

THE CATEGORIES OF PLANT PRODUCTS WHICH

DIRECTLY AFFECT HUMAN LIFE.

by

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Contents

	<u>Page</u>
Introduction	3
I. <u>PLANT PRODUCTS USED AS FOOD FOR MAN</u> ..	10
Grasses	11
Cereals of Temperate Countries	12
Cereals of Tropical Countries	16
Tuberous Plants of a Starchy Nature ..	21
Legumes	24
Table Vegetables of the Temperate Regions, other than Legumes.	27
Sugar Beet	30
Fruit	32
Fruits of Temperate Countries	33
Fruits of Warm Countries	34
Plants Supplying Non-Alcoholic Beverages..	38
The Food Requirements of Man	44
II. <u>PLANT PRODUCTS, OTHER THAN FOODSTUFFS, EMPLOYED IN INDUSTRY.</u>	48
Fibres	49
Wood	54
Cork	57
Elastic Gums	58
Gums, Gum Resins and Resins	61
Oils	63
Fixed Oils	64
Essential Oils	68
Dyes and Tans	69

Contents (contd.)

Page

III. <u>PLANT PRODUCTS USED AS MEDICINALS AND DRUGS.</u>	73
Cinchona Bark	76
Coca	76
Opium	77
Belladonna	78
Miscellaneous Alkaloidal Drugs ..	78
Digitalis	79
Chaulmoogra Oil	79
Miscellaneous Non-Alkaloidal Medicinals	80
IV. <u>PLANT PRODUCTS EMPLOYED MAINLY FOR HEDONISTIC REASONS.</u>	81
Decorative Plants	82
Cut Flowers	83
Pot Plants	84
Outdoor Flowers	85
Shrubs, Creepers and Trees	85
Spices	86
Perfumes	90
Tobacco	91

V. /

<u>Contents (contd.)</u>	<u>Page</u>
V. <u>PLANT PRODUCTS WHICH ADVERSELY AFFECT MAN.</u>	93
Poisonous Plants	94
Bacteria	95
Fungi	95
<u>CONCLUSION</u>	97
<u>BIBLIOGRAPHY</u>	101

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INTRODUCTION.

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between plant products and synthetic nitrogenous metabolism of the green plant is more difficult and the conclusions that have so far been reached are rather hypothetical and cannot be well substantiated by fact. So far as is known, all the higher plants with the exception of the Natural Order Leguminosae and some plants which have adopted a parasitical mode of life, have to obtain their nitrogen from the soil as soluble inorganic salts. This is taken in by the roots, combined at some stage with the carbohydrate material manufactured by the leaves, and appears finally in the form of highly complex molecules. The most common and most important of these are the proteins.

Practically nothing is known of the manner in which fatty substances are synthesised by the green plant though some plants such as the castor oil, lintseed etc. store up oil in large quantities.

Besides these three primary groups of substances the plant synthesises innumerable compounds in lesser degree such as the pigments, drugs, etc., many of which find application in the complexities of modern civilisation. The title of this essay indeed is so wide as to include almost the entire plant kingdom. It is rather difficult in many cases to distinguish between/

between plant products which directly affect human life and those which indirectly affect it, the breadth of the subject depending to some extent on the interpretation of the word directly. For example, plant life throughout the whole world is responsible to a large degree for scenic effect which may be regarded as directly affecting human life. I will confine myself however to products of commercial value, the stricter interpretation of the title being necessitated by the limits of an essay; even so, a single book could scarcely do justice to the scope of the subject.

Two methods of classification of plant products of commercial value immediately suggest themselves, the one botanical, the other economic. Man makes use of many parts of a few plants and a few parts of many. In one case the root may be the only commercially valuable part of the plant, in another the stem, and in another the leaf. A possible method of classification of plant products then immediately suggests itself. One might well divide plant products into those derived from subterranean parts, those derived from stem, from leaf, from seed, from fruit and so on, but it seems likely that/

that such a method would tend to lead to overlapping since numerous plants are cultivated for more than one part. The second method of classification which suggests itself, the economic, is then regarded as preferable and is adopted here, although it also is open to the same objection, though to a lesser extent. On the economic basis it is here proposed to divide the plant products into five main groups.

1. Plant products which provide foodstuffs for man.
2. Plant products other than foodstuffs, employed in industry.
3. Plant products used as medicinals and drugs.
4. Plant products employed mainly for hedonistic reasons.
5. Plant products which adversely affect man.

These five main groups may then be further subdivided into related groups as may be seen from the list of contents.

All plants were originally wild, yet it is often difficult to tell with any degree of certainty among/

among plants which were long ago domesticated what the wild forms were. Alexander von Humboldt in his "Essai sur la Geographie des Plantes" in 1807 says: "The origin, the first home of the plants most useful to man and which have accompanied him from the remotest epochs, is a secret as impenetrable as the dwelling of all our domestic animals.... We do not know what region produced spontaneously wheat, barley, oats and rye. The plants which constitute the natural riches of all the inhabitants of the tropics, the banana, the papaw, the manioc and the maize, have never been found in the wild state. The potato presents the same phenomenon."

Since the day of Humboldt modern research in the hands of de Candolle and others, has shown us the origin of quite a number of these domesticated plants but in some cases their origin is still equally obscure.

Evidence of the antiquity of cultivation of any particular species is sometimes found in written descriptions or allusions which can be interpreted as referring to the plant in question or perhaps they appear in the form of pictures or carvings. Ancient names cannot always be depended upon because writers/

writers would often confuse under one name two or more different plants. More certain than old lists are the actual remains themselves, which have been unearthed by archaeologists. Modern research agrees in assigning an age of at least 4000 years to the more important food plants of the old world, and at least 2000 years to many less important ones. In the New World records and information are not so complete but are sufficient to show that the most valued plants have been for a long time under cultivation.

The three ancient centres of agriculture, the oriental region, the Mediterranean region, and the tropical American region, are geographically widely separated and have very different climates. Climate implies a greater or less degree of heat, light and moisture, and is generally determined by latitude; it becomes hotter the nearer we approach to the equator and colder the nearer we approach to the poles. This general statement is of course subject to numerous exceptions, the chief being elevation above sea level and distance from the sea. Climate is the main factor controlling the growth of plants so that the three basins of primitive agriculture with/

with widely differing types of climate, might well be expected to have produced characteristic domesticated plants specially suited to each region. This is indeed what is indicated when one studies the staple plant products of the three regions at a period before human communication had distributed the various types over the entire earth and so obscured their natural habitats. Rice is believed to have been the main agricultural product of the oriental countries at least four thousand years ago. As might be expected it requires a moist sub-tropical climate such as found in those regions. Wheat requires a temperate climate such as is found in the Mediterranean region. The earliest records indicate its wide cultivation in this region about four thousand years ago, while cocoa which requires a tropical climate, appears to have been used in central America at least two thousand years ago. Man, in the process of civilisation, has transported the valuable plants of any one region to others wherever a suitable climate was available, and in some cases has been able by careful selection and breeding to acclimatise such plants to rather different climates and so extend their distribution.

Grasses

The natural order Gramineae comprises some 5000 to 6000 different species including the cereals which supply the chief food of the human race and the pasture grasses which supply the chief food of farm VI. PLANT PRODUCTS USED AS FOOD FOR MAN

are all used while the root hairs to provide us with a firm turf on which to indulge in sports. Indeed so important has this aspect of grass cultivation become in recent years that a special Soil Research Station at Bingley, Yorkshire, has been established for the study of lawn grasses.

Most grasses are low herbs but some such as maize and sugar cane grow to six feet or more, while a few such as the bamboos, are shrubs or trees, the giant bamboo reaching 100 feet or more.

In all grasses the fruit is one seed, dry, and does not split open at maturity to allow the seed to escape. There is abundance of starchy substance. The grass fruit or grain in domesticated species is sufficiently large and plump to give considerable food value. There is a certain amount of variation in the chemical content of these grains.

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In all grasses the fruit is one seeded, dry, and does not split open at maturity to allow the seed to escape. There is abundance of starchy endosperm. The grass fruit or grain in domesticated species is sufficiently large and plump to have considerable food value. There is a certain amount of variation in the chemical content of these grains, the/

the protein percentage being considerably higher in some than in others; the following figures however may be taken as average:

Protein 8-10%; fat 1-2%; carbohydrate 70-80%; most of the remainder being indigestible material and water.

The cereal grains, so named from Ceres, goddess of the harvest in classical mythology, may be conveniently divided into two groups: the cereals characteristic of the temperate zones such as wheat, rye and oats, and the cereals characteristic of tropical zones such as maize and rice.

A. Cereals of Temperate Countries.

Wheat. Ancient Egyptian monuments indicate that cultivation was already well established more than 4000 years ago. Until the early part of the present century it was supposed that wild wheat no longer existed, but the investigations of Aaronsohn (1905-1910) show that a form of wheat grows wild in the highlands of Syria and Palestine. It is likely that our modern wheats are hybrids derived by natural crossing of this or other species with still other/

other species now unknown in the wild state.

Different varieties of wheat were known at the time of Theophrastus, the Father of Botany, as early as 300 B.C. At the present time hundreds of agricultural varieties are known although in any given district the number actually cultivated is never very great.

Wheat under cultivation has a very wide geographical range chiefly in the temperate regions, not being cultivated to any extent where maize or rice will flourish, as it does not produce as high a food yield per acre.

The following table from Vanstone's "Commodities of Commerce" gives an excellent idea of the wide distribution of wheat resulting from modern civilisation.

Table of World's Wheat Harvests

January	-	Australia, New Zealand, Argentine, Chili.
February	-	India.
March	-	India and Egypt.
April	-	Egypt, Mexico, Cuba, Syria, Persia.
May	-	Morocco, Algeria, China, Japan, Texas, Florida.
June	-	The Mediterranean Peninsulas, southern France, California, Afghanistan.
July	/	

- July - France, Austria, Hungary, southern
Russia, U.S.A.
- August - England, Belgium, Netherlands, Germany,
Canada.
- September - Scotland, Sweden, Norway, Russia.
- October - Scotland, Sweden, Norway, Russia.
- November - Peru, South Africa.
- December - Burma, south Australia.

By far the largest proportion of the world's wheat supply is used in the preparation of flour which is used chiefly in the production of bread. The hard wheats are used more particularly in the preparation of macaroni, vermicelli or spaghetti. Various breakfast foods such as flaked wheat and puffed wheat are also widely used. Wheat grain is also used to some extent in the preparation of alcoholic beverages, while pure wheat starch has numerous industrial applications. The straw is used as animal fodder and for thatching.

