INDIGO, or ANIL, *Botany*. See INDIGOFERA.

From this plant is extracted a dyer's drug, of a deep blue colour, brought hither from the Weſt Indies and America. It is alſo made in the Eaſt Indies, particularly in the dominions of the Great Mogul, the kingdom of Golconda, &c.

The ancients were acquainted with the dye, which we call indigo, under the name of "Indicum." Pliny knew that it was a preparation of a vegetable ſubſtance, though he was not juſtly informed concerning the plant itſelf, and the proceſs by which it was fitted for uſe. From its colour, and the country from which it was imported, it is denominated by ſome authors "Atramentum Indicum" and "Indicum nigrum." Even at the cloſe of the 16th century it was not known in England what plant produced indigo. Gerarde, in 1597, is wholly ſilent about it, and ſo is Johnſon in 1632. Parkinſon, however, in 1640, treats largely of it. He calls it "Indico or Indian woade," and gives a figure of the leaf from De Laet. He then deſcribes it, firſt from Francis Ximenes in De Laet's deſcription of America; and ſecondly, from Mr. William Finch, a London merchant, in Purchas's Pilgrims. Even in 1688 Mr. Ray ſays it was not agreed among botaniſts what plant it is from which indigo is made; but that the moſt probable opinion was, that it is a leguminoſe ſhrub, allied to Colutea. He deſcribes it from Hernandez and Margraaf; and ſubjoins that of the "Ameri" from the Hortus Malabaricus. *Nil* or *Anil* is the American name. In Arabic it is *Nile*. The Portugueſe have adopted their *Anil* or *Anileira* from the American. The other European nations generally call it *Indigo*. In Chineſe it is *Tien laam*, which ſignifies ſky-blue. Mr. Miller cultivated the dyer's indigo ſo long ago as the year 1731; and calls it Guatimala indigo, ſaying that with us it is an annual plant. Specimens of the *Indigofera tinctoria*, or dyer's indigo, from different parts of India, Madagaſcar, Java, Ceylon, &c. vary very much, if they are all really the ſame ſpecies. Linnæus ſays that it is almoſt an exotic in Ceylon, but frequent in Paliacotta and Coromandel. According to Loureiro it is ſpontaneous in China and Cochinchina, and is cultivated all over thoſe vaſt empires. Dr. Patrick Browne, beſides the wild indigo already mentioned, has two others, which he calls the indigo, and the Guatimala indigo; the former yielding more of the dye than either of the others, is generally preferred, though ſubject to many more miſchances.

It has been generally believed, that the indigo plant flouriſhes only in the climate of the torrid zone, and in thoſe parts of the temperate zone which are near the tropics. But experiments lately made in Italy by Bruley, by order of government,

government, have proved that, in a ſuitable ſoil and expoſure, and with good ſeed, it may be cultivated in a ſoutherly climate. Accordingly, he has obtained the indigo plant in the gardens of the Chateau de la Venerie, near Turin; and by ſubmitting it to the proceſs employed at St. Domingo, he has extracted an indigo which might bear compariſon with the fineſt indigo of the colonies. His plantations were made towards the end of February. M. Icard de Bataligni, another coloniſt, cultivated the plant in 1805, in the department of Vaucluſe, in France; and his reſults confirm the hopes formed with reſpect to the culture of indigo in Europe.

Labat has given a particular account of the culture of the plant, and the preparation of the indigo. The ground being thoroughly cleared from weeds (one of the principal points in the culture), and, we may add, drained, a number of ſlaves, ranged in a line, march acroſs, making little trenches of the width of their hoes, and two or three inches deep, about a foot diſtance from one another every way: then, returning, they drop ſome ſeeds in each trench, and afterwards cover them with the earth taken out. The ſoil, it is obſerved by others, ſhould be free and rich, and the climate warm: and the ſeaſon of ſowing ſhould be rainy; as the earth muſt either already have imbibed water, or rain muſt ſpeedily follow the ſowing; otherwiſe the ſeed becomes heated, corrupts, and is loſt, after all the labour it has occaſioned. During the proceſs of vegetation the ground muſt be carefully weeded, in order to prevent any mixture of herbs, which would injure the indigo in its manufacture. In moiſt weather, the plant comes up in three or four days; and in about two or three months after, it is fit for cutting: if ſuffered to ſtand till it runs into flower, the leaves become too dry and hard, and the indigo obtained from them proves leſs in quantity, and leſs beautiful: the due point of maturity is known, by the leaves beginning to grow leſs ſupple, or more brittle. In rainy ſeaſons, the cutting may be repeated every ſix weeks: cutting in dry weather kills the plant, which, if that is avoided, continues to afford freſh crops for two years.

