growing of all kinds of fruit, most notably of bananas in Jamaica, apples in Canada, oranges and other citrus fruits in South Africa, Australia, and New Zealand, grapes, both fresh and in the form of raisins and currants, in Australia, and dried plums and many other kinds of fruit in South Africa.

With regard to butter the Commissioners say: 'On the whole it seems doubtful whether the supplies of butter of empire production available for consumption in the United Kingdom could be made to exceed 4½ million hundredweights at the utmost. If the consumption remains at about 6½ million hundredweights, the deficiency to be supplied from foreign countries would be about 2 million hundredweights. The deficiency could undoubtedly be met by an increasing production of margarine, the materials for which exist in adequate quantities within the empire.'

The case of sugar is notorious. Before the war our imports consisted chiefly of beet-sugar from Germany; out of a total of 23 million pounds' worth, only 1 million pounds' worth came from British countries. Yet the West Indies, Mauritius,

British Guiana, and India are capable of supplying all our needs as far as cane sugar is concerned; and with regard to beetroot, we can grow a good deal at home, while Canada can produce both beet- and maple-sugar.

Of fibres, we are poor at present in cotton, flax, and silk. Of cotton, omitting the Indian crop, which is at present not suitable for fine spinning, the empire produces only about 39 per cent. of the requirements of the United Kingdom, but great efforts are being made to increase the production in British countries (especially by the British Cotton Growing Association), and besides such well-known sources of supply as Egypt, and India, and in a less degree West Africa, the Sudan, West Indies, Nyasaland, Uganda, and Kenya Colony, great hopes are entertained that a satisfactory picker may be invented, so that Queensland may enter the lists as a cotton-producer on a large scale.

Cotton growing is making good progress in the Tana River Valley, which is very suitable for its extensive development. The rich alluvial lands adjoining the Juba River are also splendidly adapted for cotton growing, and a Government experimental cotton farm has been started there.'

Flax and silk, too, though not at present produced in sufficient quantities to make us independent of foreign supplies, yet show signs of improvement and afford hopes of increasing British supplies in the future.

There remains the **third** class of commodities, namely, those which we do **not produce** within the empire. The most important of these are quicksilver, platinum, borax, and potash.

In connexion with this question of production we must remember that the empire comprises an area of 13,153,712 square miles, and that it contains within it every kind of soil and extends through every zone of climate, and that in consequence there is scarcely a commodity which it is not capable of producing in great abundance. It behoves us, therefore, in the case of those commodities in which at present

we are not self-supporting, to ascertain in which parts of the empire soil and climate are suitable for their production, and then to encourage their cultivation in these places. Rubber, and cotton, and chinchona are notable examples of what may be accomplished in this direction.

Minerals of course are more difficult. If supplies of ore do not exist, no amount of endeavour on our part will create them. Yet in this connexion it must be noted that the resources of the empire are but very imperfectly known, and it may very well turn out to be the case that more minerals exist than we are aware of.

In respect of those commodities of which we possess an abundance, such, for instance, as coal and fish and timber, it behoves us to husband our resources instead of squandering them recklessly as though they were inexhaustible.

By these means we could realize our ideal and become a self-supporting empire, so that when the necessity arose we could be independent of supplies from foreign countries, and at other times could command the respect due to those who are under no obligation to court the favour of more fortunate neighbours.

The Commissioners say: 'In our opinion it is vital that the empire should, so far as possible, be placed in a position which would enable it to resist any pressure which a foreign power or group of powers could exercise in time of peace or during war, in virtue of a control of raw materials and commodities essential for the safety and well-being of the empire, and it is towards the attainment of this object that co-ordinated effort should be directed.'

APPENDIX II

IMPORTS OF RAW COTTON

	1913 *Centals of* 100 lb.	1914 *Centals of* 100 lb.	1915 *Centals of* 100 lb.	1916 *Centals of* 100 lb.	1917 *Centals of* 100 lb.
Germany . .	11,721	52,225	—	—	—
German East Africa .	2,099	1,092	7	—	—
Belgium . .	1,198	5,637	—	—	—
France . .	15,633	49,786	4,771	2,841	829
Portuguese East Africa . .	25,872	7,566	2,146	5,309	2,791
Italy . .	8,718	3,627	—	—	8,180
Turkey . .	8,615	4,115	—	—	—
Egypt . .	4,026,694	3,361,021	—	—	—
China (exclusive of Hong Kong, Macao, and leased territories) . .	19,828	37,498	50,065	124,389	148,223
United States of America .	15,847,695	12,844,347	20,223,859	16,468,638	11,862,413
Hayti . .	31,225	17,735	14,268	8,510	5,892
San Domingo .	3,108	2,542	—	224	58
Peru . .	384,060	370,466	384,120	445,804	235,965
Chile . .	2,738	2,671	4,508	3,223	1,533
Brazil . .	618,036	547,474	86,724	13,055	102,903
Other Foreign Countries .	16,606	55,022	36,499	81,122	95,591
Total from Foreign Countries	21,023,846	17,362,824	20,806,967	17,153,115	12,464,378
Egypt . .	—	—	4,484,908	3,567,360	2,779,301
British West Africa . .	61,614	55,476	22,913	64,005	50,273
Kenya Colony .	111,667	127,922	120,423	59,380	132,994
Anglo-Egyptian Sudan . .	—	21,683	55,045	28,881	31,664
British India .	513,039	1,042,902	939,626	800,614	759,628
British West India Islands.	29,888	29,031	20,123	15,863	11,362
Other British Possessions .	2,942	1,495	26,156	20,804	2,113
Total British Possessions .	719,150	1,278,509	5,669,194	4,556,907	3,767,335
Total .	21,742,996	18,641,333	26,476,161	21,710,022	16,231,713