Barley. The cultivation of barley is probably almost as ancient as that of wheat but records are not so definite. During Classical times barley bread was used to a considerable extent by the peasantry. At the present day barley is probably geographically/

geographically the most widely distributed of all cereals as it can be cultivated under widely varying climatic conditions. It is seldom the chief cereal crop of any district, but is usually secondary to wheat and maize. The chief use of barley is in the preparation of malt.

Rye. Rye does not appear to have been known to the ancient Egyptians or Chinese civilisations, the earliest records appearing among the peoples of the Mediterranean-Caspian region. Cultivation of rye was not at all widespread until the Middle Ages. The plant is drought resistant and will grow on poor and sandy soils. The grain provides rye bread, the main food of the poorer peasantry in parts of Central Europe. Commercial alcohol and alcoholic beverages are also extensively prepared from the fermented rye. The straw makes a good thatching.

Oats. Oats appear to be native to the eastern European Russia. There are no records of cultivation either in the Egyptian, Grecian or Roman remains or literature, but grains have been found in/

in the old Swiss lake-dwellings suggesting that the grain was cultivated by the barbarian races of Central Europe several centuries before the Christian era.

The plant thrives well in moist cool climates and is consequently grown to a fair extent around the shores of Northern Europe and Canada. The grain has a high protein and fat content and is therefore superior to barley as a foodstuff. The meal is used to some extent for human consumption in the form of porridge and oatcakes, but most of the grain is used as animal food.

B. Cereals of Tropical Countries.

Maize. Maize was cultivated by the peoples of South America, Central America and Mexico long before the arrival of Columbus. Remains in Peru indicate the cultivation of maize more than 2000 years ago. The wild ancestor of the domesticated plant is not known but was probably a native of Peru or Mexico.

Long/

Long continued cultivation in different climates and soils and cross fertilisation of different kinds have produced innumerable varieties of maize suited to the various conditions under which the plant is grown. There are now upwards of 1000 varieties under cultivation. The plant will thrive and give large returns in widely different climates, for example a variety is known which gives quite good results in Southern Canada, while in the tropics the plant may be grown from sea level to a height of more than 9,000 feet.

No other cereal serves such a variety of uses as maize, nearly every part of the plant being of commercial value. Corn meal is used extensively as a food for man, while the soft varieties may be used green, as a vegetable.

The embryos of corn contain a large percentage of oil which has many commercial uses. It is employed in salads, for cooking, in the manufacture of soaps and is sometimes vulcanised into a cheap rubber substitute.

About 50 million bushels of corn are used annually in U.S.A. in the preparation of commercial starches from which are prepared glucose, artificial gums and alcohol. All parts of the plant may be used/

used as stock food. Cellulose is prepared from the stalk and used in the preparation of fine quality paper, while the pith of the stalk is recommended as a substitute for coconut fibre and for making explosives.

Rice. Rice is probably the oldest of all domesticated grasses, being cultivated extensively in China and India by 4000 B.C. In China, in 2700 B.C., the Emperor Chenming instituted a ceremony at which every year five species of useful plants are sown, of these rice takes first place and must be sown by the Emperor himself; the others, sweet potato, wheat and two kinds of millet may be sown by members of his family. Rice in oriental countries does not merely take the place of wheat in western countries; it is far more important - it is the chief dish and is eaten at every meal since meat and vegetables are used only to a slight extent. Of all the grain crops rice supplies food for by far the largest proportion of the human race. There are many varieties of the plant under cultivation, but the two principal kinds are the common/

common or aquatic rice and the mountain rice, the former requires a high average temperature (78° or more) and very wet conditions, the fields being flooded until the ripening period; the latter is grown more in the manner of other cereals on soil at elevations up to 6,000 feet. Rice straw is employed as stock fodder and in the manufacture of paper, while in Japan an alcoholic beverage "sake" is made from the grain.

Millets. The term millet does not refer to a definite botanical species of grasses. Originally it was applied to certain species belonging to the genera *Choetochloa*, *Panicum*, and *Echinochloa*, which are still spoken of as the "true millets". The word millet now embraces various annual cereal and forage grasses which have rather small seeds and abundant foliage. In the drier and poorer parts of a number of Asiatic and African countries, millets are extensively cultivated and form the chief cereal food of the population.

Sugar Cane. Sugar cane which is a very large grass grown extensively in tropical countries is not strictly speaking a cereal as it bears no grain, but as it is closely related to the cereals just discussed/

discussed, the millets and maize, it may be conveniently included here.

According to de Candolle the sugar cane plant appears to have been a native of Southern Asia whence it spread into Africa and later into America. The plant which grows to a height of ten or fifteen feet has stems of one to two inches in diameter; these are stripped of their leaves and crushed between heavy rollers. Thirty tons of cane yield about 25 tons of juice. The juice is purified by treatment with lime and then concentrated in vacuum pans when sugar is obtained in crystalline form.

Besides the crystalline sugar, there are a number of by-products. Cane molasses from the manufacture of high grade sugars is used for baking purposes and as a table syrup. Poorer grades are used extensively in the manufacture of rum and of commercial alcohol. The refuse which accumulates during purification of the sugar is used as a manure, being rich in phosphorus and potash. The crushed cane or "bagasse" is utilised as fuel and to some extent as a wall packing in buildings.

Tuberous Plants of a Starchy Nature.

The larger part of man's carbohydrate supply is derived from the cereals already discussed, but besides these there is an important group of tuberous plants, botanically unrelated, all of which contain a high percentage of water, usually between 50 and 75%, up to 25% of starch and with a very low protein content.

The Potato. The potato family (Solanaceae) includes a large number of plants chiefly tropical, many of which provide products useful to man either as foodstuffs or drugs. Some species also are used for ornamental purposes.

The potato (Solanum tuberosum) appears to be native to Chili where it was extensively cultivated before the arrival of the Spaniards. Although popular belief credits Sir Walter Raleigh (1585) with the introduction of the plant to Europe it was undoubtedly known in Spain and Italy some years earlier. The plant does not appear to have been very widely cultivated at first and fell into some disfavour/

disfavour in the first half of the seventeenth century. This is not surprising when it is remembered that the sprouting unripe tubers may contain quite large quantities of a highly poisonous alkaloid. During the Seven Years' War, Frederick the Great, impressed by the food value of the tubers, greatly encouraged the cultivation of the plant, which now ranks second to the cereals in the provision of carbohydrate for human consumption in temperate climates. Besides its use as a human food the potato is extensively used in the preparation of commercial starch, commercial alcohol and as a stock food.

Cassava. The cassava plant, a native of South America, is cultivated extensively throughout most tropical countries. The plant of shrubby appearance reaches a height of from five to eight feet. The roots swell out into large tubers from 24 to 26 inches in length. These are rich in starch which after purification reaches the market in this country in the form of tapioca. There are two species, the bitter Cassava and the sweet Cassava. The former contains considerable quantities of hydrocyanic acid and/

and must therefore not be consumed without careful preparation.

Arrowroot. The West Indian arrowroot (Maranta arundinacea) and several related species are cultivated to a fair extent in the tropics as a source of starch. Arrowroot powder is especially valued as an easily digested food for children and invalids.

Yams. Several species of Dioscorea known popularly as yams have been cultivated in oriental countries as far back as records go. The plants grow wild in the southern Asiatic Archipelago and most of the cultivated African and American species are probably originally derived from this region. The tubers vary very much in size depending on the species, those of the Greater Yam reaching a weight of from 20 to 60 lbs. They are more nutritious than the common potato and supply an abundance of wholesome food to the inhabitants of tropical and sub-tropical regions.

Sweet Potato. The sweet potato is regarded as native to Central America where it has probably been under cultivation for at least two thousand years. The cultivation of the plant must have spread over the/

the rest of the tropics at an early period however and it is today widely cultivated as a valuable source of carbohydrate in these regions.

Besides the tuberous plants already mentioned, there are a number of plants of similar nature cultivated to a lesser extent. Among these may be mentioned Jerusalem artichoke (Helianthus tuberosus) and Stachys tuberifera (Crosnes) a less known plant said to have been introduced to this country from Northern China in 1887.

Legumes.

The legumes are secondary only to the Grasses in their agricultural importance and geographical distribution. There are about 500 genera and 10,000 species in the family spread over both temperate and tropical regions.

According to de Candolle and others the broad bean, the garden pea and alfalfa have been under cultivation in the Old World for from two to four thousand years, while other legumes such as the kidney bean appear to be among the earliest cultivated crops of the New World.

The/

The legumes are especially valuable owing to their high protein content thus helping to balance the protein carbohydrate food ration of man and more especially of domesticated animals. The roots of legumes support a growth of bacterium (Pseudomonas radicola) which lives in symbiosis with the plant. These organisms have the power of fixing, i.e. combining with the free nitrogen of the air and so provide an invaluable means of restoring the fixed nitrogen level of exhausted soil.

The famous experiments of Gregor Mendel (1856-1864) which form the basis of modern genetics were performed on a member of this group, the common garden pea.

Common pea. There are several varieties of peas, all of which grow best under temperate conditions with a fairly low rainfall. The seed of the plant in the green state is a common table vegetable, and is also tinned in large quantities.

Chick pea. A small legume grown in tropical and sub-tropical countries. The chick pea provides a valuable source of nutritious food. The dried seeds and the green pods are both consumed, but the leaves are not suitable for fodder on account of an acid secretion.

Jack bean, sword bean, Lima bean, Lablab bean and Urd.

The Jack bean and sword bean belonging to the genus Canavalia and the other three species named above belonging to the genus Phaseolus, are all widely cultivated in tropical and sub-tropical countries, the seeds being valued as a human food.

French bean (kidney bean) and Windsor bean (broad bean).

The French bean (genus Phaseolus) and the Windsor or broad bean (genus Vicia) are annuals grown extensively in temperate regions. The broad bean which appears to be a native of the Old World has probably been cultivated for at least four thousand years, while the kidney bean which is native to America although probably not quite so old is estimated by de Candolle and others to have been under cultivation for about two thousand years. The seed of the broad bean and the unripe fruit (pod and seed) of the French bean are common table vegetables among the inhabitants of the temperate zones.

Soy bean. The soy bean is the most important legume of oriental countries. It has according to de Candolle been cultivated in China and Japan from remote antiquity. The bean has an exceptionally low starch content and high protein/(47%) and is also rich/

rich in oil (18%) so that it is a valuable factor in the provision of an adequate protein diet among orientals who, as already mentioned, consume rice as their staple diet. The oil expressed from the seeds is used extensively in the manufacture of soaps, lubricants, rubber substitutes and paints and varnishes. The 'cake' remaining after the oil is expressed from the seeds is a valuable stock food.

