juice obtained with an ordinary mill varies from 60 to 65 per cent. One of the most useful devices for improving the machinery is the substitution of an hydraulic attachment, which can be applied to the headstocks of any of the rollers, in place of the rigid and immovable screws and wedges of the ordinary mill. This secures a uniform pressure with the most irregular feed and much greater pressure than is possible with rigid rollers, resulting in a greatly increased yield of juice (67 to 70 per cent.) and a megass or refuse proportionately drier and therefore more available for fuel for steam-raising. The juice from the mill is led into a trough, whence it is carried by pipes to the clarifiers. But even the most perfect system of mechanical pressure leaves a large percentage of sugar in the refuse cane, and to remedy this the diffusion method (see below), which has been attended with remarkable success in the beet industry, has been also applied to the extraction of cane juice. At Aska (Madras) in India it has been found possible by that process to obtain as much as 87½ of the 90 per cent. of juice present in canes. Considerable difficulty was at first found in slicing the silicious stalks for diffusion; but this process seems to promise a much more exhaustive extraction of the juice than can be secured by mechanical means. The juice is a turbid frothy liquid of a yellowish green colour, with a specific gravity of from 1·070 to about 1·100. The variety of cane cultivated, its age, and especially the nature of the season in which it has grown as regards rain, all have an important influence on the yield of sugar. The expressed juice contains from 15 to 18 per cent. of solids, showing on a good average—sugar, 14·55 per cent.; glucose, 1·65; non-saccharine solids, ·917; ash, ·283. The juice got from sugar-cane is much richer in sugar and less contaminated with non-saccharine solids than that yielded by beet; and its pleasant taste and aromatic odour contrast markedly with the acrid taste and unpleasant smell of beet juice.

Purification of cane juice.

Purification of the Juice.—In the hot climates where sugar-canes grow a process of fermentation is almost immediately set up in the impure juices from the canes, causing the formation of invert sugar and later products of fermentation, and thereby a serious loss of sugar. It is therefore essential that with the least possible delay the manufacturing processes should be proceeded with. The juice is first filtered through a set of sieves to remove the mechanical impurities it carries from the mill. Then it is run into the clarifiers, a series of iron vessels capable of holding six or eight hundred gallons of juice, and in these it is heated up to about 130° Fahr., and milk of lime is added in quantity sufficient to neutralize the acid constituents it contains. The heat is then raised to just under the boiling-point, when gradually a thick scum rises and forms on the surface, and when the defecation thereby effected is complete the clear liquid below is drawn off. Various other substances besides lime are employed for the defecation of juice, one of which, the bisulphite of lime in the so-called Icery process, has attained considerable favour. The bisulphite is added in excess; the acids of the juice decompose a certain proportion of it, liberating sulphurous acid, which by its influence promotes the coagulation of the albuminous principles and at the same time promotes the bleaching of the liquid. In another process the green juice is first treated with sulphurous acid, which (with the natural acid constituents) is subsequently neutralized by lime. Recently also phosphoric acid has come into favour as a defecating agent.

Boiling Down.—From the clarifier the juice passes on to the battery, a range of three to five pans or "coppers," heated by direct fire, in which it is concentrated down to the crystallizing point. The juice, gradually increasing in density, is passed from the one into the other till it reaches the last of the series, the *striking teach*, in which it is concentrated to the granulating point. The skimmings from these pans are collected and used for making rum. From the striking teach the concentrated juice is removed to shallow coolers, in which the crystals form. A few days later it is transferred to hogsheads in the curing-house, and the molasses is drained away from the crystallized raw sugar into tanks. The sugar so obtained is the *muscovado* of the sugar-refiners, and both that and the molasses form their principal raw materials. Clayed sugar consists of raw sugar from which a portion of the adherent molasses has been dissolved by the action of moisture percolating through it from moist clay laid over its surface. Labour difficulties and scarcity of water operate against the general introduction of improved systems of working cane-juice, but in many plantations central usines or sugar-factories have been established with great success. In these the canes of many growers are worked up with the aid of the *triple effect apparatus*, the vacuum pan, and the centrifugal separator employed by beet manufacturers. Wetzel's pan, Fryer's concreter, and similar devices for the efficient evaporation of juice by exposing it to the action of heat in thin films over an extended surface are also in use.