A large quantity of the herb is put into a vat or ciſtern of ſtrong maſon work, with ſo much water as is ſufficient to cover it; and ſome wood laid above to prevent its riſing up. The matter begins to ferment, ſooner or later, according to the warmth of the weather, and the maturity of the plant, ſometimes in ſix or eight hours, and ſometimes not in leſs than twenty. The liquor grows hot, throws up a plentiful froth, thickens by degrees, and acquires a blue colour, inclining to violet. In proportion as the caloric increaſes, azote is diſengaged, the herbaceous mucilage ſeparates, the vegetable is diſcompoſed, and the mixture abſorbs oxygen. The fermenting fluid paſſes from a green to a violet tinge, and this by degrees changes to a blue colour. The great art of the manufacturer is to check the fermentation at a proper degree. If the fermentation is too feeble or too brief, the plant remains impregnated with much eſſential ſalt, which diminiſhes the quantity of indigo. If it be too long, the tender extremities of the plant undergo a putrefaction which deſtroys the colour. Some years ago, the following criterion was publiſhed at St. Domingo, for aſcertaining invariably the correct fermentation of the indigo. It is only requiſite to write on white paper with the matter to be examined. If this ink be of very high colour, it is a proof that the fermentation is not yet at its true point. The experiment is repeated every quarter of an hour, till it is perceived that the liquid has loſt its colour. This was pronounced an infallible index to ſhew the true point of fermentation. Others, however, judge of the proper ſtage of fermentation by means of a ſilver cup, into which they throw the liquid, ſhaking it till grains are formed; by their quality, and that of the fluid, they judge of the fermentation. When the feculent particles begin to precipitate to the bottom of the cup, it is then judged, that the herbs have attained the true degree of maceration for obtaining indigo. It has been obſerved, however, that this procedure often led into error; and, therefore, five or ſix minutes after the liquid has been put into the cup, it was perceived to form round its ſides a cordon of feculæ, or ſediment, at firſt of a green colour, and then blue. When the maceration is not at the requiſite point, this cordon, or girdle, detaches itſelf with difficulty from the ſides of the cup, but finally precipitates, and concentres at the bottom, always towards the centre, and the water above it becomes limpid, though of a yellowiſh tinge. When theſe ſigns are perceived, they indicate infallibly the ſucceſs of the firſt operation. At this time, without touching the herb, the liquor impregnated with its tincture is let out, by cocks in the bottom, into another vat placed for that purpoſe, ſo as to be commanded by the firſt. The firſt vat is called the "ſteeper;" the ſecond and third are called the "beaters."

In the ſecond vat, the liquor is ſtrongly and inceſſantly beat and agitated, with a kind of buckets fixed to poles, till the colouring matter is united into a body. A good deal of nicety is requiſite in hitting this point; if the beating is ceaſed too ſoon, a part of the tinging matter remains diſſolved in the liquor; if continued a little too long, a part of that which had ſeparated is diſſolved afreſh. The exact time for diſcontinuing the proceſs is determined by taking up ſome of the liquor occaſionally in a little cup, and obſerving whether the blue fecula is diſpoſed to ſeparate and ſubſide.

The facility with which the grain precipitates to the bottom of the beater, is an unequivocal ſign that the beating has arrived at the correct point.

The whole being now ſuffered to reſt till the blue matter has ſettled, the clear water is let off, by cocks in the ſides at different heights; and the blue part diſcharged by a cock in the bottom, into another vat. Here it is ſuffered to ſettle for ſome time longer, then farther drained in cloth-bags, or ſacks, and expoſed in ſhallow wooden boxes to the air, without expoſing it to the ſun, and carefully keeping it from the rain, till thoroughly dry.