Besides the legumes already mentioned there are a number of other species which are used by man to some extent; among these may be mentioned the ground or pea-nut which is chiefly valued as a source of vegetable oil, the scarlet runner bean used to some extent as a human food, and the lentil, used extensively in this country in soups.

Table Vegetables of Temperate Regions, other than Legumes.

With the development of civilisation in the temperate regions an enormous variety of table vegetables have come into general use. Most of these are of ancient origin, the cucumber for example being cultivated in Egypt at least three thousand years/

years ago; it is only within comparatively recent times however that most of these have spread over the entire temperate region. Unlike the tuberous vegetables of the tropics which in many cases are the staple food of the native population, the table vegetables of the temperate zone, apart from the potato, occupy a relatively minor position in the provision of sustenance for man.

The Cabbage Family. The common cabbage, the cauliflower, the Brussel sprout, the savoy cabbage, the Portugal cabbage and the broccoli are all well known on the European dinner table. They all appear to have been under cultivation since the beginnings of history, but all except the common cabbage, have been confined to relatively small districts until comparatively recently. The Portugal cabbage for example was unknown in this country before 1821 while the Brussel sprout although native to Belgium since prehistoric times, was practically unknown here until about seventy years ago. In the case of cauliflower and broccoli the inflorescence is used as human food and in the case of the others the foliage.

Closely related botanically to the cabbage is the turnip/

turnip. The swollen fleshy combined tap root and hypocotyl is used as a human food to some extent but more especially as animal fodder.

The Onion Family. Cultivation of the common onion dates back to the earliest times in the history of Egypt, India, and China. The onion was used by the Egyptians as a sacrificial offering. The bases of the leaves swell out to form a bulb which when cooked is valued as a vegetable, especially for flavouring.

Closely related to the common onion are the leek, garlic, chives and shallot, all of which find similar application.

Miscellaneous Table Vegetables.

Besides the two main groups already discussed there are numerous table vegetables which do not readily fall into any one group. It is impossible to do more than mention these here. The red beet, cucumber, vegetable marrow, asparagus, celery, carrot, parsnip, watercress, spinnach and lettuce, are familiar examples.

Sugar Beet.

Besides the red beet already mentioned as a table vegetable there is a much more important variety of the same species, the white sugar beet. The common wild beet (Beta maritima) which occurs along the Mediterranean coasts of Southern Europe, the Canary Islands and Persia, has a tough slender root. The cultivated beets are all regarded as derived from this plant. Experiments with wild beet indicate that after only two or three years of selection, a marked increase in root weight and sugar percentage may be obtained while in five to seven years a variety can be produced having as much as 15% sugar.

The occurrence of sugar in the swollen^{tap}/root of the plant was first noted by Serres in 1590, but until 1747 the beet was only cultivated as a vegetable for table use and animal fodder. In that year Marggraf reported to the Berlin Academy of Sciences on beet as a source of sugar and urged the cultivation of the plant. Little further progress was made until the Napoleonic wars when, in an attempt to injure the trade of Britain, Napoleon forbade the importation of cane sugar and provided bounties for the cultivation of beet. Under this impetus factories/

factories were set up, many of which collapsed with the fall of the Emperor. A few factories revived and developed slowly. In 1829 the beet crop was estimated as 4,000 tons. Since this date the industry has steadily developed until today at least half the world's sugar is produced from beet.

The sugar percentage and weight of the root varies considerably with different climatic conditions. High average temperature is likely to result in low sugar content as is excessive moisture or excessive manuring. The most satisfactory results are obtained in countries with cool, dry autumn weather and abundant sunshine such as the north-central European countries, and the northern states of U.S.A. The following analysis for German beet may be taken as typical.

Water	-	74.5%
Dry substance	-	25.5%
Sugar	-	16.6%
Protein	-	0.706%
Ash	-	0.8%

Instead of crushing between rollers as in the case of cane, the beet is sliced and extracted with water at about 80°C.; the watery extract is purified and worked up in much the same way as the cane sugar juice.

The beet pulp remaining after extraction of the sugar is a valued stock food, while the waste which accumulates in the purification process is a valuable fertiliser.

Fruit.

The number of different fruits consumed by man is so enormous that it will be impossible here to do more. Wild fruits have undoubtedly figured in the diet of man ever since he began to walk erect. With the advance in culture and development of populous communities the supply of wild fruits would not be sufficient to meet the demand and half-civilised man would have planted his favourite fruits in ever increasing number. Probably no conscious attempt was made at selection of large luscious types but it is certain that centuries before the Christian era began there had been developed improved fruits of many kinds.

Fruits have little food value in terms of energy content, but they are nevertheless an important feature of diet as they provide certain essential food factors - vitamins. Most fruits contain from 90-98% water, about 1% protein and from 1-10% carbohydrate, a very few are rich in oil.

Although the word fruit refers in common language to a juicy structure edible either wholly or in part without previous preparation, it must be remembered that botanically such structures as nuts, pods etc. are also fruits.

The/

The number of different fruits consumed by man is no enormous that it will be impossible here to do more than mention many of them.

Fruits of temperate countries.

The grape is undoubtedly the most important fruit of the temperate zone. As grape seeds have been found in Egyptian tombs over three thousand years old the antiquity of the fruit is well established.

The grape vine requires light dry soil and a moderately warm climate such as that of France. The larger proportion of the world's grape crop is used not as a table fruit but in the preparation of wines. The total wine production of the world is estimated at roughly 3,000 million gallons annually. Besides this enormous production of wine, large quantities of grapes are dried and sold as raisins and currants.

The apple (Pyrus malus) and the pear (Pyrus communis) though secondary in importance to the grape, are also extensively cultivated throughout the temperate zone. Besides its use as a table fruit the apple is used to some extent in the preparation of cider.

The plum, damson, apricot, peach and cherry, belonging/

belonging to the genus Prunus are all extensively cultivated as table fruits, while the dried plum is sold under the name of prune. All these seem to have been known in Italy about the beginning of the Christian era, but were not introduced into this country until the fourteenth or fifteenth century. The wood of the plum tree is valued for the manufacture of musical instruments.

Besides those already mentioned there are a number of less important fruits belonging to no particular group, all used mainly as table fruits. Among these may be mentioned the strawberry, raspberry, gooseberry, tomato, cranberry, black currant and the logan berry.

Fruits of warm countries.

The orange family comes next to the vine in commercial importance but as the greater part of the grapes cultivated are made into wine, the orange and its allied species may be said to be the most important fruits in the diet of man.

The orange can be raised in quantity only in tropical and sub-tropical climates, but is consumed mainly in temperate zones so that suitability for transport is a highly important question. By careful packing/

packing and selection the fruit can be kept so as to undergo long sea voyages.

The common orange and its related species the lemon and citron are probably natives of south eastern Asia, and of considerable antiquity, so that it is surprising to note that although the lemon and citron were cultivated in the Mediterranean region in Classical times the sweet orange was unknown until the fifteenth century.

The grape fruit which has only come into popularity during the last forty years, is a native of the Malay Archipelago, but is now grown chiefly in U.S.A. and South Africa.

The banana tree grows to a height of from ten to twenty feet depending on the variety. It is grown extensively throughout the tropics. The cultivated banana is seedless (indicative of the antiquity of the domesticated varieties) and is certainly of Asiatic origin. It appears to have been practically unknown in Europe during Classical Times, and it is only during comparatively recent years that improvement in communication has enabled the banana fruit to become important in the world's markets. The fruit of certain varieties has been a staple article of diet among the natives of the tropics for several centuries. Not only is it highly/

highly nutritious but also the most prolific of all food plants known. It is calculated that thirty pounds weight of wheat requires for its growth the same area as will produce four thousand pounds of bananas.

The date palm, a tree of eighty to one hundred feet in height is better suited to a sub-tropical than a tropical climate and is grown chiefly in Egypt, Palestine, Arabia and Iraq. The origin of the plant is uncertain as it is not now known in the wild state but it is believed to be somewhere between Abyssinia and Western Persia. The fruit is a small one seeded berry. It is exceptionally rich in sugar and forms the staple diet of the Arab in certain districts. Large quantities are exported to the colder countries, the annual imports of this country being valued at between two and three million pounds sterling. The fruit is also used locally in the preparation of alcoholic beverages.

The pineapple is probably native to South America where it was under cultivation before the Spanish conquest. The full grown plant is about three feet high and is crowned by the fruit which is a collective fruit formed by the coalescence of the parts of a complete inflorescence. The fresh fruit does not lend/

lend itself to transport as it loses its flavour when gathered green, but enormous quantities are canned and exported to all parts of the world.

The fig, a tree of fifteen to twenty feet in height is grown extensively in sub-tropical regions. The fruit when dried keeps almost indefinitely and reaches the world markets chiefly in this state.

Besides those tropical fruits already mentioned there are an enormous number which are grown and consumed locally but not exported to the temperate countries to any great extent. Among these may be mentioned the mango, the pomegranate, the papaw, the custard apple, the guavo, the bread fruit, etc.

The olive and the cocoa-nut palm will be dealt with in Section II as neither is grown primarily for its fruit.

Nuts. The term nut employed to designate a plant product is used rather loosely in popular language. It may include drupes or stone fruits from which the epicarp and mesocarp are removed. As examples of true nuts may be mentioned the chestnut, acorn, hazelnut, beechnut and filbert. The walnut, almond, hikory/

hickorynut, Brazil nut, pinyon nut and peanut although used in much the same way are not botanically speaking true nuts. In general nuts are highly nutritious having a high protein content and considerable oil.

Plants Supplying Non-Alcoholic Beverages.

The popular modern non-alcoholic beverages tea, coffee, and cocoa were introduced into Europe in the sixteenth century and their increasing consumption especially during recent years has resulted in a great increase in the areas under cultivation. It is interesting to note that each of the three ancient centres of agriculture has furnished to the world one of these beverages. Tea is a native of the Orient, coffee a native of Abyssinia, while cocoa belongs to the American tropics.

Tea. The tea plant, a large much branched shrub of the family Theaceae, is said to have been known in China since 2700 B.C. but was originally used only as a medicine. As a beverage it came into favour in that country as late as 500 A.D. Tea drinking began in Europe about the beginning of the sixteenth century and by the middle of the seventeenth century and/
was

was being served in the famous London coffee houses of the time. Pepys in his diary reports having first tasted it at one of these resorts. The cost at that time was 60/- per pound; in 1740 a price of 10/- per pound is quoted but it was not until the middle of the nineteenth century that the price fell to somewhere near its present level.

Commercial tea growing is confined to the tropics and is most successful on open well drained soil with abundant rainfall. The plant naturally grows to a considerable height if not pruned, but in plantations severe pruning is resorted to, partly so that the leaves may be reached from the ground, but more particularly because this results in the putting forth of a great number of small twigs upon which young leaves appear. The finest grades of tea are produced when the plucking consists of the youngest two or three leaves of each branch.

