acid or the ferment called “diastase,” which is supposed to be the active agent in malt. For its preparation 2 kilograms (4·40 lb) of potato starch are made into a paste with 9 litres (15·84 pints) of water over a water-bath ; after allowing it to cool down to 60° or 65° C., an infusion of from 120 to 140 grams (4·23 to 5 oz. ) of malt made at 40° C. is added. The mixture is kept at from 60° to 65° for an hour ; it is then boiled and filtered. The filtrate is evaporated to a syrup, which is exhausted twice with alcohol of 85 per cent. by weight and then once with absolute alcohol. The dextrin (mostly) remains ; the maltose passes into solution. The alcoholic extracts are evaporated to a syrupy con­sistence and allowed to stand. The absolute alcohol extract soon yields a crop of impure crystals of maltose, which are used to induce crystallization in the other two syrups. In regard to the somewhat tedious methods of purification we refer to the handbooks of chemistry. Maltose crystallizes (from alcohol on spontaneous evaporation) in fine needles of the composition C12H22O11 + H2O. The H2O goes off at 100° C. Maltose is less soluble in alcohol than dextrose, to which it is otherwise very similar. To caustic alkalis and Fehling solution it behaves exactly as dextrose does. Like it, it suffers vinous fermentation under the influence of yeast. When boiled with dilute sulphuric acid it breaks up into (so to say) dex­trose and dextrose. Maltose plays an important part in the brewing of alcoholic malt liquors. (W. D.)

*History.*

The original habitat of the sugar-cane is not known, but it seems to have been first cultivated in the country extending from Cochin China to Bengal (De Candolle). Sugar reached the West from India, and at a comparatively late date. Strabo (xv. i. 20) has an inaccurate notice from Nearchus of the Indian honey-bearing reed, and various classical writers of the first century of our era notice the sweet sap of the Indian reed, or even the granulated salt-like product which was imported from India, or from Arabia and Opone (these being entrepôts of Indian trade),@@1 under the name of sac- charum or *σάκχαρι* (from Sanskr., *sarkara,* “gravel,” “sugar”), and used in medicine. The art of boiling sugar was known in Gangetic India, from which it was carried to China in the first half of the 7th century ; but sugar-refining cannot have then been known, for the Chinese learned the use of ashes for this purpose only in the Mongol period, from Egyptian visitors.@@2 The cultiva­tion of the cane in the West spread from Khúzistán in Persia. At Gundé-Shápúr in this region “sugar was prepared with art” about the time of the Arab conquest,@@3 and manufacture on a large scale was carried on at Shuster, Sus, and Askar-Mokram throughout the Middle Ages.@@4 It has been plausibly conjectured that the art of sugar-refining, which the farther East learned from the Arabs, was developed by the famous physicians of this region, in whose phar­macopceia sugar had an important place. Under the Arabs the growth and manufacture of the cane spread far and wide, from India to Sus in Morocco (Edrisi, ed. Dozy, p. 62), and were also introduced into Sicily and Andalusia.

In the age of discovery the Spaniards became in their turn the great disseminators of the sugar cultivation : the cane was planted by them in Madeira in 1420 ; it was carried to San Domingo in 1494 ; and it spread over the occupied portions of the West Indies and South America early in the 16th century. Within the first twenty years of the 16th century the sugar trade of San Domingo expanded with great rapidity, and it was from the dues levied on the imports brought thence to Spain that Charles V. obtained funds for his palace-building at Madrid and Toledo. In the Middle Ages Venice was the great European centre of the sugar trade, and towards the end of the 15th century a Venetian citizen received a reward of 100,000 crowns for the invention of the art of making loaf-sugar. One of the earliest references to sugar in Great Britain is that of 100,000 lb of sugar being shipped to London in 1319 by Tomasso Loredano, merchant of Venice, to be exchanged for wool. In the same year there appears in the accounts of the chamberlain of Scotland a payment at the rate of 1s. 91/2d. per pound for sugar. Throughout Europe it continued to be a costly luxury and article of medicine only, till the increasing use of tea and coffee in the 18th century brought it into the list of principal food staples. The increase in the consumption is exemplified by the fact that, while

@@@1 Lucan, iii. 237 ; Seneca, *Epist.,* 84; Pliny, *H.N.,* xii. 8 (who supposes that sugar was produced in Arabia as well as in India) ; *Peri.pl. Mar. Eryth.,* § 14 ; Dioscorides, ii. 104. The view, often repeated, that the saccharum of the ancients is the hydrate of silica, sometimes found in bamboos and known in Arabian medicine as *tabáshír,* is refuted by Yule, *Anglo-Indian Glossary,* p. 654 ; see also *Not. et Extr. des MSS. de Ia Bibl. Nat.,* xxv. 267 *sq.*

@@@2 Marco Polo, ed. Yule, ii. 208, 212. In the Middle Ages the best sugar came from Egypt (Kazwini, i. 262), and in India coarse sugar is still called Chinese and fine sugar Cairene or Egyptian.