APPENDIX III

THE BRITISH EMPIRE

	Area. (Square Miles).	*Population.*
Europe :		
United Kingdom	121,030	45,500,000
Isle of Man	230	50,000
Channel Islands	70	97,000
Malta and Gozo	120	211,000
Gibraltar	2	20,000
Asia :		
Indian Empire	1,900,000	315,000,000
Ceylon	25,500	4,100,000
Straits Settlements	1,660	700,000
Federated Malay States	27,500	1,000,000
Other Malay States	24,800	800,000
Hong Kong	390	440,000
Weihaiwei	300	160,000
North Borneo	31,100	204,000
Brunei	4,000	30,000
Sarawak	50,000	650,000
Cyprus	3,600	275,000
Africa :		
Cape Province	277,000	5,100,000
Natal	35,400	
Transvaal	110,400	
Orange Free State	50,400	
South West Province	322,350	120,000
Basutoland	10,300	350,000
Bechuanaland	275,000	126,000
Rhodesia	450,000	1,750,000
Gambia	4,000	146,000
Gold Coast	80,000	1,400,000
Sierra Leone	34,000	1,100,000
Northern Nigeria	255,700	10,000,000
Southern Nigeria	78,000	7,000,000
'German' West Africa	333,000	4,500,000
Somaliland	68,000	300,000
Kenya Colony	566,000	12,000,000
Uganda	223,500	2,500,000
Zanzibar	1,020	200,000
Nyasaland	300,000	1,000,000
Egypt	400,000	12,000,000
Sudan	1,000,000	2,000,000
Mauritius	720	370,000
Seychelles	150	23,000
Ascension	40	152
St. Helena	47	3,500

	Area. (*Square Miles.*)	*Population.*
America :		
Ontario	407,250	7,200,000
Quebec	706,850	
Nova Scotia	21,500	
New Brunswick	28,000	
Prince Edward Island	2,200	
British Columbia	355,900	
Manitoba	251,900	
Alberta	255,300	
Saskatchewan	251,700	
North West Territories	1,250,000	
Newfoundland	40,000	240,000
Jamaica	4,200	850,000
Bahamas	4,400	56,000
Leeward Islands	750	140,000
Windward Islands	510	200,000
Barbados	170	196,000
Trinidad and Tobago	1,860	330,000
British Guiana	90,300	310,000
British Honduras	8,600	40,500
Bermuda	20	19,000
Falkland Islands	6,500	3,240
South Georgia	1,000	—
Australasia :		
New South Wales	310,400	1,650,000
Victoria	88,000	1,320,000
South Australia	904,000	409,000
Queensland	670,500	606,000
Tasmania	26,220	191,000
Western Australia	976,000	282,000
New Zealand	105,000	1,050,000
Fiji	7,500	130,000
Papua	90,540	360,000
Pacific Islands	12,500	200,000

APPENDIX IV

NOTES ON THE FORMER GERMAN COLONIES

1. Tanganyika Territory now forms one of the nine administrative districts of the East Africa Protectorate. Some of its most important products are sisal, copra, ground-nuts, rubber, cotton, coffee, sesame seed, millet, maize, rice.

2. German South-West Africa is now governed by the Union of South Africa. Its chief products are diamonds, wool, meat, hides, ostrich feathers, copper.

3. Kaiser Wilhelm's Land (the north-east part of New Guinea) belongs to the Commonwealth of Australia. Its chief products are copra, sisal, rubber, petroleum, tobacco.

4. Samoan Islands. Eight of these have been allocated to New Zealand. Products: copra, cacao, rubber.

AUTHORITIES AND BOOKS OF REFERENCE

Government Reports. Printed by Wyman & Sons, London.