Certain processes must be carried out to make the tea ready for the market. The freshly plucked leaves are spread out in a thin layer on canvas or wire screens and allowed to dry in the sun for several hours, after which they are fed into a rolling machine. This/

machine bruises the leaves, rolls them up into short quills, and cuts up the rolls thus formed. If green tea is to be prepared the rolls are now quickly dried in a firing machine by means of hot air, but if black tea is desired the rolls are spread out on trays and allowed to dry very slowly, so that fermentation is set up and blackening occurs.

The leaf contains three important substances, an essential oil, an alkaloid and tannin. The essential oil provides the pleasant flavour and aroma while the alkaloid is responsible for the stimulating effect. The tannin is not extracted to any appreciable extent if the infusion is made properly, but if the tea is boiled or allowed to stand too long, the tannin is extracted from the leaves and imparts a strong bitter taste to the beverage.

The world's annual tea crop is valued at about £20,000,000, of which more than half is grown in India and Ceylon. The consumption per head per annum reaches its maximum in Britain and Australia where it is 6-7 lbs., and is as low as 0.05-0.1 lb. in France and Germany.

Coffee. According to de Candolle the use of coffee seems to be very ancient in Abyssinia but did not spread to the surrounding countries until about the/

the fifteenth century. The Dutch started the growing of coffee in the West Indies about 1700, from where it no doubt soon extended to Mexico and Brazil. The plant requires a hot moist climate but is liable to be damaged by excessively strong sunshine so that it is customary in coffee plantations, to intersperse "shade trees" which throw a light shade sufficient to protect the coffee.

The coffee berries develop in clusters, which are pricked by hand and placed in water, when the ripe ones sink; these are drawn off and fed to a grating machine in which the skin and soft pulp are broken up, the mixture is now allowed to stand, when the heavy seeds sink to the bottom. The pulp is run off and the seeds allowed to lie for several days in shallow tanks and are washed periodically; by this means the residual pulp is washed away. The seeds are sun dried and stored for some time as this is believed to improve the flavour. When ready for shipment the dried seeds are run through a peeling machine which removes the silver skin and separates the two seeds of each fruit. The coffee is now in the condition which we are accustomed to in this country and merely requires to be roasted and ground before use.

The/

The important constituents of the coffee bean are essential oils and an alkaloid, caffeine. The oils are responsible for the aroma and flavour and the caffeine for the stimulating effect of the beverage.

The world's coffee production is valued at about £50,000,000 annually. The chief consumer is U.S.A., where the high figure of 14 lbs. per head per annum is reached. Scandinavia comes next with 12 lbs. while Britain and Canada only consume 1 lb. per head.

Cocoa. The cacao tree (Theobroma cacao) appears to be a native of the Amazon basin. It endures only a limited range of temperatures being strictly tropical, but does not thrive too well in very hot lowlands. Chocolate was a common beverage when the white man first visited Central America. It is said that when the botanist Linnaeus first tasted chocolate he exclaimed "food of the gods" and later gave the tree the name Theobroma, the Greek equivalent.

The tree grows fruit not upon its small twigs but on the old stems. The fruit is collected by hand and stored in heaps for several days, when fermentation sets in and the outer mucilaginous material can be readily removed by washing. The seeds are now dried/

dried in the sun and are ready for shipment.

The manufacture of chocolate and cocoa is now carried out almost entirely by machinery. The seeds are cleaned, roasted, shelled and ground. The average composition of good West Indian beans is given as:

Fat	-	50%
Starch	-	10%
Protein	-	20%
Water	-	12%
Cellulose	-	2%
Theobromine	-	2%
Mineral matter	-	4%

From this it is obvious that for the preparation of cocoa a considerable quantity of fat will have to be removed. This is done either by extraction with fat solvents or by a hydraulic press. The fat so obtained is known as cocoa butter and is valued in the preparation of cosmetics.

Besides the three well known beverages discussed Maté or Paraguay tea, a beverage made from the leaves of Ilex paraguayensis is used to some extent in South America.

The/

The Food Requirements of Man

Man like any other "heat engine" has to burn fuel in order to produce energy. Even if he is performing no work he still requires quite a large supply of food. So long as man is alive certain tissues of his body are steadily wearing out and have to be replaced; furthermore the vital functions of his body, the pumping of blood through his system and the process of respiration, although they require no conscious muscular effort, consume a fair amount of energy, while as his body temperature is maintained at a constant level, there is considerable heat loss to his surroundings. Food then answers the double purpose of a building material to replace worn out tissues and a source of energy for the maintenance of vital functions.

Since the process of tissue breakdown involves the loss of nitrogen only protein can supply the necessary materials for rebuilding purposes. Provided man is supplied with sufficient protein to compensate for tissue break down, we should then expect that all the rest of his requirements could be met by fat and carbohydrate as sources of energy. Just as an engine requires a small quantity of oil before it will run properly for any length of time, man/

man also requires certain additional factors in his diet besides pure fuel. The first of these "lubricants" the inorganic salts, are not likely to be missing except under exceptional circumstances but the second, the vitamins, are often absent from or deficient in common diets so that much unnecessary suffering and disease results.

The vitamins fall conveniently into two groups, the fat soluble vitamins and the water soluble vitamins. For an adequate supply of these vitamins man is largely dependent on the plant kingdom.

Vitamin A, the first of the fat soluble vitamins to be recognised occurs in large quantities in fish liver oils. It is not synthesised in the fish but is regarded as derived from the phytoplankton on which they feed. In addition the immediate chemical precursors of vitamin A, the carotenoids, occur to a fair extent in certain of man's plant foods such as the carrot and the apricot. Absence of or deficiency of vitamin A in the diet leads to a disease of the eyes known as xerophthalmia which is especially common among children in the east where the staple diet is polished rice.

Vitamin D appears to be an animal rather than a plant product.

Vitamin/

Vitamin E, the third of the fat soluble vitamins, occurs widely in the plant kingdom but is especially concentrated in certain plant germ oils such as rice germ oil and wheat germ oil. It has recently been isolated in an apparently pure form and has been shown to be necessary for the prevention of sterility in man.

The three well recognised water soluble vitamins, B₁, B₂ and C, are also absolutely essential to man and are derived chiefly from plant products.

Vitamin C, the anti-scorbutic vitamin, occurs in large quantities in many fruits, especially the orange and its near relations. Until about one hundred years ago scurvy was a common disease among sailors and soldiers but it is now practically unknown thanks to the recognition of the value of fresh fruit in the diet.

Beri-beri a common disease of the Orient, has also been shown to be due to a lack of vitamin, in this case B₁. Rice polishings which until comparatively recently were regarded as worthless have been shown to be exceptionally rich in the vitamin so that the natives of the eastern Asiatic countries, who subsist largely on polished rice, are discarding an essential and valuable part of the plant. Excellent results/

results have been obtained in combating beri-beri by encouraging the natives to use unpolished rice.

From this short review of recent progress in the study of essential food factors, it may be seen that besides being dependent on the plant world for the fuel to burn in the body, man is also largely dependent on it for the lubricating oil which ensures the smooth running of the human machine.

EMPLOYED IN INDUSTRY.

Man while yet in a state of savagery made
extensive use of plant products for purposes other
than the provision of food. As civilization advanced
man's needs multiplied so that more and more plant
products were found to be necessary to meet his
demands, until today he has reached a stage where his

II. PLANT PRODUCTS, OTHER THAN FOODSTUFFS,

EMPLOYED IN INDUSTRY.

Of the immense number of
plant products valued by modern industrial civilization
only the more important groups may be considered here.
Industrial plants cannot of course be separated
entirely from food or medicinal plants as has already
been noted, but plants valued primarily for their
industrial products will be considered here though
they may also find use in medicine or in the provision
of foodstuffs.

Fibres.

Primitive man obtaining his needs was not
satisfied by food and skins and turned to the
flexible strands which he found in the stems of plants,
leaves and roots and by plaiting these together he
made the development of the textile industries.

Man while yet in a state of savagery made extensive use of plant products for purposes other than the provision of food. As civilisation advanced man's needs multiplied so that more and more plant products were found to be necessary to meet his demands, until today he has reached a stage where his food requirements almost take second place to his industrial needs. Out of the immense number of plant products valued by modern industrial civilisation only the more important groups may be considered here. Industrial plants cannot of course be separated entirely from food or medicinal plants as has already been noted, but plants valued primarily for their industrial products will be considered here though they may also find use in medicine or in the provision of foodstuffs.

Fibres.

Primitive man finding his needs were not met solely by food and skins no doubt turned to the flexible strands which he found strengthening roots, stems and leaves and by pleating these together fore-shadows the development of the textile industries.

The/ conditions.

The Cotton Plant which is today cultivated generally throughout tropical and sub-tropical countries, is said to have been cultivated in India more than three thousand years ago. It appears that cotton was also under cultivation in the New World at an early date, and was in general use when the Spaniards arrived there. This is the only case in which an important economic plant has been domesticated independently in the Old and New Worlds. The American variety which is better suited to industrial requirements is now largely replacing the Old World varieties, even in India.

The plant is sensitive to low temperatures and cannot be grown where autumn night frosts occur, but although originally confined to the tropics, the larger proportion of the world's crop is today produced in the Southern States of U.S.A.

Each cotton fibre is a simple hair-like process of an epidermal cell of the seed coat. There are as a rule two kinds of hairs on the seed, the long hairs or "staple", and the short hairs or "fuzz". The length of the staple, an important point industrially, varies with the variety and the climatic conditions.

The/

The crop gathered is "seed-cotton" consisting of the seeds with the fibre firmly attached. In primitive countries the fibre or "lint" is pulled off by hand, but a special machine known as a "cotton gin" is usually employed now. The lint is spun into threads and woven into all sorts of fabrics. The short lint or "fuzz" is made into poor quality twine, carpets, etc.

In addition to supplying a valuable fibre the cotton plant supplies considerable quantities of cotton seed oil. The oil ~~is~~ present in the seed is obtained by coat, cooking the embryo to melt the oil and then extracting by pressure. A ton of seed yields about forty gallons of crude oil. The oil after purification is used as a food in the form of salad oil or margarine and in the manufacture of soap.

The cake left after the oil is pressed from the seed is ground up and used extensively as a stock food.

Artificial silk which may also be prepared from cotton is dealt with later.

The total annual world production of cotton is between 20 and 30 million bales of 500 lbs. each. America grows more than half of this, the other chief producers being India, China and Egypt.