BEET SUGAR MANUFACTURE.—The sugar beet is a cultivated variety of *Beta maritima* (natural order *Chenopodiaceæ*), other varieties of which, under the name of mangold or mangel wurzel, are grown as feeding-roots for cattle. The plants are cultivated like turnips, and the roots attain their maturity in about five months after sowing, being gathered during September and October. The efforts of growers have been largely directed to the development of roots yielding juice rich in sugar; and especially in Germany these efforts have been stimulated by the circumstance that excise duty on inland sugar is there calculated on the roots. The duty is based on the assumption that from 12½ parts of beet 1 part of grain sugar is obtained; but in actual practice 1 part of raw sugar is now yielded by 9·27 parts of root. Moreover, when the sugar is exported a drawback is paid for that on which no duty was actually levied, and hence indirectly comes the so-called bounty on German sugar. In 1836 for 1 part of sugar 18 parts of beet were used, in 1850 13·8 parts, in 1860 12·7 parts, and now (1887) about 9·25 parts only are required. In France till recently the inland duty was calculated on the raw sugar; hence the French grower devoted himself to the production of roots of a large size yielding great weight per acre, and had no motive to aim at rich juice and economical production. Many processes, therefore, have come into use in German factories which are not available under the French methods of working. But since 1884 the French manufacturers have had the power to elect whether duty shall be levied on the roots they use or on the raw sugar they make, and a large proportion have already chosen the former. The nature of the seasons exercises much influence on the composition of sugar beet, especially on its richness in sugar, which may range from 10 to 20 per cent. The following represents the limits of average composition:—

Water		juice	84·5 to 79·0
Sugar and other soluble bodies	solids	juice	11·5 to 17·0
Cellulose and other solids	solids		4·0 4·0

The non-saccharine solids in the juice are very complex, embracing albumen, amido-acids, and other nitrogenous bodies, beetroot gum, soluble pectose compounds, fat, colouring matter, with the phosphates, sulphates, oxalates, and citrates of potash, soda, lime, and iron, and silica. The relation and relative proportion of these to the sugar present are of the utmost importance.

Extraction of juice.

Two distinct ways of obtaining the juice from beet are now principally employed,—pressure and diffusion. The mechanical methods of pressure are principally used in France; the process of diffusion is all but universal in Germany. Formerly a modified diffusion process—maceration—was in use; but it has now been generally abandoned, as has also a means of separating the juice by centrifugal action. For the mechanical processes the roots have first to be reduced to a condition of fine pulp. For this purpose the roots, thoroughly trimmed and washed, are fed into a pulping machine, in which a large drum or cylinder, armed with close-set rows of saw-toothed blades, is revolved with great rapidity, so that the fleshy roots on coming against them are rasped down to a fine uniform pulp. The operation is assisted by pouring small quantities of water or of watery juice on the revolving drum, which thins the pulp somewhat, and aids the free flow of the juice in the subsequent operation. The expression of the juice is effected either by the hydraulic press or by continuous roller presses. From the hydraulic press the juice flows freely at first; but in order to obtain the largest possible yield it is necessary to moisten the first press-cake and submit it to a second pressure, whereby a thin watery juice is expressed. After having been pressed twice, the cake that is left should amount to not more than 17 per cent. of the original roots; hence, allowing 4 per cent. for ligneous tissue, &c., only about 13 per cent. of water, sugar, and soluble salts, &c., remain in the refuse. For the system of continuous pressure presses analogous to the mills employed for cane-crushing are used. Many modifications of the roller press have been introduced, and, although the best express from 3 to 5 per cent. less juice than the hydraulic press, they have several advantages under the system formerly common in France, which bound the maker to return press-cake containing a certain proportion of sugar for use as a feeding-stuff on the farm. In certain forms of press the lower rollers are perforated to allow the escape of the expressed juice; in some the rollers are covered with india-rubber, so that they give an elastic squeeze on an extended surface; and in others the pulp is carried in an endless cloth through a series of rollers, being all the while subjected to gradually increasing pressure.

Method of pressure.

The diffusion process for obtaining beet juice depends on the action of dialysis, in which two liquids of different degrees of concentration separated by a membrane tend to transfuse through the membrane till equilibrium of solution is attained. In the beet the cell-walls are membranes enclosing a solution of sugar. Supposing these cells to be brought into contact with pure water, then by theory, if the cells contain 12 per cent. of juice, transfusion will go on till an equal weight of water contains 6 per cent. of sugar, while by the passage of water into the cell the juice there is reduced to the same density. Taking the 6 per cent. watery solution and with it treating fresh roots containing again 12 per cent., a 9 per cent. solution will be attained, which on being brought a third time in contact with fresh roots would be raised to a density of 10·5. Thus theoretically seven-eighths of the whole sugar would be obtained at the third operation, and it is on this theory that the diffusion process is based. In working the process a range of