Before it is perfectly dry, it is cut in ſmall pieces of an inch ſquare, which detach themſelves readily from the box, when the indigo is entirely dry. Yet, however well drained and dried the indigo may be, it always experiences, in the firſt months of its fabrication, a diminution ſufficiently evident to warrant a haſtening of the ſale. It is cuſtomary to pack the indigo in barrels, and thus to circulate it in commerce. Indigo is packed in ſacks of coarſe linen, and the ſack is covered with an ox's hide, ſo hermetically ſewed, that nothing can penetrate it. Theſe packets are called "ceroons." They are much preferable to barrels, as they are more ſolid and more convenient for tranſportation. Two "ceroons" make the load of one animal.

The author above-mentioned, from whom the greateſt part of the foregoing account is extracted, obſerves farther, that the goodneſs of the indigo depends greatly upon the age of the plant; that before it has grown fully ripe, the quantity it yields is leſs, but the colour proportionably more beautiful; that probably the ſecret of thoſe whoſe indigo has been moſt eſteemed, is no other than cutting the herb at the time when it yields the fineſt colour; that the ſuperiority of

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ſome of the indigoes of the Eaſt Indies to thoſe of America, is perhaps owing to the former being prepared more curiouſly from only the leaves of the plant; and that by beating the herb in the ſteeping-vat, which has been practiſed by ſome with a view to increaſe the quantity, great part of the ſubſtance of the leaves and bark is blended with the water along with the colouring matter, and the indigo extremely debaſed.

It is ſaid that lime, or lime-water, is ſometimes employed in the beating-vat, to promote the ſeparation of the tinging particles from the water; and that the hardneſs or flintineſs of ſome ſorts of indigo is owing to an over proportion of this addition.

Pomet ſays, that the Indians of the village of Sarqueſſe, near Amadabat, uſe only the leaves of the indigo, and throw away the plant and branches; and from thence the moſt eſteemed indigo is brought.

Indigo is commonly divided, from the colour which it exhibits upon breaking, into three kinds, copper-coloured, purple, and blue. It is ſaid that the dyers uſe chiefly the firſt; and the calico-printers (for this drug gives a durable ſtain to linen as well as woollen) the laſt. On what particular circumſtances theſe different appearances depend, we know not; nor is it certainly known whether the real quality of the indigo has any connection with them. The deepeſt and livelieſt blue indigo, rubbed with the nail, appears like poliſhed copper; and ſolutions of all the ſorts, made in alkaline lixivia, aſſume alike a copper-coloured ſkin upon the ſurface.

Good indigo is moderately light, breaks of a ſhining ſurface, and burns almoſt wholly away upon a red-hot iron. It is quickly penetrated by water, and reduced into a kind of paſte; a conſiderable part is at the ſame time diffuſed through the liquor, and very ſlowly ſubſides. This is probably what Labat and Hellot mean by its diſſolving in water; for no part of the indigo really diſſolves; it cannot indeed be expected that it ſhould, from the proceſs by which it is obtained.

Indigo requires an equal quantity or more of fixed alkaline ſalt, to render it totally ſoluble in water. On digeſting the indigo, with a gentle heat, in the ſolution of the alkaline ſalt, a ſhining copper-coloured ſkin begins to appear, and gradually covers the whole ſurface: on agitating the matter, a large blue flower or froth ariſes, and the liquor underneath appears of a deep green. If woollen cloth, without any other preparation than moiſtening it with warm water, be dipped in this hot liquor, it comes out perfectly green, and changes almoſt inſtantly in the air to a fine blue. This is the common proceſs of dyeing blue.

Mr. Hellot deſcribes two indigo vats with urine; one of which is uſed hot, like the foregoing, and the other cold. The hot vat conſiſts of equal parts of indigo, alum, and tartar, digeſted in urine till the liquor becomes green. The cold one is prepared, by digeſting powdered indigo with vinegar for twenty-four hours, in the proportion of four pounds to about three quarts; then mixing the matter with about fifty gallons of urine, and ſtirring the whole together every night and morning, till the liquor turns green, and gathers a head like the common vat.