The/



The Flax plant, a slender annual about two feet tall with small narrow leaves and bright blue flowers, has long been cultivated in the Eastern Mediterranean region. That the plant is not known in the wild state is indicative of its antiquity, while archaeological remains leave no doubt that the art of preparing linen was well known to the Egyptians thousands of years ago.

Unlike cotton, flax may be grown in cool climates either on light or heavy soil. The best quality fibre is produced in moist climates. The plants are pulled by hand, tied into bundles and the seed threshed out. The stems are now spread out and exposed to the weather for several weeks, after which they are placed in tanks of water, when a fermentation process known as "retting" sets in. The linen fibres are highly resistant to decay and are not affected. The fibres are now pounded till free from the other parts of the stem, sorted and woven. As the fibres are almost pure cellulose, they are more resistant to decay than cotton and maintain their whiteness better when bleached. A fine grade of paper is prepared from linen rags.

The flax seed like the cotton seed is rich in oil. The seeds are crushed and extracted with fat solvents, and the oil so obtained, linseed oil, is used/

used in large quantities in the preparation of paints, patent leather and varnishes. Linoleum is prepared by treating canvas with a mixture of ground cork and hardened linseed oil.

The residual cake remaining after extraction of the oil from the seeds is used as a stock food.

Hemp is the term given to the fibres of the plant Cannabis sativa which are prepared in much the same way as flax. These fibres which are very long and strong are used especially in the manufacture of ropes. Besides the true hemp there are a number of other fibres known as hemp, thus the fibre from a plant similar to the banana is known as Manilla hemp; besides these there are the sisal hemp, Mauritius hemp, and Calcutta hemp.

Jute is obtained from two cultivated species of Corchorus. The fibre which is prepared in somewhat the same way as flax is rather coarser and is used chiefly in the manufacture of bagging and similar rough fabrics.

Coir which is obtained from the nut husks of the cocoanut palm by rotting away the softer material makes/

makes ropes of exceptional lightness and elasticity. It is also used for door mats and other matting subject to particularly hard wear.

Brush fibres are obtained from a variety of plants such as the "Broom Millets" and a number of tropical palms.

Besides the fibre plants already mentioned there are a number of plants which are used locally in the making of paper and other fibre products but which do not find a place in the world markets.

Wood.

In economic importance woods rank next to the fibres already discussed. Few if any of the products of nature are of such manifold utility. Just as the great use of fibres is for clothing which is almost as necessary to us as food, so the great use of wood is for buildings which are scarcely less needful than clothing.

From the earliest times wood has been the most widely useful material of construction. Our civilisation has been developed upon its possibilities. Though today stone, brick, iron and steel are substituted for it in large constructional works, new uses/

uses are constantly arising so as to more than make up for the saving effected by these substitutes.

To the plant which produces it wood serves mainly for mechanical support, and is distinguished from the fibres already discussed in that, whereas fibres offer little resistance except to stretching, wood is hard and massive and tends to maintain its form against any severe mechanical strain.

So numerous are the uses to which wood is applied that it would be hopeless to attempt to enumerate them here. Still less would it be possible to mention all the different kinds of wood locally employed for each purpose, or to describe the methods in which they are treated. The most that can be done within the limits of a general essay is to group the uses of wood into what appears to me to be three main divisions and to expand each of these very briefly.

Fuel. All woods except a few of the extremely hard varieties are probably used locally as fuels but the general use of wood as a fuel has declined greatly during the last century or so owing to the increased use of coal. Coal is also however a plant product, being ancient vegetation variously modified through decay, pressure and heat.

Constructional/

Constructional Purposes. Wood for constructional work is obtained from an enormous variety of trees in both tropical and temperate regions. Different types of wood may be roughly divided into "hard" and "soft" woods. The hard woods are used where particular strength or resistance to decay is necessary, as in shipbuilding, and the soft woods where such properties are not essential. The soft woods are more important however for the preparation of wood pulp.

Wood Pulp. The manufacture of paper from wood pulp although a comparatively recent industry, has now assumed such dimensions as to threaten a serious shortage of timber supplies. The poplars, alders, buckeyes, spruces and the softer pines are the most suitable woods for the purpose. It is estimated that something like two million tons of timber annually passes through the printing presses of British newspapers alone.

Besides being used in the manufacture of paper, considerable quantities of wood pulp are now used in the artificial silk industry and in the preparation of explosives, celluloid and other cellulose derivatives.

Cork /

Cork.

Most trees have a protective layer of bark outside the wood which is not fibrous and which contains a high percentage of a waxy substance, suberin, thus rendering the bark impervious to water. Only a few trees, however, produce cork which is soft, elastic, and sufficiently thick to be commercially usable. Quercus suber, the cork oak of the Mediterranean region is the source of this useful plant product.

Cork is first stripped off the cork oak when the tree is about twenty years old. After that large slabs up to two inches or more in thickness may be removed every ten years, the quality improving as the tree grows older.

By far the most important use of cork is for stoppers, it being estimated that the daily consumption amounts to about twenty million. Pulverised and mixed with rubber or hardened linseed oil, it forms the basis of linoleums and cork mattings. Coarsely ground it forms an excellent packing material. On account of its lightness it finds use in the making of artificial limbs and handles for various instruments, while on account of its impermeability to water it is useful to the fisherman for net floats.

Cork/

Cork appears to have been known in Classical Times and used for the soles of shoes and as stoppers for wine vessels, but extensive cultivation has only developed within the last few centuries.

Elastic Gums.

Many plants yield a milky juice when an incision is made in the stem. In the case of certain tropical trees and shrubs this milky exudate curdles on standing or on treatment with suitable adulterants such as acetic acid. The tough more or less elastic solid so obtained is crude rubber or gutta-percha.

Rubber was first made known to Europe in the report of Columbus' second voyage where statement occurs that the natives were found playing with elastic balls which bounded better than the "wind balls" of Castile.

At the present time most of the world's supply of rubber is obtained from the Para rubber tree (Hevea brasiliensis) which is native to the Amazon valley but is now extensively cultivated, especially in the East Indies and Malay Peninsula. Cuts are made in the bark of the tree and the juice is collected. It is coagulated either by chemical treatment or in the native method. By dipping a paddle in the juice or "latex"/

latex and holding it in the smoke of a fire of locally collected nuts, a thin layer of rubber coagulates on the paddle, the paddle is then again dipped in the latex and smoked and the process repeated until a thick layer of rubber has coagulated.

Besides the para rubber tree a number of American, Asiatic and African trees give rubbers very similar to the para rubber. They usually go under the name of the region from which they are derived. Among these may be mentioned Castilloa or Panama rubber obtained from a large tree Castilloa elastica which occurs in the Central American forests and has been cultivated to a small extent; Assam rubber obtained from a large Asiatic tree (Ficus elastica) closely related to the fig tree, and Lagos rubber obtained from a tree Funtumia elastica, a tree found wild only in tropical Africa.

Crude rubber has the disadvantage of becoming very sticky when warm and cracking when cold. As a result of these drawbacks rubber was very little use until in 1830 Charles Goodyear discovered that by mixing the rubber with sulphur and heating a much more elastic material was obtained, which retained its properties over a wide range of temperature. Further research has steadily increased our knowledge of/
of/

of how to utilise rubber to the best advantage. By increasing the sulphur content up to 40 per cent. a hard black horny substance known as vulcanite is obtained, while addition of phenol derivatives and other anti-oxidants has resulted in a rubber which deteriorates only very slowly under the worst conditions.

The chief use of rubber today is in the manufacture of motor car tyres, but it is also used in an extraordinary variety of every-day articles from life preservers to corsets. Synthetic rubbers are also on the market but unless state-aided can scarcely compete in price with the natural product.

Gutta-percha is a somewhat rubber-like substance obtained from the latex of several species of the genus Palaquium, native to Sumatra, Borneo and other East Indian islands. The latex hardens very quickly on exposure to air, giving a tough very slightly elastic material. The chief use of gutta-percha is as an insulator for submarine telegraph cables, for which it is especially suited on account of its imperviousness to water. It also finds use in the manufacture of golf balls, surgical appliances, waterproof soles of boots, etc.

Gums, Gum Resins and Resins.

The term gum is loosely applied in commerce to a number of different products which are better divided into three groups: the true gums, the gum resins and the resins.

True gums are exudates from the stems of many trees and shrubs which are regarded as formed by the progressive breakdown of cellulose. In the dry condition they are hard and translucent, but in contact with water swell up and with sufficient water form mucilages. Gums are used for adhesive purposes and by pharmacists to hold emulsions. Gum Arabic which has been known since early Classical Times is derived chiefly from a shrub, Acacia senegal, native to northern and central Africa. Gum tragacanth is obtained from Astragalus gummifer, a plant native to south-western Asia. The gums are now being displaced to some extent by artificial gum prepared from starch and consisting chiefly of dextrin.

Gum Resins are mixtures of gum and resin and are obtained from a variety of plants. A well known example is Gamboge which is derived from an ever-green/

green (Garcinia hanburyi) native to Siam. Gamboge is used in the preparation of paints and to a small extent in medicine.

True Resins are distinguishable from the gums by being soluble in organic solvents and insoluble in water while the true gums show exactly opposite solubilities. The true gums are apparently decomposition products of cellulose but the true resins appear to be elaborated from the essential oils and usually occur in plants associated with them. The resins of commerce may be conveniently divided into three classes, the varnish resins, the oleo resins and the balsamic resins.

The various copals and amber are varnish resins. They are not obtained directly from plants but are dug up from the ground as fossilised plant exudates. Kauri copal for example is exported in large quantities from New Zealand where it is dug from the ground where kauri pine forests have existed centuries before. The varnish resins are very hard and are rather insoluble in organic solvents so that in the preparation of varnishes it is necessary to submit the resin to destructive distillation as a preliminary process.

The/

The oleo-resins are mixtures of essential oil and resin. They are liquids or semi-solids. The most important oleo-resin is turpentine which is obtained by tapping various species of pine and collecting the exudate. On distillation turpentine yields the familiar "oil of turpentine" used extensively as a paint solvent and "rosin" which is used in cheaper varnishes, low grade sealing wax, cheap soap, shoemaker's wax, and as a flux in plumbing. Other oleo-resins are "Canada balsam" and "Balsam of Copaiba".

Balsamic resins contain either benzoic or cinnamic acid, the presence of one or both of these giving the substances their peculiar "balsamic" odour.

Oils.

The vegetable oils include two quite different types of compounds which are distinguished as the fixed oils and the essential or volatile oils. As indicated by the name, the ~~two~~^{volatile} oils can be distilled in steam, whereas the fixed oils will not distil without decomposition except at reduced pressure. Chemically the fixed oils are fats, whereas the essential oils are terpenoid in nature. It is convenient/

convenient to consider the fixed oils and essential oils separately.