ten or twelve diffusers are employed, eight being in operation while the others are being emptied, cleaned, and refilled. These diffusers consist of large close upright cylinders capable of holding each two or three tons of sliced roots. They are provided with manholes above, perforated false bottoms, and pipes communicating with each other, so that the fluid contents of any one can be forced by pressure into any other. In working, pure water from an elevated tank is run into No. 1 cylinder, which contains the slices almost exhausted of their soluble contents; it percolates the mass, and by pressure passes into No. 2, where it acts on slices somewhat richer in juice. So it goes through the series, acquiring density in its progress and meeting in each successive cylinder slices increasingly rich in juice. Before entering the last cylinder the watery juice is heated, and under the combined influence of heat and pressure the juice within the cylinder becomes richly charged with sugar. No. 1 cylinder when exhausted is disconnected; No. 2 then becomes No. 1, and a newly charged cylinder is joined on at the other extremity; and so the operation goes on continuously. The juice ultimately obtained is diluted with about 50 per cent. of water; but it is of a comparatively pure saccharine quality, with less gummy, nitrogenous, and fibrous impurities than accompany the juice yielded by mechanical means.

Purification of beet juice.

If the juice obtained by any process were a pure solution of sugar the manufacturing operations would be few and simple. But beet juice is at best a very mixed solution, containing much gum, acid bodies, nitrogenous matter, and various salts. These adhere to the saccharine solution with the utmost obstinacy; they attack the sugar itself and change crystalline into invert sugar, communicating to it a dirty brown colour and a disagreeable acrid taste and smell. To separate as far as possible the non-saccharine constituents and to remove the colour from the juice are troublesome tasks. The preliminary purification embraces two sets of operations,—first the treatment of the juice with lime and carbonic acid, secondly, filtration through animal charcoal. Under the old method of working the juice is first boiled in a copper pan with milk of lime to the extent of from ½ to 1 per cent. of lime to the weight of juice operated on. The boiling serves to coagulate the albuminoids, while the lime forms with certain of the other impurities an insoluble precipitate, and in part combines with the sugar to form a soluble saccharate of lime. The insoluble lime combination and the coagulum rise as a scum over the surface of the juice, and the latter, now comparatively clear, is drawn off by a siphon pipe, to be treated in another vessel with carbonic acid. The acid breaks up the saccharate of lime and forms insoluble carbonate of lime, which in precipitating carries down further impurities with it. After settlement the clear juice is drawn off and the precipitated slime pressed in a filter press, whereby it gives up the juice it contains. As now commonly conducted these operations—treating with lime and carbonic acid—are combined, according to the method devised by Jelinek. The juice to be purified is heated and treated with as much as 5 per cent. of lime, while carbonic acid is simultaneously injected into the mass. The juice meantime is raised to a temperature just under boiling-point. The addition of such a large amount of lime effects the precipitation of a great proportion of the non-saccharine constituents of the juice. The whole mass of turbid liquid formed by this treatment is forced into a filter press, and there the lime compounds and impurities are separated with great rapidity from the saccharine juice. Numerous other methods of purification have been proposed, and to some extent have met with favourable reception; but of these we can only mention that of Dubrunfaut and De Massy, in which baryta is substituted for lime, thereby producing an insoluble barium saccharate, and the analogous process of Scheibler, in which strontia is employed in the same sense, producing likewise insoluble strontia saccharate. The juice, which still contains much saline and other non-saccharine matter, is next filtered through animal charcoal; this largely removes colouring matter and carries away a further proportion of the salts. Charcoal filtering is an expensive process; being, moreover, a feature of the subsequent refining, many attempts have been made to dispense with it, and the success of the Jelinek method in producing a comparatively pure and colourless juice has given rise to hopes that it may at this stage be yet dispensed with.