Indigo is fitted for printing on linen, by diluting it with water into the conſiſtence of a ſyrup; then adding ſome powdered pearl-aſhes, green vitriol, and lime newly ſlaked; with ſo much water, occaſionally, as will reduce them into the conſiſtence of thin paint; mixing the whole thoroughly together, and ſtirring the matter every now and then, till it gains a copper colour on the ſurface. The proportions uſed by the workmen are, two parts of indigo, one of pearl-aſhes, three of vitriol, and two of lime. The ſame compoſition, diluted with a ſufficient quantity of water (about ſix gallons to a pound of indigo), and boiled, gives a durable blue to tanned ſkins, whether dipped in hot or cold.

Indigo digeſted in a moderate heat with different volatile alkaline ſpirits, gave only yelloviſh and browniſh red tinctures; with rectified ſpirit of wine, a reddiſh one; to lime-water, and to water acidulated with the vitriolic, nitrous, and marine acids, it gave no tincture at all.

The concentrated vitriolic acid unites with it into a ſmooth paſte, eſpecially if the indigo is previouſly well ground with powdered glaſs, ſand, or other like ſubſtances. The indigo is thus rendered ſoluble in boiling water along with the acid, ſo as to paſs through the pores of a filter; the ſolution, whilſt hot, appears of a deep bright green colour, like that made by fixed alkalies, but fades as it grows cold, and changes at laſt to a browniſh. Theſe experiments, which were many times repeated with the ſame event, ſeem to overturn Mr. Hellot's ingenious theory, which deduces the green colour of ſolutions of indigo from the common property of blue juices being turned green by alkalies; and the blue colour which the cloth acquires ſoon after it is taken out of the vat, from a ſeparation of the alkali. We here find, that a green ſolution of this concrete is obtainable by the ſtrongeſt of the acids, and that with volatile alkalies it diſcovers no tendency to greenneſs.

For the method of preparing SAXON *blue* and SAXON *green* from indigo, ſee thoſe articles.

Indigo is ſometimes uſed among the painters for paper-hangings, and ſuch groſs uſes, who grind and mix it with white to make a blue colour; for without that mixture it would paint blackiſh.

They alſo mix it with yellow to make a green colour. It is alſo uſed in dyeing, and by the laundreſſes, to give a blueiſh caſt to their linen.

In the Hortus Indus Malabaricus is an account of the plant whence indigo is drawn; the decoction of whoſe root is ſaid to be excellent againſt nephritic colics; its leaves, applied to the abdomen, good to promote urine; and the indigo itſelf is ſaid to be of good uſe in drying of tumours.

Some phyſicians have recommended indigo in the quantity of a drachm, while others look upon it as a poiſon; and in Saxony the internal uſe of it is prohibited.

INDIGO, *Baſtard*. See AMORPHA.

INDIGO *Mills*. For the purpoſe of effecting the ſolution and union of indigo with the liquid uſed along with it, for the purpoſes of dyeing, mills of various conſtructions are in uſe. In this proceſs trituration or friction is as much as poſſible avoided, and the pulverization is effected merely by bruiſing. For this two very ſufficient reaſons may be aſſigned; the firſt, in point of economy, and the ſecond, to avoid chemical inconveniency. On whatever ſubſtance the indigo was triturated or rubbed, a certain proportion of the ſtuff would be mixed or incorporated along with the pulverized indigo, and that proportion of indigo which was abſorbed by this ſtuff would be either totally loſt, or brought into union with another ſubſtance which might prove uſeleſs, and probably injurious in the ſubſequent proceſs of dyeing. If the former only was the caſe, the abſorbed indigo would be totally loſt; if the ſecond took place, the whole proceſs might be utterly ſpoiled by the combination. In the appropriate plate, *fig.* 1. repreſents the ground or horizontal plan of ſuch an indigo mill as is generally uſed in ſmall dye-works, and which is occaſionally turned by a man's or boy's hand. This is tedious and laborious, for the operation muſt be continued for a very long time before the indigo is ſufficiently mixed with the liquid to be fit for uſe, and only a

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ſmall quantity can be put into the veſſel at once. *Fig.* 2. is an elevated ſection of the ſame mill.