A. Fixed Oils.

Fixed oils are with few exceptions obtained from the seeds or kernels of plants. The chief exceptions are olive oil and "palm oil" in which the oil is obtained from the pericarp or outer portion of the fruit. Commercially the most important fixed oils are copra or coco-nut oil, palm and palm kernel oils, peanut oil, cotton seed oil, linseed oil, maize oil, olive oil and castor oil.

Coco-nut oil is expressed from the dried kernel of the coconut known as copra.

The coconut palm is a large tree which is widely distributed especially near sea shores throughout the entire tropical world. Since all its botanical relatives occur in the Amazon region it is regarded as native to South America, but was certainly distributed over the tropics in prehistoric times. It is conceivable that this was accomplished by ocean currents, for immersion of the ripe fruit in sea water for a considerable time does not prevent germination.

The/

The natives of the tropics find the coco-nut palm one of their most useful plants. The wood is employed for building and for furniture, the leaves for thatch, the shells for water vessels and the milky liquid contained in them as a beverage. The chief products reaching the temperate zone are copra, coco-nut oil, and coir which has already been mentioned.

In the preparation of copra oil the nuts are first split open and sun dried so that the kernel (copra) may be more readily separated from the shell. In the modern mills the main operations for obtaining the oil from the copra are: (1) reducing the copra to a fine meal; (2) heating to temperatures sufficiently high to evaporate all excess moisture and to melt the oil; (3) crushing in a press so as to squeeze out the melted oil.

The oil so obtained is used chiefly for soap making and to some extent in butter substitutes.

The world's annual production of copra is estimated at about two million tons.

Palm oil and palm kernel oil are obtained from a tree native to West Africa which is now cultivated in a number of tropical countries. In the Malay States and Sumatra cultivation is well established and the production of oil is of growing importance.

The/

The palm oil is obtained from the fleshy outer covering of the fruit and is usually yellow or reddish in colour. The kernel oil which is colourless is obtained by cracking the hard nut shell and extracting the kernel in the usual way.

Locally palm oil and kernel oil are used for foodstuffs, but in this country they are used chiefly in the manufacture of soap.

Peanut oil. The leguminous plant Arachis hypogaea produces fruit known as the earth nut, ground nut, monkey nut or peanut. A number of varieties are cultivated throughout tropical and sub-tropical countries. The nuts are used to some extent as human food but are chiefly valued for the oil which may be obtained by crushing.

The oil may be used as a salad oil or in the preparation of butter substitutes and soap.

Olive oil is obtained from the fruit of a small tree, Olea europaea which is native to the Mediterranean region and was cultivated in early Classical Times.

The fruit is used to some extent in the preparation of pickles but is more important as a source/

source of salad oil. The pulp of the fruit is pressed firstly in the cold and then hot. The oil obtained in the cold is fine quality salad oil, while the second fraction obtained after heating is employed in soap manufacture and as a lubricant.

Castor oil is obtained from the seeds of Ricinus communis which is regarded as native to North Africa, and was cultivated by the ancient Egyptians. It is now cultivated wherever the climate is suitable, India being the chief exporter.

The fresh seeds are cleaned, crushed and then placed in a hydraulic press. The oil which runs out is boiled with water to remove albuminoids and mucilage, and then filtered. A second fraction of oil may be obtained by hot pressing.

Cold drawn oil is preferred in medicine and as a lubricant, but the cruder oil is used extensively in the manufacture of Turkey-red oil, required in the dyeing and printing of cotton goods.

Cotton seed oil, linseed oil and maize oil which are "drying" oils have already been discussed.

Besides the fixed oils already discussed, a number of other vegetable oils of lesser importance are also used by man. Among these may be mentioned Kapok oil, the various Rape oils, Carapa fat, Shea butter, and Cacao butter.

B. Essential Oils.

Essential oils occur in a variety of plants either in the fruit, flower, leaf or stem. There are several methods of extraction, the most common being distillation. The material to be extracted is ground up, covered with water in a copper still and allowed to stand for some hours. The still is then heated so that the water boils and the volatile oil is carried over with the steam to a condenser. The distillate is allowed to stand in tall narrow vessels when the oil separates as a layer on the top.

In some cases distillation cannot be resorted to as the high temperature destroys the valuable odiferous constituents. In this case various methods are used involving mechanical rupture of the oil containing cells and pressing out of the oil.

Where the oil is present in so small quantities that such mechanical methods are not successful, a method known as "enfleurage" is adopted. This process consists in soaking the material in warm fat such as olive oil and subsequent extraction of the essential oil from the fat with suitable solvents.

Oil of Turpentine is industrially the most important of the essential oils. It has already been described in the section on Resins.

Camphor and Camphor Oil are terpenes extracted by distillation from the wood of the camphor tree which is grown in China and Japan, especially in the island of Formosa. Camphor is used mainly in the manufacture of celluloid and to a lesser extent in medicine. Synthetic camphor is now a serious competitor of the natural product.

Eucalyptus Oil is obtained from various species of Eucalyptus indigenous to Australia. The oil is used as an antiseptic and deodorant.

Many other essential oils are on the market, but are not used to any extent in industry. A few are of medicinal value, but the majority are used chiefly in the preparation of scents and flavourings and will therefore be considered in the fourth main section of the essay, "Plant products employed mainly for hedonistic reasons".

Dyes and Tans.

Many plants have brightly coloured juices in their roots, stems, or flowers, some of which have no doubt been utilised as dyes by primitive peoples for countless centuries, but today, since the introduction of/

of synthetic dyestuffs, the use of natural dyes has declined almost to vanishing point. Various artificial methods of tanning are now in use, but as the older methods are regarded as giving better results in the preparation of leather, the tannins have not fallen into disuse in the same way.

Indigo is probably the best known vegetable dye. It is believed to have been in use in Egypt as early as 3000 B.C. and a century ago was the most important dyestuff known; since then, however, it has been very largely ousted by the synthetic product. Indigo does not occur as such in the plant (several Indigo-ferra species) but as a colourless glucoside which has to be fermented to obtain the dyestuff.

Haematoxylin is obtained from the wood of the logwood tree, a native of Central America. The tree is felled when about ten years old and the trunk cut up into logs. The sap wood is cut off and the heart wood, which is deep brownish red in colour, is then cut up into chips by machinery. Haematoxylin is extracted from the chips with water and when fermented gives a deep purple-red dye.

Unlike indigo and other vegetable dyes,
haematoxylin/

haematoxylin has not been entirely displaced by synthetic aniline dyes, as for certain purposes such as staining microscopic sections no satisfactory substitute has been found.

Besides these two dyestuffs which are probably the most important, there are a number of others used in small quantities such as Litmus obtained from certain lichens and Tumeric obtained from the rhizomes of Curcuma longa. Woad, a blue dye extracted from a European plant, Isatis tinctoria, also deserves special mention for although now practically unknown it was, before the introduction of indigo, the chief dyestuff of Europe.

Tannin is the term applied to a group of natural products which have certain properties in common. Most tannins occur in the plant as glucosides. Free tannins are uncrystallisable colloidal substances which have the property of precipitating proteins. On this property depends their use in the conversion of hide into leather. Tannins are also used in the preparation of ink. Tanning materials are derived from a number of plants.

Hemlock-fir bark, oak bark, birch bark, larch bark, spruce bark, chestnut bark and willow bark are/

are the chief sources of tannins in Europe. In warmer countries different sources are employed such as wattle bark in Australia and Africa, considerable quantities of which are imported into this country, and divi-divi, the dried husks of the pods of a leguminous plant cultivated in Central and South America. A number of other tropical plants, the chief of which is probably Mangrove, also provide tannins.

PLANT PRODUCTS USED AS MEDICINALS AND

1913.

In the earliest times, as in savage communities today, there was no special knowledge of medicinal plants. Among primitive peoples the priest or "witch doctor" is the physician and botanist. Savage man is always subject to periods of food scarcity and at such times is forced to eat roots, berries or seeds. By such enforced experimentation he would learn to distinguish certain plant products as poisonous and others as useful.

III. PLANT PRODUCTS USED AS MEDICINALS AND

DRUGS.

Use of plant extracts as medicines is in fact one of the oldest and most important methods of medicine. The ancient peoples of India also were learned in the use of medicinal plants as is shown by the existence of certain Sanskrit works, in which are described methods of gathering and curing herbs for medicinal use. Hippocrates described after a fashion three hundred plants regarded as useful in the treatment of disease. The earliest Dissertation on Materia Medica which was compiled in the first century of the Christian era served as a textbook to the pharmacist, botanist and physician for over a thousand years. This fact is indicative of the almost complete lack of progress in Materia Medica during the Middle Ages. Modern pharmacology has

In the earliest times, as in savage communities today, there was no doubt some knowledge of medicinal plants. Among primitive peoples the priest or "witch doctor" is the physician and botanist. Savage man is always subject to periods of food scarcity and at such times is forced to eat roots, berries or buds. By such enforced experimentation he would learn to distinguish certain plant products as poisonous and others as useful.

As might be expected the earliest record of the use of plant extracts as medicinals is in China some four or five thousand years back. The ancient peoples of India also were learned in the use of medicinal plants as is shown by the existence of certain Sanskrit works, in which are described methods of gathering and curing herbs for medicinal use. Hippocrates described after a fashion three hundred plants regarded as useful in the treatment of disease. The book of Dioscorides on *Materia Medica* which was compiled in the first century of the Christian era served as a textbook to the pharmacist, botanist and physician for over a thousand years. This fact is indicative of the almost complete lack of progress in *Materia Medica* during the Middle Ages. Modern pharmacology has developed/

developed rapidly along with modern medicine during the last two to three hundred years.

The number of plant products used medicinally is very large. Originally each country developed its own medicinal plant resources in order to meet its own requirements. As intercommunication increased the drugs of each nation became available to the others and were extolled by enthusiastic supporters, with the result that many plant products became introduced as part of the common materia medica of civilised countries, although practically identical in physiological action and medicinal value with substances already in use.

Besides the well recognised Materia Medica, there are of course a number of plant products employed in the manufacture of patent medicines and "quack" remedies which are medicinally quite worthless except in so far as they may have a beneficial psychological effect.

In this section it would be quite impossible to mention all the plant products of medicinal value. A few such as castor oil and camphor have already been mentioned and a number of others, which are used in pharmacy chiefly for flavouring unpleasant medicines, will be considered in Section IV, "Plant Products Employed Mainly for Hedonistic Reasons". The most that/

that can be done here is to mention as briefly as possible the more important plant products used as medicinals or drugs and indicate their application.