The next operation consists in concentrating the comparatively pure but thin and watery juice,—a work formerly done in open pans by direct firing, but now carried out in closed vessels, in which the vacuum pan principle of boiling is brought into play. The apparatus consists of a series of three closed vessels, hence called a "triple effect," although in some cases a two-vessel apparatus or double effect is employed. These pans are provided internally with a series of closed pipes for steam-heating, the steam from the boiler of the first passing by a pipe into the worm of the second, and similarly the steam from the second into the worm of the third when a third pan is employed. The steam which rises in the third pan is drawn off by a condenser and vacuum pump, and, as the vacuum so created acts through the whole series, the juice is evaporated and concentrated at a comparatively low temperature by the agency of the steam supplied to the first pan. The juice increases in gravity as it is drawn from the one pan to the other, till by the time it is run off from the third cylinder it has attained a concentration representing a gravity of about 25 Baumé. This concentrated juice is while in a heated condition filtered through fresh charcoal, from which it comes ready for boiling down to crystallization. To bring the dense juice to the crystallizing point it is necessary to conduct the evaporation at the lowest possible temperature. High temperature increases the uncrystallizable at the expense of the crystallizable portion, and burns some proportion into caramel, which darkens the liquid and the resulting sugar crystals. Boiling down at low temperature is effected by the use of the vacuum pan, a closed globular vessel in which by the aid of a condenser and air-pump a vacuum is maintained over the boiling juice and the boiling-point is lowered in proportion to the decrease of air pressure. In vacuum pan boiling the thick juice may simply be concentrated to that degree of density from which, on cooling, the crystals will form, or the crystals may be allowed to separate from the mother-liquor in the pan while the boiling proceeds; these crystals, forming nuclei, increase in size from the concentration of fresh charges of juice added from time to time. By this method the boiled-down juice as it leaves the pan consists of a grainy mass of crystals floating in a fluid syrup. After being allowed to cool, the mass is fed into the drum or basket of a centrifugal machine, which by its rapid rotation separates the fluid molasses from the crystals, driving the liquid portion through the meshed wall of the basket. For further cleaning of the crystals from adherent syrup a small quantity of either water or pure syrup is added to the drum, and is likewise forced through the sugar crystals by centrifugal action. Steam also is employed for cleaning the crystals whilst in the centrifugal machine. The syrup from the first supply of sugar is returned to the vacuum pan, again boiled, and treated as above for a second supply of less pure sugar; similarly a third supply is yielded by the drainings of the second. The molasses from the third supply is a highly impure mixture of crystallizable and invert sugar, potash, and other salts, smelling and tasting powerfully of its beet origin. Many methods have been tried to recover the large amount of sugar contained in this molasses. That most extensively employed is the osmose process originated by Dubrunfaut, in which, by the application of a dialyser, it is found that the salts pass through the membrane more rapidly than does sugar. The elution process of Scheibler, which depends on the formation of a saccharate of lime, and the more recent strontia process of the same chemist, in which a strontiate of lime is formed, are also much employed. Another means of utilizing the molasses consists in fermenting and distilling from it an impure spirit for industrial purposes.

Separation of crystals from molasses.

Refining.

Sugar-Refining.—Sugar-refiners deal indifferently with raw cane and beetroot sugars which come into the market, and by precisely the same series of operations. The sugar is first melted in charges of 5 or 6 tons in *blow-ups*,—cast-iron tanks fitted with mechanical stirrers and steam-pipes for heating the water. The solution called *liquor* is brought to a certain degree of gravity, from 25 to 33 Baumé, and formerly it was the practice to treat it, especially when low qualities of sugar were operated on, with blood albumen. The hot liquor is next passed through twilled cotton bags encased in a meshing of hemp, through which the solution is mechanically strained. From 50 to 200 of these filters are suspended in close chambers, in which they are kept hot, from the bottom of a perforated iron tank, each perforation having under it a bag. These bags have from time to time to be taken off for cleaning out and washing. From the bag filter the liquor is passed for decolorizing through beds of animal charcoal enclosed in cisterns to a depth of from 30 to 50 feet, the sugar being received into tanks for concentration in the vacuum pan. In that apparatus it is "boiled to grain," and the treatment is varied according to the nature of the finished sugar to be made. To make loaves small crystals only are formed in the pan, and the granular magma is run into steam-jacketed open pans and raised to a temperature of about 180° to 190° Fahr., which liquefies the grains. The hot solution is then cast into conical moulds, the form of the loaf, in which the sugar as it cools crystallizes into a solid mass, still surrounded and mixed with a syrup containing coloured and other impurities. After thorough settling and crystallization, a plug at the bottom of the mould is opened and the syrup allowed to drain away. To whiten the loaves they are treated with successive doses of saturated syrup, ending with a syrup of pure colourless sugar. These doses are poured on the upper side of the cone, and, percolating down through the porous mass, carry with them the impure green syrup which still may adhere to the crystals. The liquor which obstinately remains in the interstices is driven out by suction or centrifugal action; the loaf is rounded off, papered, and placed in a stove for drying. The syrup which drains from the loaves is sold as golden syrup. When refined crystals are to be made the contents of the vacuum pan are passed into the centrifugal machine; the syrup is then driven off by rotation, and the crystals purified either by adding pure syrup to the revolving basket or by blowing steam through it.