In this machine the pulverization or granulation of the indigo is effected by the preſſure of a number of ſmooth caſt-iron balls, like thoſe uſed for the ſhot of great guns, which, being rolled among the indigo, preſs it into a paſte by their weight, until it unites with the liquid by which it is to be held in ſolution.

In *fig.* 1, A repreſents the bottom and rim of the veſſel which contains the indigo, and which is of a cylindrical form. B is an upright ſpindle, which, in this figure, does not appear. Upon the ſpindle B is fixed a wheel C C, with a convenient number of arms projecting round the veſſel, like the radii of a circle; and below each of theſe arms are projecting pieces of iron, like the pins or teeth of a harrow, for moving the balls. When this wheel C is moved round its axis, the whole balls in the veſſel A are ſet in motion, and, by rolling over the indigo, gradually preſs it, until it unites with the water or liquid with which it is ſurrounded. If the bottom of the cylinder be flat, a very ſmall part of the ſurface of each ball can act upon the indigo; but by caſting circular hollow grooves, as repreſented in *fig.* 2, nearly the ſemi-diameter of the ball will preſs upon the ſtuff. The mill is moved by a handle D, *fig.* 2, which ſets in motion the ſmall bevel wheel E, and this wheel acting upon the horizontal wheel F, fixed upon the ſpindle B, ſets it alſo in motion, and conſequently the wheel C C is moved round its axis, and all the balls roll round upon the indigo. G is a croſs ſhaft upon the top of the ſpindle B, loaded at each end with a heavy ball. There is generally another ſhaft placed at right angles to this, when they aſſiſt in regulating and equalizing the motion in the ſame manner as any other fly wheel. When the indigo is found to be ſufficiently diſſolved, and united with the water, the liquid thus formed is drawn off into any other veſſel for uſe by means of a vent and ſpiggot placed in any convenient part of the bottom of the veſſel.

The great labour and time which it requires, and the ſmall quantity of ſtuff which can be prepared at once by a machine of this kind, renders it ill adapted for the uſe of large works where much indigo is conſumed, and where they have generally a horſe-power water-wheel, or ſteam-engine, for raiſing water, cutting madder, and other purpoſes neceſſary in extenſive works. *Fig.* 3. repreſents an elevated croſs ſection of one of theſe machines, driven by any moving power, and capable of preparing a very great quantity of indigo at all times, as it requires no attendance, excepting to empty the veſſel when the indigo is wanted, and add a freſh ſupply. H is a ſemi-circular veſſel of caſt-iron, placed upon a ſtrong wooden frame O, and of any convenient length. I is a cover made in two pieces, with a circular aperture to admit the upright ſhaft K working upon the centre, or pivot P. At Q, the upright P is jointed to a horizontal ſhaft of wood M, the other end of which is connected by the joint R, with a crank fixed on the end of a horizontal ſhaft N driven by the moving power. The circular motion of the ſhaft and crank N communicates an alternate, or reciprocating motion, by means of the horizontal connecting ſhaft M, to the upper end of the upright ſhaft K, which vibrating upon the centre joint P, ſets in motion the iron cylinders L, L, in the body of the veſſel, which preſs upon the indigo, and produce the ſame effect, but to a much greater extent, as the balls in the machine firſt deſcribed. The cylinders L, L, may be made of any diameter or length which is found convenient. The greater maſs of iron that they contain, the quicker and more effectual will be their operation upon the ſtuff, provided there is a ſufficient power to drive them. The frame under the joint P extends the whole length of the ſemi-circular veſſel H, which may be any length, according to the extent of the power and quantity of work required. As this machine requires no attention whatever, it is found very uſeful in large dye works, as, by means of it, they can conſtantly command a large ſupply of prepared indigo, which may be drawn off when wanted, for the longer it is under the preparing proceſs, the better in every reſpect, and freſh indigo may be added as the ſupply gets low.