Cinchona Bark is obtained from a medium sized evergreen tree native to South America. The value of cinchona bark is said to have been recognised by the natives before the Spanish invasion. It was introduced into Europe in 1639 and was soon recognised as an excellent antimalarial.

The antimalarial properties of the bark are due to the presence of an alkaloid, quinine, to the extent of 5-10%. In the early days a concoction of the ground bark was commonly used, but today the pure alkaloid is extracted on a commercial scale and used as such.

The various species of cinchona tree which were originally grown almost entirely on the slopes of the Andes are now largely cultivated in India, Java and other eastern tropical regions.

Coca consists of the dried leaves of two species of Erythroxylon, a small shrub which grows wild in the South American Andes at elevations ranging from two thousand to nine thousand feet. The leaves are universally chewed by the natives of Bolivia, Peru and/

and the neighbouring countries. The chewing of the leaves exerts a pleasurable effect on the mind, and enables the subject to undergo considerable physical fatigue without undue discomfort.

The leaves contain several alkaloids, the most important being cocaine. Cocaine is used extensively in dentistry and surgery as a local anaesthetic. As the amount of alkaloid present in the leaves is less than one per cent. considerable quantities of the leaves are required for the preparation of the pure product. Peru, Bolivia and Java are the main sources.

Opium is obtained from the milky juice of a member of the poppy family (Papaver somniferum) which is regarded as native to Western Asia but which is now cultivated widely especially in the oriental countries.

The unripe fruit of the plant is incised and the milky juice which exudes is collected. On evaporation a brownish plastic material is obtained which when completely dry becomes hard and brittle and can be reduced to a powder in which form it is largely employed.

Among oriental races large quantities of opium are consumed by smoking and in other ways as an intoxicant/

intoxicant often with serious results on both mind, and body. It contains about twenty different alkaloids, the most important being morphine. Morphine is used extensively in the relief of physical pain.

Opium was known to the Greeks in early Classical Times.

Belladonna, a small much branched herb three to five feet in height is native to Central Europe but does not appear to have been recognised as possessing medicinal properties until the sixteenth century. The value of the plant lies in the fact that the leaves are a source of the alkaloid Atropine which is extensively used by ophthalmologists in order to paralyse the muscles of the eye which cause accommodation.

Besides the medicinal plants already discussed which are probably the more important alkaloid containing plants, there are a large number of other plants from which alkaloids employed in medicine are extracted. Among these may be mentioned henbane from which hyoscyamine is obtained; Strychnos nuxvomica, the source of strychnine and brucine; Aconitum Napellus (monkshood), the source of aconitine; and Psychotria ipecacuanha, from which the two powerful emetics/

emetics emetine and cephaeline, are obtained.

Besides the alkaloid containing plants there are however a number of other plants of medicinal importance which contain active principles other than alkaloids.

Digitalis or Foxglove (Digitalis purpurea) which is of considerable medicinal value owes its action not to an alkaloid but to a glucoside known as digitalin. The glucoside is extracted from the leaves of the plant, and is specially valued because of its action in slowing down the rate of the heart beat, and so permitting this tireless organ to rest somewhat.

The plant is indigenous to Europe and cultivated chiefly in England and Germany. The value of digitalis in medicine does not appear to have been recognised in Classical Times, but during the Middle Ages extracts of the plant figure in family recipes.

Chaulmoogra Oil is obtained from the seeds of a large tropical tree (Taraktogenos kurzii) by the usual methods of expression.

Chaulmoogra seeds have been known for centuries to the natives of south-eastern Asia as a palliative in/
in/

in leprosy and other skin diseases, but it is only within the last few years that chaulmoogra oil has been recognised by modern medicine as of great value in combating the disease. It was during the first few years of the present century that European and American physicians first became interested in the value of chaulmoogra oil. Early results were promising but it was found that treatment was so painful that patients refused to continue it. The modern chemist has however been able to improve upon nature. He has shown that the ethyl ester of chaulmoogric acid possesses all the potency of the crude oil in the treatment of the leprosy and none of its drawbacks.

The valuable purgatives Liquorice from rhizomes of Glycyrrhiza glabra (Europe), Cascara sagrada from the bark of Rh^aomnus purshiana (N. America), and rhubarb from the rhizomes of Rheum palmatum (China) may be quoted as further examples of common medicinals of a non alkaloidal nature.

The lower animals require food and drink; primitive man requires food, drink, and a place to live; as he rises higher in the scale of civilization his wants become more numerous: in addition to food and shelter he requires cloth, which he obtains from animals; as each civilization progresses he desires his needs become more diverse, and widely separated.

IV. PLANT PRODUCTS EMPLOYED MAINLY FOR

HEDONISTIC REASONS.

The plant world provides the material for three main groups of these luxuries. Decorative plants are utilized in the improvement of surroundings, spices for flavoring of foods, and essential oils in the provision of exotic perfumes. In addition to these there is one plant product, tobacco, which deserves special mention on account of the unique position it occupies in modern civilization.

Decorative Plants.

Man has gathered plants from all corners of the earth to decorate and embellish their houses and grounds. Many of these are so familiar in everyday

The lower animals require food and drink; primitive man requires food, drink, and a rude hut; as he rises higher in the scale of civilisation his wants become more numerous; in addition to food and shelter he requires cloth from which to fashion clothes; as each milestone in progress is passed his needs become more diverse, more widely separated from his animal requirements. Civilised man becomes dissatisfied with the appearance of his surroundings, with the taste of his food and with the smell of his body. He tries to improve them all and so introduces the so-called "refinements of civilisation". The plant world provides the material for three main groups of these luxuries. Decorative plants are utilised in the improvement of surroundings, spices the flavouring of foods, and essential oils in the provision of exotic perfumes. In addition to these, there is one plant product, tobacco, which deserves special mention on account of the unique position it occupies in modern civilisation.

Decorative Plants.

Men have gathered plants from all corners of the earth to decorate and embellish their houses and grounds. Many of these are so familiar in everyday/

everyday life, that we do not realise their distant origin or the great improvement effected in them through the art of the gardener and plant breeder. The decorative plants conveniently fall into four main groups based on their uses.

Cut Flowers.

Under this heading may be considered the flowers which are of first commercial importance to florists, and which generally serve in house decoration as vase flowers.

The Rose is at once one of the commonest and one of the most beautiful cut flowers. It has long been valued by man as a decorative plant and is mentioned by Horace as a decoration at Roman banquets.

Because of their ancient cultivation it is very difficult to be sure of the true botanical origin of the numerous rose varieties.

Besides being grown for "cut flowers" the rose is grown as a garden plant. One species, Rosa damascena, is grown for the production of attar of roses, a highly valued perfume.

The Sweet Pea is first recorded in a botanical treatise of an Italian priest in 1695; it was not until/

until about 1880 however that professional gardeners and breeders became interested in the flower and raised it to its present high standard. It is valued as a "cut flower" throughout the north temperate zone, over one thousand horticultural varieties being in every-day use.

The Carnation, Tulip and Daffodil are further examples of flowers valued for indoor decoration.

It is impossible here to name all the flowers so used as each climatic zone produces a variety of types for such purposes.

Pot Plants.

As distinct from the cut flowers already discussed, flowers of the pot plants, although also valued in indoor decoration, are not cut from the plant. This fact necessitates that the leaves of the pot plant be decorative as well as the flowers, a point which is of no great importance in cut flowers.

The Geranium is probably now the most familiar pot plant in North America and Europe. The plant appears to be native to South Africa from where it was transported by early Dutch and English settlers.

The/

The Begonia, a native of tropical jungles, various Ferns, the Hyacinth, and various dwarf Palms, are among the numerous other pot plants in common use.

Outdoor Flowers.

The distinction between cut flowers and garden flowers is perhaps rather narrow, but there are many plants the beauty of which we are more accustomed to admire in garden "beds" than in the vase.

The Pansy is one of the best known and probably also one of the oldest of horticultural plants. It was certainly appreciated along the shores of the Mediterranean in the time of Vergil, and full descriptions of the flow appear in the early English books on gardening.

The Nasturtium (Peru), the Anemone (N. Hemisphere) and the Petunia (Argentine) are further examples of flowers valued by the garden lover.

Shrubs, Creepers and Trees.

Much of the quiet beauty of a fine garden is often due to a judicious use of non-flowering plants. Besides beautifying the garden they generally/

generally serve to give shelter to their more delicate neighbours, the many hued flowering plants. Among the best known shrubs may be mentioned Hawthorn and Laurel. Ivy, the Grape vine and Virginia creeper are the best known "climbers", while a variety of trees such as Beech, Oak and Rowan and in tropical countries the various Palms make a pleasing background to the picture.

Spices.

Spices are valued for their flavouring properties. Food which is normally insipid or unpalatable is rendered attractive and appetising. Before modern communication, refrigeration and canning developed, the variety of foodstuffs available was relatively small, and much tended to be stale before reaching the bigger markets, so that anything which tended to improve flavour and banish monotony became a highly valued luxury.

The history of the trade in spices is most interesting. In the Classical period spices were in great demand, but were hard to obtain as they had to be brought from the east by a long and dangerous caravan journey. During the Middle Ages spices were/

were little more than a luxury of the very rich, but, at the end of the fifteenth century, with the discovery by Vasco de Gama of the sea route to India, new possibilities were opened up. It became possible to obtain spices more easily and in larger quantities, so that as long as the price level was kept high the trade was exceptionally profitable. At first Portugal practically held a monopoly, but by the end of the sixteenth century the trade had passed largely into the hands of the Dutch. Their supremacy was short lived however, as during the seventeenth century the lure of profit attracted England, and the resulting struggle ended finally in most of the trade passing into her hands. The subsequent development of the British Empire in the east, although influenced by a number of other factors, is to be attributed in the first place to the spice trade.

Spices differ from essential oils in that although their flavour is due in most cases to the presence of certain volatile oils, they are plant tissues themselves and not extracts from them.

Cinnamon seems to have been the first spice sought after by oriental travellers, and was certainly known to the Hebrews, Greeks and Romans. There is some evidence also that it was in use in China as early/

early as 2700 B.C.

Cinnamon bark is obtained from a number of Asiatic trees of the Laurel family. The cultivation of cinnamon trees is quite a recent development, most of the spice before 1800 being obtained from wild trees. To-day most of the imports to this country are from Ceylon and India, where the tree Cinnamomum zeylanicum is successfully cultivated.

Cinnamon is used as a spice in foods, and as a flavouring in medicines. The characteristic odour and flavour are due to the presence of essential oils.

Pepper like cinnamon was known to classical civilisation. Black pepper is the dry pulverised berry of Piper nigrum, a climbing shrub native to India. White pepper is prepared from the same berry by first removing the black outer skin. Cayenne pepper on the other hand is the dried fruit of a tropical American plant of the family Solanaceae. Most of the world's supply of black and white pepper is now grown in the Malay Peninsula, and is used extensively in flavouring foodstuffs.