There are numerous modified and subsidiary processes connected with refining, as well as with all branches of the sugar industry, regarding which it is not possible here to enter into detail. The industry is essentially progressive and subject to many changes.

SORGHUM SUGAR.—The stem of the Guinea corn or sorghum (*Sorghum saccharatum*) has long been known in China as a source of sugar, and the possibility of cultivating it as a rival to the sugar-cane and beetroot has attracted much attention in America. The sorghum is hardier than the sugar-cane; it comes to maturity in a season; and it retains its maximum sugar content a considerable time, giving opportunity for leisurely harvesting. The sugar is obtained by the same method as cane sugar. The cultivation of sorghum sugar has not found much favour in the United States; the total yield from that source in 1885 did not exceed 600,000 lb.

MAPLE SUGAR.—The sap of the rock or sugar maple, *Acer saccharinum*, a large tree growing in the United States and Canada, yields a local supply of sugar, which also occasionally finds its way into commerce. The sap is collected in spring, just before the foliage develops, and is procured by making a notch or boring a hole in the stem of the tree about 3 feet from the ground. A tree may yield 3 gallons of juice a day and continue flowing for six weeks; but on an average only about 4 lb of sugar are obtained from each tree, 4 to 6 gallons of sap giving 1 lb of sugar. The sap is purified and concentrated in a simple manner, the whole work being carried on by farmers, who themselves use much of the product for domestic and culinary purposes. The total production of the United States ranges from 30,000,000 to 50,000,000 lb, principally obtained in Vermont, New York, Ohio, and Pennsylvania. In Canada also a considerable quantity of maple sugar is collected for domestic use.

Palm sugar.

PALM SUGAR.—That which comes into the European market as *jaggery* or *khaur* is obtained from the sap of several palms, the wild date (*Phœnix sylvestris*), the Palmyra (*Borassus flabelliformis*), the cocoa-nut (*Cocos nucifera*), the gomuti (*Arenga saccharifera*), and others. The principal source is *Phœnix sylvestris*, which is cultivated in a portion of the Ganges valley to the north of Calcutta. The trees are ready to yield sap when five years old; at eight years they are mature, and continue to give an annual supply till they reach thirty years. The collection of the sap (toddy) begins about the end of October and continues, during the cool season, till the middle of February. The sap is drawn off from the upper growing portion of the stem, and altogether an average tree will run in a season 350 lb of toddy, from which about 35 lb of raw sugar—jaggery—is made by simple and rude processes. Jaggery production is entirely in native hands, and the greater part of the amount made is consumed locally: it only occasionally reaches the European market.

Starch sugar

STARCH SUGAR.—This, known in commerce as glucose or grape sugar, an abundant constituent of sweet fruits, &c. (see p. 623 above), is artificially elaborated on an extensive scale from starch. The industry is most largely developed in Germany, where potato starch is the raw material, and in the United States, Indian corn starch being there employed. The starch is acted on by a weak solution of sulphuric acid, whereby soluble starch is formed, which ultimately results in a mixture of glucose and dextrose in varying proportions, constituting the starch sugar of commerce. The operations embrace the boiling of the starch with water containing the requisite proportion of acid, the neutralization of the acid with lime, and the formation of a precipitate of sulphate of lime, which is separated by filtration in a filter press. The filtered liquid is, when necessary, deprived of colour by passing it through a bed of animal charcoal, and then it is concentrated to a density of from 40 to 45 Baumé in a vacuum pan. If the resulting syrup contains little dextrin it will on cooling slowly solidify into a granular concretionary mass; but if much dextrin is present it remains in the condition of a syrup. Starch sugar is very largely used by brewers and distillers, and by liqueur makers, confectioners, and others for making fruit and other syrups. Burnt to caramel, it is also employed to colour beverages and food substances. As an adulterant it is largely employed in the honey trade and for mixing with the more valuable cane sugar. In 1885 there were about fifty factories in Germany engaged in starch sugar making, in which 10,000 tons of hard sugar, 20,000 tons of syrup, and 1250 tons of "colour" were made.

Commerce.