INDIGOFERA, in *Botany*, yields the blue dye called Indigo or Indicum, ſo eminently uſeful in dyeing various manufactures of a blue colour. This ſubſtance obtained the name of indigo from its native country, India.—Linn. Gen. 383. Schreb. 506. Willd. Sp. Pl. v. 3. 1220. Mart. Mill. Dict. v. 2. Ait. Hort. Kew. v. 3. 67. Juſſ. 359. Lamarck Dict. v. 3. 244. Illuſtr. t. 626. Gærtn. t. 148. Claſs and order, *Diadelphia Decandria*. Nat. Ord. *Papilionaceæ*, Linn. *Leguminoſæ*, Juſſ.

Gen. Ch. *Cal.* Perianth of one leaf, ſpreading, almoſt flat, five-toothed. *Cor.* papilionaceous; ſtandard rounded, reflexed, emarginate, ſpreading; wings oblong, obtuſe, ſpreading at the lower margin, of the ſhape of the ſtandard; keel obtuſe, ſpreading, deflexed, marked on each ſide by an hollow awl-ſhaped point. *Stam.* Filaments in two bundles, diſpoſed into a cylinder, aſcending at their tips; anthers ſomewhat roundiſh. *Piſt.* Germen cylindrical; ſtyle ſhort, aſcending; ſtigma obtuſe. *Peric.* Pod roundiſh, long. *Seeds* numerous, kidney-ſhaped.

Eſſ. Ch. Calyx ſpreading. Keel of the corolla having an awl-ſhaped ſpur on each ſide! Pod linear.

Obſ. Till within the laſt century it was but imperfectly made out what plants produced the dye known to the Romans by the name of *Indicum*. Mr. Miller, however, cultivated the *Indigofera* ſo early as 1731; but he was acquainted with only five ſpecies of it; which ſame number Linnæus imperfectly deſcribed. Profeſſor Martyn enumerates thirty-five ſpecies, and Willdenow fifty-one; but ſince this genus is particularly known and eſteemed for its utility in the arts, and that moſt of its ſpecies yield the blue dye, as well as many other plants of the ſame natural family, we ſhall merely give a general outline of the genus, without entering into a long ſyſtematic arrangement of the ſpecies.

The genus *Indigofera* is compoſed of ſhrubs and herbs, whoſe leaves are, in certain caſes, ſimple, more generally ternate, but moſt frequently unequally pinnate. The leaflets in ſome ſpecies are jointed and awned at the baſe. Stipulas diſtinct from the leaf-ſtalk. Peduncles axillary, generally many-flowered, in ſpikes or bunches. Many ſpecies are natives of the Cape of Good Hope; for inſtance, I. *filifolia*, *fericea*, *depreſſa*, *ovata*, *pſoraloides*, *candicans*, *amæna*, *incana*, *procumbens*, *ſarmentoſa*, *denudata*, *erecta*, *coriacea*, *filiformis*, *digitata*, *fruteſcens*, *ſtricta*, *anguſtifolia*, and *capillaris*.—The reſt are either from the Eaſt or Weſt Indies, Arabia Felix, New Holland, and the coaſt of Guinea.

It is ſaid that Pliny was aware that *Indicum* was a preparation from a vegetable ſubſtance, though he was ill-informed both concerning the plant itſelf, and the proceſs by which it is made fit for uſe. The following is a curious anecdote to ſhew that at the cloſe of the 16th century it was unknown in England what plant produced Indigo, for in a book entitled "Remembrances for Maſter S. by Richard Hakluyt," written in 1582, Maſter S. is inſtructed "to know if Anile that coloureth blew, be a natural commodity of Turkey, and if it be compounded of an herbe—to ſend the ſeed or root with the order of ſowing, &c.—that it may become a natural commodity

commodity in the Realm, as woad is (*Isatis tinctoria*), that the high price of foreign woad may be brought down."

I. *tinctoria*, Dyer's Indigo, is a native of the Eaſt and Weſt Indies, Madagaſcar, Ceylon, Java, &c. Its ſtem is ſuffruticoſe. Leaves pinnate, ovate. Bunches of flowers ſhort. —Loureiro ſays it is cultivated all over the vaſt empires of China and Cochin-china. It is figured under the name of Ameri in the *Hortus Malabaricus*, v. 1. 101. t. 54.