@@@3 So the Armenian *Geography* ascribed to Moses of Chorene *(q.v.* for the date of the work); St Martin, *Mém. sur l’Arménie,* ii. 372.

@@@4 Istakhrí, p. 91 ; Yakut, ii. 497. Tha'álibí, a writer of the 11th century, says that Askar - Mokram had no equal for the quality and quantity of its sugar, “notwithstanding the great production of 'Irak, Jorján, and India.” It used to pay 50,000 pounds of sugar to the sultan in annual tribute *(Latáif,* p. 107). The names of sugar in modern European languages are derived through the Arabic from the Persian *shakar.*

in 1700 the amount used in Great Britain was 10,000 tons, in 1800 it had risen to 150,000 tons, and in 1885 the total quantity used was almost 1,100,000 tons.

In 1747 Andreas Sigismund Marggraf, director of the physical classes in the Academy of Sciences, Berlin, discovered the existence of common sugar in beetroot and in numerous other fleshy roots which grow in temperate regions. But no practical use was made of the discovery during his lifetime. The first to establish a beet-sugar factory was his pupil and successor, Franz Carl Achard, at Cunern (near Breslau) in Silesia in 1801. The processes used were at first very imperfect, but the extraordinary increase in the price of sugar on the Continent caused by the Napoleonic policy gave an impetus to the industry, and beetroot factories were established at many centres both in Germany and in France. In Germany the enterprise came to an end almost entirely with the downfall of Napoleon I. ; but in France, where at first more scientific and economical methods of working were introduced, the manufacturers were able to keep the industry alive. It was not however, till after 1830 that it secured a firm footing ; but from 1840 onwards it advanced with giant strides. Now it is an industry of national importance, especially in Germany, control­ling in the meantime the market against the cane-sugar trade. While cane sugar was practically without a rival, the cultivation was in general highly profitable, but it was conducted under tropical skies, largely by slave labour and entirely removed from scientific supervision. The staple produced at the plantations was raw sugar, whieh was sent to Europe to be refined. It was not till the pressure of the competition with beet sugar began to make itself felt that planters realized the necessity for improving their methods of working. It has now been found possible to apply many of the processes and appliances devised in connexion with the production of beet sugar to the extraction of its older rival.

*Manufacture.*

Cane Sugar Manufacture.—The sugar-cane *(Saccharum officin­arum)* is a species of grass, the stalks or canes of which reach a height of from 8 to 15 feet, and attain a diameter of 11/2 to 2 inches. The stalks are divided into prominent joints or internodes, the long sheathing alternate leaves springing from each joint. As the canes approach maturity they throw up a long smooth hollow joint termed the *arrow,* whence springs the flower head, consisting of beautiful feather-like loose panicles. The points are filled with a loose spongy fibrous mass, saturated with a juice which is at first watery but afterwards becomes sweet and glutinous. As the joints ripen, the leaves wither and fall away and the stem becomes externally smooth, shining, and hard, containing much silica. The varieties of sugar-cane in cultivation are very numerous, and are distinguished from each other by external colour, length of internodes (31/2 to 10 inches), height to which they grow, richness in juice, and many other characters. The four principal classes cultivated in the West Indies are the Creole or country cane, the Tahiti cane, the Batavian cane, and the Chinese cane. An average sample of Tahiti cane at maturity contains—water, 71·04 per cent. ; sugar, 18·00 ; ligneous tissue and pectin, 9·56 ; albumen, colouring matter, and insoluble salts, 1·20 ; silica, 0·20. The sugar-cane requires a rich, well-drained, but moist soil. It is propagated by slips taken from the upper part of the canes, which are planted at intervals about 5 feet apart or in close-set rows 6 feet apart. In the West Indies the planting takes place between June and October, and in the case of the Creole variety the canes are ready for cutting down by the beginning of January in the second following year. When mature the canes are cut down close to the ground, the remaining leaves and upper shoot removed, and the stalks immediately taken to the mill for crushing. The stocks left are liberally manured with crushed remains and ashes of former crops, combined with nitrogenous manures, and are covered over ; they then send up a crop of new stems, termed *rattoons.* The system of rattooning can be continued for several years, but the canes so treated go on declining in size and in yield of sugar. The yield of canes, of course, varies within wide limits ; but 20 tons per acre may be regarded as a good average crop.

*Cane-Crushing.—*The juice is extracted by pressing the canes in a sugar-mill between three, or sometimes five, heavy close-set rollers of iron, placed horizontally in a powerful framework or cheeks. In a three-roller mill they consist of a *cane, top,* and *megass* roller respectively. The top roller is set above and between the other two, and under its periphery is a fixed metal plate called the *trash turner,* which guides the cane coming from between the cane and top rollers into the bite between top and megass rollers. Generally the cane roller is screwed up to within half an inch of the top roller, while the free space between top and megass rollers is considerably less. The mill is set in motion by steam power, and the canes are fed by hand on a travelling band or carrier into the rollers. If a thick feed is placed at one side and little at the other, one portion passes through imperfectly crushed, while the other severely strains the mill and may either stop the machinery or cause a breakdown by some portion giving way. The yield of