At the present time, judging by the amount sent to the market, cane and beet sugars are produced in about equal amount; but, since vast quantities of cane sugar are grown and consumed in India, China, and other Eastern countries of which we get no account, there cannot be a doubt that the annual production of cane far exceeds that of beet sugar. Still, as a growth of not more than forty years, the dimensions to which the beet sugar trade has attained are certainly remarkable. But these dimensions would not have been so suddenly attained had it not been for the system of protection established in the producing countries and of bounties paid to the beet manufacturers on exporting their produce. The United Kingdom is the only open market for sugar, which is consequently sold there at an unprecedentedly low price. The following table shows the relative proportions of the beet and the cane sugar trade and the principal sources of the supply for 1880-85:—

	1880-81.	1881-82.	1882-83.	1883-84.	1884-85.
1. BEET SUGAR	Tons.	Tons.	Tons.	Tons.	Tons.
German empire	594,223	644,775	848,124	986,000	155,000
Austria-Hungary ..	498,082	411,015	473,002	446,000	558,000
France	333 614	393,269	423,194	474,000	308,000
Russia and Poland.	250,000	308,779	284,991	308,000	387,000
Belgium	68,626	73,136	82,720	107,000	88,000
Holland and other countries	30,000	30,000	35,000	40,000	50,000
Total....	1,774,545	1,860,974	2,147,031	2,361,000	2,546,000
2. CANE SUGAR.					
Cuba..............	484,000	500,300	485,000	560,900	627,800
Porto Rico	57,100	80,000	70,000	65,000	60,000
Trinidad	43,600	53,400	54,000	59,800	65,700
Barbados..........	45,000	53,000	52,000	56,000	60,700
Jamaica	17,000	27,000	25,000	20,000	18,000
Antigua & St Kitt's	16,800	23,000	16,000	23,000	20,000
Martinique	42,000	47,800	46,800	49,400	38,800
Guadeloupe	43,000	57,000	52,000	55,300	41,200
Demerara	92,300	124,200	117,000	126,000	96,000
Réunion	27,100	25,000	34,000	37,800	37,000
Mauritius..........	119,000	118,000	116,700	120,400	128,000
Java	210,500	273,000	283,600	311,400	380,000
British India	45,000	66,000	87,000	60,000	45,000
Brazils	344,600	304,400	218,000	359,000	269,000
Manila, Cebu, Iloilo	199,000	151,500	211,600	123,000	203,400
Louisiana	121,900	71,400	135,300	128,400	94,500
Peru	40,000	40,000	31,000	25,000	35,000
Egypt	32,000	29,000	21,000	30,000	40,000
Total....	1,979,900	2,044,000	2,056,000	2,210,400	2,260,100
Beet and Cane..	3,754,445	3,904,974	4,203,031	4,571,400	4,806,100

The relative values of beet and of a low quality of raw cane sugar for 1879-86 are shown in the following table:—

Average Price each Year.	1879.		1880.		1881.		1882.		1883.		1884.		1885.		1886.	
	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
Unclayed Manila (taal) on spot	14	8	15	3	15	0	13	11½	12	9	10	0	10	0½	9	10½
German beet; basis 88 per cent. f.o.b.	21	3	22	3	22	9	22	0	20	2	14	0	14	0½	13	1

Average Price of the Fourteen Years 1872 to 1885.		Price, August 1886.
Unclayed Manila (taal)	14s. 11½d. per cwt.	8s. 3d. per cwt.
German beet; basis 88 per cent. f.o.b.	21s. 6¾d. ,,	11s. ,,

(J. PA.)

SUGAR-BIRD, the English name commonly given in the West India Islands to the various members of the genus *Certhiola* (generally regarded as belonging to the Family *Cœrebidæ*[1]) from their habit of frequenting the curing-houses where sugar is kept, apparently attracted thither by the swarms of flies. These little birds on account of their pretty plumage and their familiarity are usually favourites. They often come into dwelling-houses, where they preserve great coolness, hopping gravely from one piece of furniture to another and carefully exploring the surrounding objects with intent to find a spider or insect. In their figure and motions they remind a northern naturalist of a Nuthatch, while their coloration—black, yellow, olive, grey, and white—recalls to him a Titmouse. They generally keep in pairs and build a domed but untidy nest, laying therein three eggs, white blotched with rusty-red. Apart from all this the genus presents some points of great interest. Mr Sclater (*Cat. B. Br. Museum*, xi. pp. 36-47) recognizes 18 "species," therein following Mr Ridgway (*Proc. U.S. Nat. Museum*, 1885, pp. 25-30), of which 3 are continental with a joint range extending from southern Mexico to Peru, Bolivia, and south-eastern Brazil, while the remaining 15 are peculiar to certain of