1. Annual Statement of the Trade of the United Kingdom.
2. Statistical Abstract for the United Kingdom.
3. Statistical Abstract for the Self-Governing Dominions.
4. Final Report of the Royal Commission on the Natural Resources, Trade, and Legislation of certain Portions of His Majesty's Dominions.
5. Final Report of the Royal Commission on Coal Supplies.
6 Mines and Quarries : General Report with Statistics.

Imperial Institute Bulletin. Published quarterly.

Imperial Institute Series of Handbooks to the Commercial Resources of the Tropics, with special reference to West Africa.

Geographical Journal. Published monthly.

The Statesman's Year-Book.

Encyclopaedias. Chambers and others.

Handbook for Australia. B.A.A.S.

Our First Half-Century. By authority of the Queensland Government.

Pamphlets on Rubber, &c., issued by the Malay States Agency.

The British West Indies. A. E. Aspinall.

Provincial Geographies of India. Bengal, by L. S. S. O'Malley.

Marketable Marine Fishes. J. T. Cunningham.

Medicinal Plants. Bentley and Trimen.

Pamphlets on Medicinal Herbs. M. Grieve.

Tropical Agriculture. P. L. Simmonds.

A Handbook of Tropical Gardening. H. F. Macmillan.

Origin of Cultivated Plants. A. de Candolle.

A Dictionary of the Economic Products of India. Sir G. Watt.

Peruvian Bark. Sir Clements Markham.

On the Plantation, Cultivation, and Curing of Indian Rubber. H. A. Wickham.

The Oil Palm and its Varieties. J. H. J. Farquhar.

The Banana : its Cultivation, Distribution, and Commercial Uses. W. Fawcett.

A Short History of Sugar. G. Martineau.

The Cane Sugar Factory. F. I. Scard.

Tea. D. Crole.

Golden Tips. H. W. Cave.

Wild and Cultivated Cotton Plants of the World. Watt.

Modern Flax and Hemp and Jute Spinning. H. R. Carter.

Jute and Linen Weaving. Woodhouse and Milne.
The Treasures of Coal Tar. A. Findlay.
Coal and what we get from it. R. Meldola.
Dye-stuffs and Coal-Tar Products. Beacall, Challenger, Martin.
Jubilee of the Discovery of Mauve. R. Meldola.
The Romance of Modern Industry. J. Burnley.
Industrial History of England. H. de B. Gibbins.
Mines and their Story. Bernard Mannix.

INDEX

[1] *Britain* is equivalent to the *United Kingdom.*

PRINTED IN ENGLAND

AT THE OXFORD UNIVERSITY PRESS

GEOGRAPHICAL BOOKS

The Oxford Geographies

October 1920

Designed and in large measure produced by Professor and Mrs. HERBERTSON, whose great services to the teaching of Geography were terminated by their deaths in 1915, these books came rapidly into use. The earlier books have passed through several editions, and the constant reprinting has given abundant opportunity for revision by the authors while living, and subsequently by Mr. O. J. R. HOWARTH, Assistant Secretary of the British Association and author of two of the series In particular, many of the diagrams have been renewed and improved in 1916, 1917, 1918.

The Elementary Geographies

By F. D. HERBERTSON

In seven volumes

1 Physiography. Pp. 96, with twenty-three illustrations. 2s.
2 In and About our Islands. Pp. 112, with twenty-three illustrations and three maps. 2s. 6d.
3 Europe, excluding the British Isles. Pp. 112, with twenty-nine illustrations and maps. 2s. 6d.
4 Asia. Pp. 128 with thirty-six illustrations and two maps. 2s. 6d.
5. North and Central America and the West Indies. Pp. 152, with twenty-three illustrations and four coloured maps. 2s 6d.
6. The Three Southern Continents (Africa, Australia, New Zealand, and South America). Pp. 186, with fifty-seven illustrations and four coloured maps. 3s.
7. The British Isles. Pp. 192, with forty-one illustrations and thirty-two maps. 3s.
8. Britain Overseas, by ELEANOR K. HOWARTH. Pp. 160, with twenty-four illustrations. 3s.

The Clarendon Geography

By F. D. HERBERTSON

2 vols. 4s. each or 6 parts 2s. each

1 Principles. Pp. 112, with fifty-nine maps and illustrations.
2 British Isles. Pp. 140, with forty-seven maps and illustrations.
3 Europe. Pp. 128, with thirty-one maps and illustrations.
4 Asia. Pp. 120, with thirty three maps and illustrations.
5 Africa and Australia. Pp. 112, with thirty-one maps, &c.
6 America. Pp. 144, with thirty-eight maps and illustrations.

Preliminary, Junior, Senior

By A. J. HERBERTSON

Revised 1916–18

The Preliminary Geography. Pp. viii + 152, with examination questions and 72 illustrations. 2s.

The Junior Geography. Pp. 288, with 166 maps and diagrams. 3s.

With Principles of Geography (Clarendon Geography, Part I). Pp. 288 + 112. 4s.