Cloves were highly appreciated during the period of the Roman empire as is indicated by the price paid, which at one time reached a figure equivalent to several/

several hundred shillings per ounce.

Cloves are obtained from the clove tree (Eugenia aromatica). The tree which is native to south eastern Asia bears, under normal conditions, clusters of crimson flowers, but when cultivated for cloves the young flower buds are gathered before the flowers appear, and these when dried form the well known spice.

Cloves are used chiefly as a spice, and to a lesser extent in perfumery and in dentistry.

Ginger is prepared from the dried rhizomes of Zingiber officinale, native to India, but now cultivated extensively throughout the tropics.

Ginger was known during the Classical period, and its use had spread to England as early as the Norman Conquest. Besides its use as a condiment, ginger is used extensively in the preparation of beverages such as ginger ale.

Allspice, the dried fruit of a West Indian tree, Nutmeg and Mace, the dried seed and seed coat of a New Guinea tree, and Mustard, the ground seeds of Brassica nigra and B. alba, are further well known examples of plant products valued as spices.

Perfumes.

In addition to improving the appearance of his surroundings and the flavour of his foods, civilised man must needs try to improve the aroma of his environment. The Egyptians were experts in the preparation of perfumes, as were the Greeks and Romans. During the Middle Ages the art was allowed to languish, but under the stimulus of modern civilisation it has reached a point where it is rapidly becoming a science rather than an art.

The odiferous principles of perfumes are volatile oils. The methods employed in the extraction of volatile oils from plants have already been discussed. The flavours of many spices also depend, as already mentioned, on volatile oils, so that, as might be expected, many of these oils are used both in perfumery and in foods.

Attar of Roses (from Rosa damascena), Geranium oil (from several species of Pelargonium), Lemon Grass oil (from Anaropogon citratus), Lavender oil (from Lavandula vera and related species), Bergamot oil, Orange oil, Lemon oil and Almond oil, may be quoted as well known examples of essential oils used in perfumery.

Tobacco.

Tobacco is prepared from the leaves of several species of Nicotiana, a genus of plants belonging to the natural order Solanaceae. The first trustworthy account of the use of the herb is to be found in the report of the first voyage of Columbus in 1492. Later as the Spaniards penetrated the new country, it became more and more obvious that the practice of smoking the tobacco leaf was an ancient and universal usage among the native peoples. The plant was first introduced to Europe by a physician, Francisco Fernandez, who was commissioned by Philip II of Spain to investigate the economic possibilities of the flora of Mexico. For some considerable time it appears to have been considered as a medicinal herb only; so that it fell to an Englishman to introduce the habit of smoking the herb to the inhabitants of the Old World.

When in 1586, Lane, the first governor of the New English Colony of Virginia, and Francis Drake, returned from that colony they brought back with them the tobacco leaf cured for smoking, and in addition the pipes and apparatus used in the process. There seems to be some doubt as to who was the first Englishman to adopt the new habit; but the honour is generally ascribed/

ascribed to Lane, although familiar stories are more generally associated with the name of Sir Walter Raleigh.

No sooner had the habit of smoking been established than it spread like wild fire among the nations of the Old World. At first the new habit was frowned upon by the state and the church, and most drastic measures were taken for its suppression, but by the end of the seventeenth century it had gained such a hold that opposition gradually faded.

To-day tobacco occupies quite a unique position in human affairs. Of all the luxuries of modern civilisation it most nearly approaches the status of a food, an everyday necessity of life.

The tobacco of commerce is almost entirely the produce of three species, Nicotiana tabacum, N. rustica and N. persica. These three species are all native to the New World, but to-day their cultivation has become almost universal. In the preparation of tobacco the leaves are first dried, then slightly fermented by bacterial action so as to impart flavour, and finally made up into cigars, or rolled and cut for pipe and cigarette. The annual production of tobacco is considerably over a million tons, valued at more than £50,000,000 sterling.

The first section of this report deals with the general principles of plant products which adversely affect man. It discusses the various types of plant products and their effects on human health. The second section deals with the specific types of plant products which are known to be harmful to man. These include the alkaloids, glycosides, and other toxic substances. The third section discusses the various methods of plant product extraction and purification. The fourth section discusses the various methods of plant product analysis and testing. The fifth section discusses the various methods of plant product control and regulation. The sixth section discusses the various methods of plant product utilization and application. The seventh section discusses the various methods of plant product storage and preservation. The eighth section discusses the various methods of plant product distribution and sale. The ninth section discusses the various methods of plant product importation and exportation. The tenth section discusses the various methods of plant product research and development.

V. PLANT PRODUCTS WHICH ADVERSELY AFFECT MAN.

This section discusses the various types of plant products which are known to be harmful to man. It includes a list of the various types of plant products and their effects on human health. The first type of plant product discussed is the alkaloids. These are a group of naturally occurring compounds that are found in many plants and are known to be highly toxic to humans. The second type of plant product discussed is the glycosides. These are a group of naturally occurring compounds that are found in many plants and are known to be highly toxic to humans. The third type of plant product discussed is the other toxic substances. These include a wide variety of plant products that are known to be harmful to humans, such as the cyanides, the saponins, and the tannins. The fourth type of plant product discussed is the alkaloids. These are a group of naturally occurring compounds that are found in many plants and are known to be highly toxic to humans. The fifth type of plant product discussed is the glycosides. These are a group of naturally occurring compounds that are found in many plants and are known to be highly toxic to humans. The sixth type of plant product discussed is the other toxic substances. These include a wide variety of plant products that are known to be harmful to humans, such as the cyanides, the saponins, and the tannins.

Poisonous Plants.

There are certain plants some of which have already been mentioned which contain extremely poisonous principles. Many of these find use in medicine and so although they may cause death if taken carelessly, they may save life if administered skilfully. It is obvious then that no real line of separation can be drawn between medicines and poisons.

The number of poisonous plants which are found growing wild or in gardens is quite considerable, and the cases of poisoning annually reported as due to them are more numerous than is commonly realised. Among the common wild plants which have^a bad reputation in this respect may be mentioned the Water Hemlock, the poison hemlock (believed to be the plant by which Socrates was poisoned), the common pokeweed and the monkshood.

There are a number of poisonous plants also which owe their poisonous nature not to their alkaloidal content, but to the presence of cyanogenetic glucosides which on hydrolysis yield the extremely poisonous substance hydrocyanic acid. Cassava, which has already been discussed may be mentioned in this connection. The tubers of bitter cassava are used extensively as a foodstuff, but only after very careful extraction of the contained prussic acid, which normally renders the tuber extremely poisonous.

Whether/

Bacteria and Fungi .

Whether the bacteria and fungi are to be classed as plants is a disputed point. Unlike ordinary plants they possess no chlorophyll and are therefore, like the animal kingdom, dependent upon preformed organic material. They are however generally considered as more nearly allied to the plant kingdom and therefore deserve brief mention here.

Various pathogenic bacteria such as B. typhosus, B. diphtheriae and B. tetanus, when they obtain a foothold in the human body, produce toxins which cause serious illness and death.

Ergot may be mentioned as having been at one time one of the most fatal, and to-day one of the most highly valued of fungi. The ergot develops on growing rye, and when the crop is harvested is liable to contaminate the grain. Formerly this led to much suffering and death among poor peasant populations, dependent largely on rye bread, but since the recognition of the cause of ergotism such cases have become increasingly rare. The poisonous properties of ergot are due to the presence of a number of alkaloids which have now been isolated in the pure state. Some of these have physiological properties which render them especially valuable as drugs in child birth.

Other fungi which often cause isolated deaths/

deaths in every country are the poisonous mushrooms. There are a large number of edible species of these fleshy fungi which grow abundantly in the wild state in our fields and woods, but every year cases are reported of deaths resulting from eating poisonous species which are mistaken for the edible types.

It has been impossible in the short space of an essay to mention all the plants which directly affect human life, but, without any claim to completeness, it may be said that almost every species of really first-rate importance has been mentioned. When it is remembered that there are something like 250,000 known species of flowering plants, it is realized that man has indeed made a very small selection out of the available flora.

It would seem that man, early in his history, exploited the CONCLUSION. useful plants, and that they have since been used more and more extensively. It is not to be supposed that the use of plants has tended to spread rapidly over the world, but that it has been slow and gradual. This is not to say that no others can be used, but that, as in natural selection, the line of least resistance has been pursued. While the products of the species which have been used are not abundant, others, but if the source of raw material is cut off, additional species are used. This has been strikingly illustrated during the Great War. The plants which can be used are not abundant, and a reserve of substitutes, as it were, is necessary for future exploitation.

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It has been impossible in the short space of an essay to mention all the plant products which directly affect human life, but, without any claim to completeness, it may be said that almost every species of really first-rate importance has been mentioned. When it is remembered that there are something like 250,000 known species of flowering plants, it is realised that man utilises intensively a mere handful of the available flora.

It would seem that man, early in his history, exploited the cream of the world's useful plants, and that they have sufficed him ever since. Civilisation has tended to spread already utilised species rather than develop new ones. This is not to say that no others can be used, but that, as is natural enough, the line of least resistance has been pursued. While the products of one species suffice there is little inducement to develop others, but if the source of raw material is cut off, additional species formerly ignored are soon pressed into use. This was strikingly illustrated during the Great War. The plants which can be thus utilised when need arises constitute, as it were, a reserve for future exploitation.

While/

While little has been done as yet by modern science in the direction of developing entirely new cultivated species from natural wild plants, much has been done in the way of improving existing varieties of valuable cultivated plants, and in increasing crop yield by manuring and rotation.

Until about half a century ago, the only methods known of improving plant breeds were selection and hybridisation, but a far more valuable method is now available, thanks to the researches of Mendel. It is impossible to discuss the vast subject of Mendelism here, but expressed shortly its value lies in that, by following certain well defined laws, it is possible to vary the constitution of a race very much, and to eliminate many undesirable characters.

In the control and prevention of plant diseases scientific investigation again has been of the greatest possible value. Some diseases have been eradicated almost completely, and others brought under some degree of control.

The trend of modern agriculture then appears to be in the direction of the improvement of existing species of cultivated plants, and in increasing the yield per acre of cultivated land.

Finally might I emphasise just once again the dependence of man on the plant world. The most fundamental/

fundamental fact about the human race is that, biologically, man is an animal, and is in the most fundamental respects little different from the other members of that class. It is true that man has, by the development of reason, risen to a position of dominance over other living things, but the high level of culture which he has attained has increased rather than lowered his dependence on plant products. He is indeed a parasite on the green leaf.

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