[1] Known in French as *Guit-guits*, a name used for them also by some English writers. The *Guitguit* of Hernandez (*Rer. Medic. N. Hisp. Thesaurus*, p. 56), a name said by him to be of native origin, can hardly be determined, though thought by Montbeillard (*Hist. Nat. Oiseaux*, v. p. 529) to be what is now known as *Cœreba cærulea*, but that of later writers is *C. cyanea*. The name is probably onomatopoetic, and very likely analogous to the "Quit" applied in Jamaica to several small birds.

the Antilles, and several of them to one island only. Thus *C. caboti* is limited, so far as is known, to Cozumel (off Yucatan),[1] *C. tricolor* to Old Providence, *C. flaveola* (the type of the genus) to Jamaica, and so on, while islands that are in sight of one another are often inhabited by different "species." Further research is required; but even now the genus furnishes an excellent example of the effects of isolation in breaking up an original form, while there is comparatively little differentiation among the individuals which inhabit a large and continuous area. The non-appearance of this genus in Cuba is very remarkable. (A. N.)

SUGDEN, EDWARD BURTENSHAW. See ST LEONARDS, LORD.

SUHL, a manufacturing town in an isolated portion of Prussian Saxony, is picturesquely situated on the Lauter, on the southern slope of the Thuringian Forest, 6½ miles to the north-east of Meiningen and 29 miles to the south-west of Erfurt. The armourers of Suhl are mentioned as early as the 9th century, but they enjoyed their highest vogue from 1550 to 1634. The knights of south Germany especially prized the swords and armour of this town, and many of the weapons used in the mediæval campaigns against the Turks and in the Seven Years' War are said to have been manufactured at Suhl. Its old popular name of the "armoury of Germany" is more appropriate, however, to its past than to its present position, for, already seriously crippled by the ravages of the Thirty Years' War and by frequent conflagrations, it has suffered considerably in more modern times from the competition of other towns, especially since the introduction of the needle-gun. It still contains, however, large factories for firearms (military and sporting) and side arms, besides iron-works, machine-works, potteries, and tanneries. The once considerable manufacture of fustian has declined. A brine spring (Soolquelle) at the foot of the neighbouring Domberg is said to have given name to the town. The population in 1880 was 9937 and 10,605 in 1885. Suhl, made a town in 1527, belonged to the early principality of Henneberg, and formed part of the possessions of the kingdom of Saxony assigned to Prussia by the congress of Vienna

SUICIDE. The phenomenon of suicide has at all times attracted a large amount of attention from moralists and social investigators. Though of very small dimensions, even in the countries where it is most prevalent, its existence is rightly looked upon as a sign of the presence of maladies in the body politic which, whether remediable or not, deserve careful examination. To those who look at human affairs from a theological standpoint, suicide necessarily assumes a graver aspect, being regarded, not as a minute and rather obscure disease of the social organism, but as an appalling sign of the tendency of man to resist the will of God. Compare FELO DE SE. As a great number of persons are, either directly or indirectly, under the influence of the theological bias, and as the act of suicide is in itself of a striking character to the imagination, the importance of the phenomenon from a sociological point of view has been to some extent exaggerated, especially in those countries of the Continent where suicides are most numerous. Moreover, the matter has during the last twenty years become of direct interest to the Governments of those countries where the whole able-bodied male population are more or less under the control of a military organization; for, rightly or wrongly, a portion of the recent considerable increase in the suicide rate of Prussia, Saxony, Austria, and France is attributed to dislike of military service. It may be observed in passing that the suicide rate among soldiers is high in all countries, Great Britain not excepted, as was shown by Mr W. H. Millar in the *Journal of the Statistical Society*, vol. xxxvii., 1874, and more recently by Dr Ogle in the same *Journal*, vol. xlix. (March), 1886. As enlistment is voluntary in the United Kingdom, the alleged dislike to conscription cannot be the sole cause of the high rate prevailing in some of the Continental states. Before referring to the more general characteristics of suicide, it will be well to furnish some idea of its magnitude in relation to the category of social phenomena to which it belongs, namely, death. The following tables are constructed for this purpose. The first (I.) gives the absolute number of cases of suicide as officially stated in a number of countries for a series of

[1] In the article BIRDS (iii. p. 749) attention was drawn to what was then believed to be a fact—namely, that the form found in this island was identical with that which inhabits the Bahamas; but now the two forms are regarded as distinct.