With Questions and Statistical Appendix. Pp. 288 + 28 + 64. 3s. 6d.

With Principles, Questions, and Statistical Appendix. 4s. 6d.

With Physiographical Introduction. Pp. 288 + 128. 4s.

With Physiographical Introduction and Statistical Appendix. Pp 288 + 128 + 64. 4s. 6d.

The Senior Geography, by A. J. HERBERTSON and F. D. HERBERTSON. Pp. 372, with 117 maps and diagrams. 3s. 6d.

With Questions and Statistical Appendix. Pp. 372 + 64. 4s.

With Physiographical Introduction. Pp. 372 + 128. 4s. 6d.

With Physiographical Introduction, Questions, and Statistical Appendix. Pp. 372 + 128 + 64. 5s.

Physiographical Introduction, revised by O. J. R. HOWARTH. Pp. 128, with 70 maps and diagrams. 2s.

Questions, by F. M. KIRK, and Statistical Appendix by E. G. R. TAYLOR, revised by E. K. HOWARTH. To the Junior Geography, 1s. 6d. To the Senior Geography, 1s. 6d.

The Prices are net

Pi ountry, by
Ui p. 124, with
ma 2s. 6d. net.
tw by A. J.
Co MPSON, and
W . 256, with
19
sta
Th Discovery,
M. . Pp. 318,
115 . 3s. 6d. n.
Pla additional
to 1. net each.
six alasia, by
. 2, 1918.
An s and 242
NEV
illus
Sco I TAYLOR.
Pp. vith fifty-
2s. 6 net.
Irel aphic and
1911 GRIFFITH
illus Pp. 266,
5d. net.

Sch Modern
tical 914, by
With d J. G.
forty nty-nine
(11 × teen half
cloth all ; with
The ory text.
and 6d. net.
series dited by
MEW. s at the
(letter by W.
of col al quarto
Desig , 182 pp.
of ad 36s. 6d.
also a al Cata-
contai ch map,
than
11,000
of ma Geo-
with t EW and
ages of
A Sch pages.
B. V. net.
4to (10
and six pages of index. Cloth limp, 1s. 6d. net.

Atlas Notes, by J. C. CHUTE. Second edition revised, 1913. 8vo ($8 \times 5\frac{1}{2}$), pp. 82. 1s. 9d. net.

School Economic Atlas, by J. G. BARTHOLOMEW and L. W. LYDE. Revised 1912. Containing over 180 maps and diagrams, with twelve pages of introduction. Demy 4to ($11\frac{1}{4} \times 9\frac{1}{4}$). 5s. 6d. net.

The Oxford Survey of the British Empire

being a description of the Empire and its constituent territories, in their geographical, economic, administrative, and social aspects. Edited by A. J. HERBERTSON and O. J. R. HOWARTH, in collaboration with seventy-three contributors. Pp. 3198, with 210 photographs, 27 coloured maps, 193 figures in the text, full indexes, &c. In six volumes. 8vo (9 × 6), cloth gilt, 60s. net; or separately, 15s. net per volume. On Oxford India paper, in three double volumes, leather back, 90s. net.

Vol. I. British Isles, &c.
Vol. II. Asia.
Vol. III. Africa.
Vol. IV. America.
Vol. V. Australia.
Vol. VI. General Survey.

Regions of the World

Edited by H. J. MACKINDER. 8vo ($9\frac{1}{2} \times 6\frac{1}{2}$), with maps by Bartholomew and many illustrations in the text. Six volumes.

Britain and the British Seas, by H. J. MACKIN[illegible] With six coloured maps an[illegible]
Pp. xii +[illegible]

Central [illegible] the Gern[illegible] coloured [illegible] and diag[illegible] net.

Nearer [illegible] With six[illegible] four map[illegible] 296. 8s.

North America, by I. RUSSELL. With seven coloured maps and

An [illegible]

Originall[illegible] seven vol[illegible]
For fuller[illegible]

Recent Books

Map Work. By V. SEYMOUR BRYANT and T. H. HUGHES. 1918. ($9\frac{1}{4} \times 7$), pp. 174, with ninety illustrations. 5s. net.

'An excellent book, written by two experts on the subject . . . for fullness of detail nothing has been published equal to this volume.'—*Scottish Geographical Magazine.*

Frontiers, a Study in Political Geography, by C. B. FAWCETT. 1918. Pp. 108, with five diagrams. 3s. 6d. net.

'This able and suggestive little book is a good introduction to the study of a most difficult subject.'—*Spectator.*

Ireland the Outpost, by GRENVILLE A. J. COLE. 1919. Pp. 78, with eight illustrations from photographs by the author, and four maps. 3s. 6d. net.

The Foundations of Geography in the Twentieth Century, by FRANZ SCHRADER. The Herbertson Memorial Lecture, 1919. Pp. 26. 2s. 6d. net.