I. *Statement of the Number of Cases of Suicide in the Principal Countries of Europe during the undermentioned Periods and Years.*

Periods.	Sweden.	Norway.	Denmark.	England and Wales.	Prussia.	Belgium.	France.	Baden.	Wurtemberg.	Bavaria.	Saxony.	Austria (proper).	Italy.
1836-40	214	113	272	967	1471	183	2574	..	..	..	264	523	..
1841-45	212	138	306	..	1642	[1]235	2951	[1]89	..	247	340	595	..
1846-50	229	150	341	..	1696	[1]263	3446	..	185	218	373	[1]774	..
1851-55	253	154	402	1025	2075	166	3639	150	196	275	496	666	..
1856-60	211	145	446	1310	2152	213	4002	170	144	332	509	[1]799	..
1861-65	301	141	[1]431	1343	2247	221	[1]4700	189	[1]175	[1]384	601	1051	[1]718
1866	309	121	443	1329	2485	215	5119	189	244	410	704	1265	588
1867	371	131	469	1316	3625	365	5011	198	270	471	752	1407	753
1868	366	130	498	1508	3658	376	5547	212	283	441	800	1566	784
1869	356	131	462	1588	3544	257	5114	221	251	430	710	1375	633
1870	369	148	486	1554	3270	338	4157	195	247	459	657	1510	788
1866-70	354	133	472	1459	3316	310	4989	203	259	442	725	..	739
1871	321	128	505	1495	3135	367	4490	244	238	419	653	2040	836
1872	309	132	464	1514	3457	356	5275	219	258	405	687	2194	890
1873	337	126	439	1518	3345	377	5525	216	304	447	723	2463	975
1874	394	99	439	1592	3490	374	5617	244	282	450	723	2617	1015
1875	376	144	394	1601	3432	836	5472	226	334	459	745	2741	922
1871-75	347	126	448	1544	3368	362	5256	231	294	436	706	2411	923
1876	409	142	507	1770	4448	439	5804	269	343	522	981	3376	1024
1877	430	130	530	1699	4568	470	5878	291	324	650	1114	3598	1139
1878	411	132	544	1764	4992	490	6434	317	425	674	1126	3486	1158
1879	438	141	505	2035	4881	553	6496	309	380	750	1121	3469	1225
1880	384	124	496	1979	5034	591	6638	338	371	682	1171	3649	1261
1876-80	414	134	516	1849	4784	509	6250	305	369	656	1103	3516	1161
1881	384	123	495	1955	5159	550	6741	306	348	695	1248	3504	1313
1882	482	136	505	1965	5312	595	7213	283	..	724	1128	3530	1389
1883	470	134	513	1962	5337	599	7267	341	..	..	1205	3595	1456
1884	431	..	..	2043	5013	..	..	..	..	..	..	3783	..
1881-84	442	..	..	1981	5205	..	..	..	..	..	..	3603	..

II. *Statement of the Estimated Population of the undermentioned Countries in the Years 1868, 1876, and 1882; the Number of Deaths from Suicide and other Causes in the same Years in the same Countries; and the Proportions borne by the Deaths to the Population in each case.*[2]

—1868.

Countries.	Estimated Population in the Middle of the Year.	Deaths.			Number of Deaths per 1,000,000 Inhabitants.		
		Suicide.	Other Causes.	Total.	Suicide.	Other Causes.	Total.
Austria	20,026,554	1986	569,566	571,552	99	28,401	28,500
Baden	1,453,939[3]	212	39,677	39,889	146	27,284	27,430
Bavaria	4,750,000[4]	441	158,559	159,000[5]	93	33,377	33,470
Belgium	4,961,644	376	107,180	107,556	75	21,625	21,700
Denmark	1,748,000	498	33,318	33,816	285	19,015	19,300
France	38,329,617	5547	916,491	922,038	145	23,955	24,100
Italy	25,434,376	784	776,440	777,224	31	30,569	30,600
Prussia	24,069,379	3658	655,070	658,728	152	27,248	27,400
Saxony	2,453,555	800	71,918	72,718	325	29,315	29,640
Sweden	4,173,080	366	87,441	87,807	88	20,912	21,000
United Kingdom—							
England and Wales	21,948,713	1508	479,114	480,622	69	21,731	21,800
Ireland	5,465,914	87	86,098	86,185	16	15,784	15,800
Scotland..........	3,275,350	123	69,293	69,416	37	21,163	21,200
	158,090,121	16,386	4,050,165	4,066,551	104	25,636	25,740

[1] Uncertain data. [2] Still-births are excluded.
[3] Adding natural increase of 1868 to population of 1867 (Kolb).
[4] Estimate, deducting natural increase of 1869-1870 from figure in census of 1871. [5] 159,186 including still-births.